Information for Contributors

General Information: Interested contributors should submit manuscripts electronically. Microsoft Word is the preferred format; if another word processor is used, files should be saved in rich text format (RTF) with an accompanying PDF version. Main articles generally are of 2,000 to 6,000 words. **Editing Guidelines:** Please use Times New Roman fonts with font size 12. Manuscripts should be formatted and prepared using *The Chicago Manual of Style,* 15th edition, published by the University of Chicago Press (2003), as a guide. Any computer code should be placed in fixed-width format to facilitate readability. Footnotes and references should be numbered consecutively and gathered at the end of the manuscript. Musical examples should be sent as separate attachments for ease of layout. **Graphics:** Any artwork, graphics, photos, and flowcharts should be sent separately as an attachment. We recommend uncompressed graphic files such as TIFF at 300 dpi. **Submission Information:** Articles in electronic format should be submitted to the Managing Editor Steven Kemper at the following email address – steventkemper@gmail.com. For announcements of books, recordings, and event related articles please direct your emails to Assistant Rachel Foote at foote.rachel@gmail.com. Items for *Tips and Tricks* and all other inquiries should be sent to Editor Tae Hong Park at thp1@nyu.edu or Steven Kemper.

About SEAMUS

Founded in 1984, The Society for Electro-Acoustic Music in the United States (SEAMUS) is a non-profit national organization of composers, performers, and teachers of electro-acoustic music representing every part of the country and virtually every musical style. Electro-Acoustic music is a term used to describe those musics, which are dependent on electronic technology for their creation and/or performance. Many members of SEAMUS, like Jon Appleton, the guiding light in the conception of the Synclavier, are recognized world leaders in their fields. All are dedicated to the use of the most advanced technology as the tools of their trade.

SEAMUS seeks to provide a broad forum for those involved or interested in electronic music. Through its journal, newsletter, national meetings, and its national archive at the University of Texas, SEAMUS seeks to increase communication among the diverse constituency of the relatively new music medium.

The Society's objectives include:
To encourage the composition and performance of electro-acoustic music
To develop a network for technical information and support
To promote concerts and radio broadcasts of electro-acoustic music both in the US and abroad
To create an exchange of information through newsletters and other means of communication
To establish and maintain a national archive and information center for electro-acoustic music
To attract a wide diversity of members and supporters
To advocate licensing and copyright concerns

SEAMUS strives to address not only relevant technology but also the non-technical issues pertinent to the electro-acoustic music community. In a field usually dominated by technical concerns, it is refreshing to hear paper sessions devoted to aesthetics, collaboration, education, and of the ethical and social issues facing electro-acoustic musicians. The provocative sessions provide fuel for lively discussions during the national meetings.

SEAMUS Board of Directors

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From the Editor

It is difficult to think of names and figures that have worn – with ease and comfort – the hat of the composer and the hat of scientist. Only very few come to mind but one name that immediately emerges is the late Jean-Claude Risset. The story that is Jean-Claude Risset and the legacy he leaves behind is remarkable when considered from the lens of contribution to the field. What makes the Risset story even more remarkable is when considering it in the context of his humanity. I fondly remember a seminar led by Jon Appleton at the Dartmouth College Electro-Acoustic Music program. As was typical of Appleton, when students had questions that he didn't have a clear answer to, he would put the telephone on speaker-phone, make an impromptu call to the person who would know best, and start a discussion on the topic at hand – in this particular case, it was Risset's classic composition *Inharmonique* (1977). What was exciting, surprising, and "extremely cool" was to see Risset making and taking time to discuss electro-acoustic music with us – none of the students knew him personally and he could have easily (for whatever reason) declined to do so. That was one of a few occasions I had the fortune of "meeting" Risset and the next time we met, he (even more surprisingly) remembered my name. Similar experiences are also reflected in the two articles included in this year's Journal SEAMUS publication. He will be dearly missed but his contribution to our field, I am certain, will remain a resonant pole for a long time and hopefully inspire many of us in our daily effort to retard the decay of curiosity as Risset surely did.

Speaking of wonderful figures in our field, two additional articles in the 2016 issue are interviews with Scott Wyatt and Miller Puckette – in one we learn about Wyatt's double life as a classical pianist and rock bassist/keyboardist, and the other we learn about Puckette's affinity towards colorless graphical interfaces, being pro-aliasing (graphically-speaking at least), and being a Max user. Two other articles included in the 2016 issue are Des Voyages Sonores (first part of a series of two articles) by composer Gemma Peacocke and Robin Cox's essay on *to click or not to click* in the context of live electro-acoustic music performance.

In the *Recordings* section, Tom Dempster reviews two CD releases – Per Bloland's *Chamber Industrial* and *Pheromone* featuring a collection of works performed by flutist Meeranai Shim. Eli Fieldsteel wraps up the 2016 issue with a continuation of Supercollider insights where he walks the reader through a number of strategies in managing a sequence of events.

Tae Hong Park, Editor

Articles

Jon Appleton

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How many friends, who are composers, have you known for 50 years? I had two: Lars-Gunnar Bodin (Sweden) and the late Jean-Claude Risset (France). Jean-Claude was a polymath and we visited each other at least once a year, sometimes more often when he taught at Dartmouth College and I worked at the studio of the Groupe de Musique Expérimentale (GRM) de Marseille. That was at the dawn of computer music and Max Mathews guided us both. We used to play four-hand piano music, even a piece I composed for him. He was a much better pianist than I. Our favorite composers were Fauré, Ravel**,** and Debussy. Jean-Claude was tireless. We hiked the mountains around Marseille and Vermont, sometimes with our wives. We knew each other's children and even grandchildren. Writing about him fills me with sadness even though he died of a series of strokes more than a year ago. May the readers of this remembrance be so fortunate to have life-long friends dedicated to music and to each other.

Brian Belet

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Like many of us in the computer music field, when I read that Jean-Claude Risset had died (November 21, 2016), I was struck by the realization that yet another one of the true icons of electro-acoustic music had passed on to the next realm. His was a name that we all placed in the reserved upper tier of pioneers from the field's early days, as well as one who continued to shape the aesthetics of the practice for many years past the first wave. In the weeks and months ahead, many people will be writing summaries of his work, and studies of his music will deservedly continue well into the future. In addition to my deep respect and admiration for his music, I wish to record here a more personal remembrance of Jean-Claude Risset, based on the two occasions when my path intersected with his. In both instances I was (then as now) the junior party in the equation; a fact that adds to my heartfelt homage at this time.

In 1994, I participated in a conference in Luxembourg City, Luxembourg, that became a seminal experience in my musical development. Titled "Technology and the Composer: The Continuing Tradition of Music Composed for Tape," this conference was a celebration of what we used to call "tape music," although "studio music" was even then becoming the more standard term for fixed-media compositions as computer generation and production had largely replaced the traditional analog tape medium. At this conference, I presented my composition *[MUTE]ation* (1993) and also participated in a panel discussion. Jean-Claude Risset and Gottfried Michael Koenig were keynote members of the conference. This was the first conference I attended where the number of invited participants was quite small (in this case, only ten composers comprised the conference group), a benefit that permitted everyone to attend every session, and to subsequently make meaningful connections between diverse presentations. As a result, the conference

became a single "mega-session" divided simply into chapters for time management convenience. It provided a model that remains, for me, the most desired format for any professional gathering. I wrote a review of the event for *Computer Music Journal*, and that article (including a handful of memorable photographs) remains available for those who wish a little bit more detail of the conference (Belet 1995).

Two things about Risset and Koenig struck me during this conference. Even though they were the "big guns" for the event, they went out of their way to include the rest of us in the full circle of the conference. They listened when we presented our music and when we presented our ideas through paper sessions and panel discussions. When I write that they listened, I must emphasize that they LISTENED. And, they commented on what they heard, and by example, invited us to comment on what we heard, including their music and ideas. There was no line drawn between the established masters and the young upstarts. We were all included as equal adventurers in the sea of electro-acoustic music. This overall atmosphere of inclusion and genuine respect made a tremendous impression on me at the time – now more than two decades ago.

My other memory from that conference, one that both diverges from yet still complements the first, was the orchestration of our daily lunches. Like much of Europe, each midday, Luxembourg City virtually closed down for two hours for lunch. Each day of the conference, all of the participants would literally promenade to a local outdoor café, order lunch, and talk music for an hour or so. For each of these lunches, Risset and Koenig would sit at a table (the rest of us sitting either at their table or at adjacent tables): Risset would order a glass of wine and Koenig would order a glass of beer. This prefatory stage setting would open the curtain for a most earnest exchange of the French vs.

German approaches to creating electronic music. The two would wrestle with vigor. I recall several variations on: "My dear Koenig, the points you raised this morning simply do not stand up to deeper consideration." Countered by: "My dear Risset, of course you say that. However, you must see that." I watched and listened as they argued their aesthetics back and forth with vigor and urgency. Then, with the lunch break winding down, they would walk arm in arm back to the conference site to prepare for the afternoon sessions. I was "floored" by this daily ritual, reflecting that this was not what we usually find in American artistic and scholarly discourse!

Six years after this wonderful Luxembourg adventure, I met Risset once again, this time at the home of Allen Strange in Los Gatos, California. Allen was my mentor at San Jose State University from 1994, when I moved across the country with my family from Massachusetts, until he retired in 2002. Allen was also a great cook, and he devoted three days to the composition and subsequent performance of this meal. When I arrived at Allen's house that night in 2000 with my wife Marianne, and as Allen began the introductions, Risset jumped in with: "So good to see you again, Brian. I enjoyed your participation in Luxembourg. What have you been working on lately?" As dinner progressed we all talked freely and easily about music, wine, life, and the many tangents that naturally developed. (Quite late in the evening we wandered in memories and musings of nuns and Catholic school, but that is better left for another place and time, preferably with good wine in hand!)

Once again, I was impressed by his courtesy, his memory of my earlier participation in the conference, his comfortable manner as he included me into the evening, and (most importantly) his genuine humanity. The word that comes to mind is gentleman, sadly a term that has fallen out of favor in our modern language usage. During both of my brief convergences with Jean-Claude Risset, I encountered a man who treated those around him with kindness and compassion, a person who displayed old-world charm and who moved easily through the space around him. Am I still impressed and enriched by his music? Yes, of course. Still, knowing this real side of him as a person, even if from a rather ephemeral glance, leaves a richer and deeper trace in my life.

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Belet, Brian. 1995. "Technology and the Composer: The Continuing Tradition of Music Composed for Tape Luxembourg City, Luxembourg, 12-15 June 1994; College Park, Maryland, USA, 10-12 November 1994." *Computer Music Journal* 19 (1): 102–5. https://doi.org/10.2307/3681304.

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Abstract

University of Oregon Professor and SEAMUS 2006 Conference Host Jeff Stolet conducted the following interview with former SEAMUS President (1989 - 1996) Scott Wyatt, an admired and respected composer, teacher, and champion of electronic music for decades through his service to SEAMUS and as Director of the Experimental Music Studios at UIUC. This article originally appeared in the Winter 2015 issue of the SEAMUS Newsletter.

Jeff Stolet (JS): Professor Scott Wyatt has been a faculty member at the University of Illinois School of Music for 40+ years teaching composition, theory, and electroacoustic music, as well as serving as director of the University of Illinois Experimental Music Studios. He is an acclaimed, award-winning composer whose music is admired around the world. Among his compositions are *Counterpoints* (1992), *Time Mark* (1989), *A Time of Being* (1996), *Private Play* (1997), *In the Arms of Peril* (2001), *Night Visitors* (2002), *On a Roll* (2004), *A Road Beyond* (2007), and *ComLinks* (2010), all of which were selected to be on the SEAMUS Series CD. Professor Wyatt is one of my musical heroes, so it is a great honor and privilege for me to ask him a few questions and to learn from his replies. Scott, thank you so much for consenting to respond to my musical inquiries.

JS: Let's begin with a fundamental question. What is music?

Scott Wyatt (SW): For me, I consider music as being creatively organized sounds in time, combined to form artistic and dramatic expression, with more successful music incorporating a composed structure, flow, direction, progressive development, and drama. Music exists in many hybrid forms, and within a changing world having many diverse opinions, its definition lies with the individual; the composer, performer, conductor, producer, and listener.

With no malice intended, I differentiate music from sound art because of my composer preferences as listed above. These characteristics are often not the main concern of sound art, where space (and sometimes sound) rather than time, is emphasized.

The term sound art is often used for practices of sound installations, some performance art, as well as sound sculptures, which are all valid art forms. William Hellerman supposedly first used the term in the early 1980's for a show he organized in New York, although I'm sure it has strong roots from the Futurists' fascination with noise and machines, and with breaking the boundaries of the past. To paraphrase Max Neuhaus' and Carsten Seiffarth's definitions, sound art is an exploration of sound in a unique space, and of the relationship of sound to and in a specific context of its hearing, thus turning space into place. Here is where definition and distinction become blurred, especially with acousmatic music.

There is no right or wrong here, just personal preference, and I prefer working with music composition rather than sound art.

JS: Given your response above, what is electro-acoustic music and how does it provide a vehicle for what you do creatively?

SW: Electro-acoustic music, within the context of contemporary concert art music, refers to a genre of music, whose compositional idea is specifically composed to require specialized electronic means for its sonic creation, assemblage, and presentation — that could not be created in any other manner.

I studied classical piano as a child, but soon began living a double life of playing keyboards

and bass in rock bands (as the Beatles and the Byrds dominated much attention at this time) during middle school and high school, while still studying classical piano. My family didn't have money, and so I learned to build speaker cabinets and amps to have access to gear. I was always fascinated with technology and music, and so for me, I was drawn to both the music and the equipment when I began hearing about "electronic music" while still in high school. In 1964 Bob Moog and others, such as James Beauchamp, Don Buchla, and Alan Pearlman, had introduced the modular voltage-controlled synthesizer and an excitement was in the air. While in high school, my only awareness of synthesizers was with their commercial and entertainment industry use, along the lines of Wendy Carlos' *Switched-On Bach*, the Beach Boys, the experimental band Organisation (later called Kraftwerk), and Jean-Michel Jarre's early efforts. By 1970, I was a freshman in college at West Chester University studying music education and piano performance. Here I was given access to a new Moog Series 900 modular synth that had no manual! At that time, no one there knew how to use it. Fortunately, I had enough experience with bands and building equipment that I began trying to figure out the beast by writing up a user manual for both faculty and students. Keep in mind this was before the Internet. Information had to be obtained the old-fashioned way. I was simultaneously introduced to the music of Babbitt, Cage, Hiller, Subotnick, Stockhausen, Varese, and Xenakis, which for me, was a different kind of excitement, and I wanted to find out how and why this creative form existed. This music was foreign to me, yet I was very much drawn to it. In my sophomore year, my composition teachers at that time included Larry Nelson and John Melby, who challenged me compositionally and musically. I was fortunate to have access to a fairly large studio, complete with army surplus microphones, the Moog, two Scully two-tracks, and a Scully half-inch four-track, that gave me opportunities to explore both concrète and synthesis. In the long run, this degree of enthusiasm, exposure to new music composition, aesthetic challenges, and access to technology, and its inherent problems, launched me into a long relationship and career.

Skipping over several decades to today, I enjoy the challenge of working with technology and attempting to create a work that does not sound as if it was created easily. Technology has advanced to the point that it produces good sound quality easily in comparison to the early days. Many students and composers new to electroacoustic music are drawn to the accessibility and the ease of generating output. This, coupled often with a lack of investigation of what determines art status and even higher audio quality production, results in many elemental compositions and performances. I have tried to combat this by continually challenging my students and myself, to avoid the obvious and the elemental, with respect to concert art electroacoustic music works. Electroacoustic music has satisfied my desire to work with art music and technology.

JS: In your 1998 article "Gestural Composition" (Wyatt 1998) you describe the design and use of sonic gestures along with their transformation and development as a basis for an electro-acoustic composition. Can you take us through your thinking about sonic gestures that culminated in that article and also any evolution that your ideas have underwent during the past seventeen years? In addition, do you regard the gesture as you describe in this article as a central element of your compositional method?

SW: In order to answer your question, I have to refresh my memory and reread part of the article. The article states that many American electro-acoustic works are often concerned with the use of pitch as one of the primary compositional focal points. While I consider this a valid approach, I have been interested in the design and use of sonic gestures that are not immediately based upon pitch as the obvious focal point. These gestures can be concrète and/or electronically generated, and I have no prejudices for either, that are much further processed and shaped electronically to create new identities that transform and develop throughout the designed course of the composition. This approach, with its roots in both traditional concrète and synthesis techniques, takes on a time-based sculptural performance that affords the listener a desired

opportunity to discover the interplay and development of molded sonic events, without the interference of pitch as the primary factor. Attention turns to gestural evolution and gestural development within a host space or spaces. Some have labeled this approach "gestural composition" or "sound mass composition," and while other approaches are often pursued within the University of Illinois Experimental Music Studios, "gestural composition" has maintained a major presence during the Studios' 50-plus year history.

All too often, I hear a lack of clearly defined compositional motives and very little progressive development of these motives within electroacoustic music works. For me, the presentation of clear motivic gestures and their evolution through progressive development promotes more than just the sounds; it advances the work itself with an evolving energy, motion, direction, and the composed drama beyond that of the original sound objects. This remains a central concern for my compositional approach.

JS: It appears to me that a great deal of the initial material of your compositions originated as sound from our acoustic world. Can you comment on your preference of using sampled audio as the basis of so many of your compositions?

SW: Early in my career, I spent a great deal of time with sound synthesis, not only through my initial work with the Moog, and later, the Buchla synthesizer, but also with sound synthesis programs Music 4BF, Music 360, and later with MIDI driven by Vision and Digital Performer sequencer software. Almost all of my early works were synthesis based. I began to embrace concrète as a way of exploring sound by looking for and harnessing the natural energy that lies within an acoustic sonic event. Currently, I record all of my initial sonic material within a studio setting to capture and sculpt as much of the life of the sound as possible rather than working with downloaded samples. Trying to discover the essence of the characteristic gesture of a sound is a revealing and an exciting process. It leads to further future discovery and compositional opportunities. I endeavor to record sounds and capture the sonic essence with

what I consider to be the highest quality which is determined by mic selection, placement, and positioning through careful monitoring. At times, achieving high quality does not involve the most expensive mics or the highest sample rate or bit rate, but more careful listening, good recording techniques, and some unorthodox recording approaches. I record generally at 44.1 kHz/16-bit to avoid having to go through a conversion process. Capturing the lifeblood of the sonic moment is the key, and very much part of the chase. This discovery process often leads me to carefully alter the sound later in an effort to accentuate the gestural characteristic of the sound. In thinking about this approach now, I believe my time with synthesis has given me experience to sculpt and process my recorded material.

JS: I spent a year and a half in Eugene, Oregon working out at a local health club to a playlist of your compositions. When I hear your music the impeccable balance between the musical elements, the detailed spatialization, the musical nuances that are revealed, and the sheer amount of time within each composition that I, as the listener, am placed in a state of musical anticipation, I am completely awed. The anticipatory moments often lead to spectacular and satisfying articulatory moments. Please describe for us how you think about the creation of these musical elements?

SW: My dear Jeff–we need to work on your playlists for the gym! I begin by sketching out a basic structure based upon whatever idea is behind the work. I endeavor to clearly define all aspects of the compositional idea(s) including contrasting motives, a developmental plot, and potential dramaturgy. After recording my initial material and going through a discovery process of altering them through an array of hardware and software, I begin assembly of the skeletal framework through to the end of the piece, within a stereo context. I revisit the structural design, existing temporal activity, various twists and turns of the plot, any dramatic extensions and shifts, and spatial designs. Much of this is done on paper against the timeline of the work. While some of my works incorporate an underlying narrative, all of my compositions

revolve around the energy and pure development of the gestures and motives. The developmental activity needs to present the listener with a sonic rollercoaster ride of unexpected shifts and drama, while also having concern for continuity of presentation. I then attempt to engineer/realize sound movements (translations), the many shifts of environments, and juxtapositions of depth proximities that often take many hours of studio time. I have found this actually requires a well-designed studio with very reliable monitoring at consistent listening reference levels. Any sounds that move within the space must initially imply such movement, and for me, this is engineered manually rather than using any multi-channel panners, and characteristics of the movement often need to be exaggerated. Additional attention is required to prevent other sounds and sonic events from masking the main sonic translations. The engineering of the sound translations and various host environments have to be believable. Too many times composers'/engineers' intent is not realized effectively. It is worth striving for this level of achievement.

JS: Is there a musical work that most influenced your technical approach to the composition of electro-acoustic music? Along the same lines, what composition inspired your musical work the most?

SW: My guess is that I have been influenced by a variety of works and composers for musical elements, compositional design, spatial exploration, and engineering prowess. A few earlier works that come to mind include Morton Subotnick's *Touch* (1969) because of his pioneering four-channel sound design, control signal process, and synthesis work, John Chowning's *Turenas* (1972) with his amazing simulated Doppler shifts and depth proximities, and Lars-Gunnar Bodin's *For Jon, Fragments of a Time to Come* (1977) with its intriguing narrative and very high-quality engineering. Some of the spatial translations created by Salvatore Martirano with his 24-channel *Sal-Mar Construction* (1972-75) also inspired me with my early research and initial engineering attempts with spatialization. Herbert Brün's

SAWDUST series (1976-78) drew remarkable focus to gesture and progressive development of gesture. Mario Davidovsky's *Synchronisms* greatly influenced my compositional thinking with my instrumental compositions involving electroacoustic accompaniment. Mid-career strong influences came from discussions I had with Kevin Austin of Concordia University and with Jonty Harrison of the University of Birmingham (UK) concerning diffusion and spatialization aesthetics and practice. This, and the overall influence of the electroacoustic masters, my past teachers, my colleagues at the University of Illinois and within SEAMUS (including your music – Jeff!), and many of my students, has motivated me to continually expand and refine my compositional and engineering abilities.

JS: Do you have any routines or preparatory rituals that you employ to help you perform your compositional work? Are there special conditions you create for yourself to establish the most favorable environment in which to compose? Do you mine philosophy or other arts as inspiration for your musical creations?

SW: Well – deadlines are motivational! I never really had dedicated creative time due to the constraints of my University position supervising and managing our large studio facilities and the usual teaching overload that demanded even more time commitment. For me, I had to learn efficiency and focus. All of this was very much a balancing act between family, the University job, and career pursuits. I am sure you have experienced this continuing saga. I found that compositional motivation is enhanced when some extra musical idea or notion that strongly interests me, becomes a driving force that propels me to want the composition to exist. This could mean the composition is programmatic, at least for the composer, or that there is an idea fostering the compositional elements, design, and/or structure that is the raison d'être for the piece's creation. This was the approach taken with *A Time of Being* (1996) dedicated to the memory of those who perished on that day at the Oklahoma City bombing, *In the Arms of Peril* (2001) presenting a sense of impending danger just prior to 9-11, ...and

nature is alone (2005) in memory of the victims of the Chernobyl accident on the 20th anniversary of the disaster, *A Road Beyond* (2007) created in response to the death of a close friend, *All At Risk* (2004) concerning the Iraq War, and *ComLinks* (2010) where I offer a sonic commentary on our so-called connected society. I spent time researching the subject at hand, defining terms, defining plots and subplots, storyboarding, and considering elements of drama prior to working with notes and/or sound. This degree of preparation assisted me with efficiency and focus for both composition and studio realization.

JS: You've shared a number of things with us, can you tell us what you think makes a musical composition a success?

SW: Well, my question in response would be: from whose perspective: the composer, the performer, or the audience?

My best answer to you is that I gauge the degree of success for my own compositions based on the comments and reactions received from my colleagues in the field and those reactions of my students whom I feel are both informed and experienced. I also count general audience reaction in this overall mix. Obviously, I have to sign off on the quality of my own work, but I also have to keep in mind the overall reason why we create. It is both a personal and social act. We create because we want to, but most of us also want our creations heard, and in some cases, also seen. This sense of exhibiting our creations through public performance allows us to display our wares, as well as share the end result within a social context that is very different from individual listening. The collective reactions we receive from our colleagues and audience members provide us with additional information we can use to determine the success of our creation beyond our own perspective, which is valuable information.

JS: Which of your electro-acoustic compositions do you find most satisfying?

SW: This is difficult to answer, as most of my works have a very different focus. Some of my

earlier works remain close to me due to the amount of time they took to realize, involving very old-school techniques. *Time Mark*, for solo percussionist with electroacoustic accompaniment, has been a favorite due to the interplay between the percussion part and the accompaniment along with part of the accompaniment being positioned behind the audience. *In the Arms of Peril* was a response to the tension I felt within the country just prior to 9-11 – it is now dedicated to the many victims. On a Roll took more than 1000 hours to realize but was very effective with spatialization and 3D encoding in the long run. *All At Risk*, for video with 5.1 electroacoustic accompaniment, still receives a remarkable response from audience members as they read riveting email from a news correspondent friend embedded with military during the Iraq war. Perhaps one of my favorites is *All Sink* featuring the playful sounds of my dishwashing skills – don't let my wife know...

JS: What's the most challenging aspect of creating a fixed media electro-acoustic composition?

SW: Creating energy; making the sounds, the gestures, the environments, the performance itself come to life through both composition and engineering. I work very hard to create extra energy especially with fixed media works.

JS: I found it rather striking that as a Professor Emeritus at the University of Illinois that you still listed your teachers in your professional biography. Can you talk about what your instructors meant to you in terms of what they taught you and how you have employed what you absorbed from them?

SW: It has been my experience that many people do not express "gratitude" to others. I am truly thankful for the time my teachers spent with me and for their knowledge passed on during the many lessons. To this very day I am sincerely appreciative of their teaching, their time, their influence, and their support of my effort both during school and long after I graduated. All of them played a strong influential role in my development. These teachers include Richard M.

Smith (Audubon High School – helped me initiate a strong passion for music), Larry A. Nelson (West Chester University – helped ignite my strong interest in composition, orchestration, and synthesis technology), John Melby (West Chester University and University of Illinois – taught me serial composition techniques and computer music composition), Herbert Brün (University of Illinois – offered discussions and lessons about gestural composition, cybernetics, and misuse of language), Ben Johnston (University of Illinois – introduced me to just-intonation), Salvatore Martirano (University of Illinois – offered discussions and lessons on the music and compositional techniques of Dallapiccola), and Paul Zonn (University of Illinois – offered composition lessons plus a strong focus on orchestration techniques).

JS: Aside from the economic factors, can you tell us why you teach and what you enjoy the most about teaching?

SW: I have always enjoyed teaching and working with students. For me it has always been enjoyable to exchange ideas and knowledge, and to get to know them on a personal level. While we may have had some similar experiences, I welcome the differences. I try to present myself as being open, personable, and caring individual, and not better than anyone else in the room. I approach them as colleagues, and that we all have something to offer to each other.

While there has always been subject matter and information to present, getting them involved with the creative process, interpretation, decision-making, and problem solving with the hands-on projects has allowed them to approach creativity, technology, aesthetics, and professionalism at a very personal, individual, and real level. I shared many of my own experiences and compositions with them to show both problems and successes, as I have always wanted my creative output to display the attributes we discussed in classroom conversations. It has always been my hope they would realize the amount of dedication and hard work that is behind a creative work at this level.

JS: You have a number of accolades, but what do you want your legacy to be?

SW: Overall, I have been a very small cog in a rather large wheel, and so I think my influence has been minimal in the grand scheme of our world of electro-acoustic music, however I do hope that I have brought about a more involved level of awareness of and commitment to musicianship, artistry, and professionalism that could and should be part of these creative works. I have experienced so many changes in technology during the course of my career, and today, the technology is very accessible and permits cool sounds to be achieved easily, yet all too often, elemental ideas and/or experiments are presented as being a work of art. It is my hope that we raise the bar of what art can and should be, and challenge ourselves to meet this objective. This has been a part of my message passed on to my students and colleagues - perhaps this message could be part of my legacy...

JS: P.S. You drive a yellow Corvette, please tell us about your interest (obsession) in fast cars?

SW: I always wanted to get to work quickly, and then after the long day at work, boogie on home, while enjoying the driving experience... After all of these years, patience, at the end of the day, still eludes me.

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Conducted by Teddy Ryles, 2016, via Skype

Introduction

While conducting research on Max Mathews, a researcher who established multiple systems of computer-based tools and real-time music software, I found a plethora of resources in text, which illuminated his work and thoughts. However, what was lacking in my understanding of Mathews was a personal account from someone who worked directly with him.

   In turn, I decided to contact Dr. Miller Puckette for more information on both Dr. Mathews and other topics regarding computer music. Dr. Puckette obtained a B.S. in Mathematics from MIT in 1980 and a Ph. D. in Mathematics from Harvard in 1986. He was a member of MIT's Media Lab from its inception until 1987, and was also a researcher at IRCAM. At IRCAM Dr. Puckette developed the widely used computer music software environment Max, which, in fact, is directly named after Dr. Mathews.[1]

   As I delved into my conversation with Dr. Puckette, my aim was to procure more information about Dr. Mathews, his methodologies, and his theories. However, I was also interested in using the topic of Dr. Mathews and his work as a platform for a multitude of other discussion points. Within this conversation, I found Dr. Puckette and myself discussing the relevancy of Dr. Mathews' theories, the impact of the digital age, current usage of technology in music, as well as the future of computer music in general. Dr. Mathews strived to make the computer a credible source for musical output, and its usage has now become engrossed in culture and has changed both art and our daily lives.

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[1] http://msp.ucsd.edu/bio.htm

Early Work

Teddy Ryles (TR): Can you give a brief overview of your initial work before developing Max MSP and PureData — what you were focusing on?

Miller Puckette (MP): That's complicated. Max/MSP itself — it's not really clear when that became what it is or what came before it — was a long process that might have ended in 1988 or 1989. I started working in computer music in 1979 and started trying to write a real-time system in the summer of 1980. Somewhere in there is about 18 years of trying to find out what worked and what didn't. One thing that was formative was that Max Mathews spent a summer at MIT as a visiting researcher in 1983 or 1984 which allowed me to get to know him. At that point Barry Vercoe's Music 11 existed, but this predates Csound so there was essentially a non-real time computer music scene going on at MIT.

   I was busy trying to make a real-time computer music program that would have essentially a combination of three ideas: One was the Music-*N* idea which was Max Mathews' "baby" — the concept of a unit generator, a real-time compiler, a virtual score, an orchestra, etc. The second thing that I was interested in, which was also from Max, was a thing he called RTSKED which was a project he worked on after Music-*N* after he did more with GROOVE (an early real-time computer-controlled analog system at Bell Labs). RTSKED was a computer model of real-time control based on distributed asynchronous processes, that would in some way, de-linearize or put into real-time, the starting and stopping of oscillators. That was an attempt to essentially leave the question of synthesis alone while it looked at the idea of the

score. Music-*N* was a bunch of notecards, which were prescheduled, whereas RTSKED was replaced by these events that would happen in real-time, which could appear in different orders, and happen as a result of external events.

That was essentially a model for doing something like a score language in real-time. And I believe it was Max's insight for taking up the most flexible way of doing a real-time scheduling system, which based its events on multiple concurrent processes. These processes could make rigorous the idea that you did not know what order things might happen. I think it was not true that things were missing from that model and I don't think that model had any notion of branching. In other words, the idea there was simply that if you wanted to make something in real-time, what you wanted to do was to have sequences that could run in parallel so that one of them could stop while the other one went along; that was an important insight. Max actually had things that could do looping in GROOVE, but just abstained from implementing it into RTSKED.

For me, Music-N and RTSKED were two major influences. The third, however, was the emergence of certain kinds of graphical patching interfaces that were computer imitations of the idea of an analog patchable synthesizer. I actually knew about analog patchable synthesizers back in the day, and I thought that was an excellent way to put together orchestras as opposed to how you did it at the time, which was writing lines of code in Csound or Music 11. People knew how to do that for audio signals but did not know how to do that for messages — things that were not audio. Also, I think it was Max's idea that making sound should be separated, or could be separated, into one programming model, which included streams of audio, while another programming model was event based. I had that idea pretty much in mind, although, no one had put those two things together in a single system for the good reason that there were no general-purpose processors that could do an orchestra language in real-time. When you used RTSKED, or ran Max's earlier real-time programs, you were basically driving analog synthesizers because that was the only thing that could run fast enough.

TR: So basically, your interest was combining these two separate entities into one system: having the graphical user interface and its own independent scheduler. Was there anything at that time being developed that was similar to Max/MSP?

MP: There were things that pre-staged it pretty well. There was a thing called HookUp! [interviewer's spelling] which might have actually become a commercial product in 1985 or 1986. I'm aware of something that happened before 1979, which was called O-edit [interviewer's spelling], which stood for orchestra editor. It only dealt with the unit scenario part of the problem but was actually a graphical editor.

I later found out that people had been trying to make graphical programming languages like that — the boxes, the wires modeled for specifying computer programs — and that was even a computer science research project in the 1960s. The thing about the graphics is that I did not actually start putting graphics into the systems that I was working on until 1988, because I was more concerned about getting the real-time aspect of it — the real-time synthesis language — all working together at once. I tried to do that in 1982 and 1983, but the hardware just would not catch up.

TR: In *Electric Sound* (Chadabe 1997), you even said, "I figured that we'd need a graphics interface because the configurations were getting too complicated to visualize in a text file ... I cooked up a graphics interface that I called the Patcher ... It turned out that the graphics interface became a bigger project than the real-time scheduler" (Chadabe 1997, 183-184).

MP: Yeah...bigger in two senses, the main sense being that it was a lot more work and a lot more of the code involved the graphics rather than the real-time scheduler. But the scheduler was actually more original than the graphics.

Max Now
TR: What are your thoughts on the developments of Max/MSP now? I know that you started it originally, but currently it has

shifted into more of a community-based project. It has evolved into something that is increasingly disparate but conversely unified in that it has coalesced into its own company (Cycling '74). Max is divergent in that there are many different types of people who are involved in the process of developing this software. What are your thoughts on its impact with music now and also the type of software Max has developed into?

MP: Well the short answer is that I don't use it. I have a pretty strong stylistic preference in computer software. For instance, I am not into color on screen — I can rationalize it just fine — I find that it is easier for me to see black-on-white than it is for me to see stuff in color, especially if it is text! I have heard that there is a physical reason for that, that your eyes, just like a camera lens, have different focal lengths of different wavelengths. If you have red and green in close proximity, you can either focus on the red or focus on the green but not both. If that is true, then that is an excellent reason to not splash a bunch of colors around on a surface someone is trying to read off of, but I am not so sure if that is the truth.

The other thing that irks me about modern graphical interfaces in general is that people anti-alias things. Whenever you see a straight line, especially one that is at a slant, instead of seeing the 1960s style zigzag, you see grey on both sides of the line. This is even true if you try to move a vertical line in a place that is defined in floating point and does not fall right on a pixel. Antialiasing will cut in and little grey shadows will appear on both sides of that line... and that just irritates me — I just can't stand that. If it was microscopically small it would be cool, but to me it just looks fuzzy and I don't like that. I am very much into having things in exact pixel location, but I think that is a minority viewpoint. That viewpoint is much more typical of a programmer or a mathematician versus someone who watches media on their iPhone.

TR: Do you think that the program itself is powerful and useful? Or do you think that it has clichéd itself in its excessive use?

MP: I would say both... the power of Max/MSP is quite different from that of PureData (PD). In both cases, a large part of the power of the program is in the community of people that use it, the knowledge base that exists, and the examples that people create. If you look at both programs, Max/MSP and PD, you will find that the communities, although they overlap, are quite distinct. Because PD is much more do-it-yourself, while Max is much more commercially-oriented, Max is therefore much more likely to be in studios.

Max is also much more production oriented so it is well integrated into production environments. That is another sense in which I am kind of a minoritarian because I actually don't give a damn about production, recording, and multi-tracking — because my idea of music is live performance. It is my own personal interest; I am much more interested in music being performed in real-time than I am in recording techniques.

TR: Interesting ... and I also think that there are many artists whose entire style is based off of the type of sound and commercialization in Max/MSP that you are talking about. Their entire aesthetic is based around the granular sound, which can be easily captured and manipulated in the software. It is fascinating seeing how Max/MSP has become a niche field — being a Max/MSP musician, being a person who uses Max/MSP — it is typifying in almost a pontificated cliché that has entered the world of computer music.

MP: Yeah, and you are not only claiming it as an instrument, but you are also claiming membership in a group, which people do even by listening to music, but even more so by tending towards different kinds of software or different kinds of tools. And you will see that in *any* field of the arts...like oil painters versus water colorists. People do both, but you know — "oh well *I* do oils!" There is this whole thing going on.

The other thing is that Max/MSP has a certain sound — not really, because it shouldn't— *but it does!* Almost without being able to avoid it, software, when you use it, guides you to do the things that it makes easy to do and guides you

away from the things that it makes hard to do. You can hear that pretty clearly within both Max/MSP and PD. This is of course something that I have spent my life fighting against because my belief is that a software should be absolutely neutral.

My way of trying to make software neutral is by avoiding the use of automation and allowing people to do everything themselves rather than have the software to provide them with high-level tools in order to get stuff done. It is my feeling that PD does it a little bit better than Max. On the other hand, I also think that someone could come up with something a lot more neutral if they went back, rethought about the tropes that software pulls people into, and provided ways of escaping said tropes.

Max Mathews' Theories & Impact
TR: Another thing I wanted to ask was in terms of Mathews' theory in how he emphasized the importance of the computer as an extension of human creativity; he underlined how it can be the burgeon towards expanding the capabilities of not only the performer, but also the composer and the technician. I understand that his theories at the time were recalcitrant to the accepted views of musical creation because people were unaccepting of the notion that computers could be an instrument — that they could forge creativity.

But now, if you look at the majority of modern music that you hear today, you can notice that all of his ideas are still clearly represented in both how music is produced, recorded, and composed. All of his models, like the Sequential Drum and his Music-*N* series, are in some way represented throughout music today. I was wondering what your thoughts were on the impact of his theories on the modern music world?

MP: Well what you said is exactly true. He had a lot of ideas that turned out to be the right ideas later on.

TR: It's just like John Cage (and many other earlier composers/artists) where he essentially predicted the sonic configuration of modern music. Albeit, today's music is not *exactly* what he wanted it to be, but the way in which he described the future of music was what it ended up evolving into. [2]

MP: Although...I don't know, it is rather easy to think about John Cage's influence on music because what came out *was* actually music and then you could say, "Hey listen to this thing by Boulez, or by Stockhausen, or by Aphex Twin" and then, "Here is a piece by John Cage" where something that is a possible antecedent in the back can be heard, seen, or written about.

I guess Max's influences are maybe in some ways just as deep but are further below the surface. It is much harder to listen to a piece of Aphex Twin and say that you hear Max's interpolating oscillator or something being triggered; it is hard because it all goes into the infrastructure, you don't see it, and then the way it comes out as sound is sometimes very indirect. It is like a mode of control, a mode of interaction between a person and a machine as opposed to a way of organizing notes.

TR: Right, and with one example of that... I have the schematic of the Sequential Drum above me and it is one of the earliest examples of a program which allows the user to store music into a computer and be able to manipulate it. I think it is really interesting, maybe not seeing the physical distribution of his software or computers, but more of the ideas of what he was doing. He represented the computer as a credible instrument and as a stand-alone method for manipulating sound, which could be commercially accessible for people. Computers now are incredibly pervasive in almost all facets of modern culture and people don't think twice about using one for music, whereas during his time, the idea was seen as alien and foreign. What are your thoughts on his vision of the computer and how people would use it?

MP: Hmm ... in terms of the vision of the computer, Max had a set of ideas that I never bought into which were essentially about the amateur musician and the way that computers

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[2] Editor's note: John Cage and Max Mathews actually collaborated with each other.

could someday unleash the musical creativity of people who did not have the decades of conservatory training that you would need to become a proper violinist or pianist. And something of what you are saying kind of mirrors that — the idea of computers being able to take over the highly skilled but mechanical aspect of music making so that the human could operate at a higher level of creativity without mechanics. And that's the thing that you could write volumes about.

There is this whole debate in the arts, which asks, "To what extent is craftsmanship inseparable from creativity or artistic merit? Can you off the craftsmanship and be a meritorious artist without having to get your hands on this stuff?" A good example would be Andy Warhol who would sign things that he hadn't even physically made; he would order his work printed, and once it came back, it would get his signature.

An opposing example would be Conlon Nancarrow who would take razor blades to piano rolls, cutting out his own piano music (rectangle by rectangle), and doing it over again for decades upon decades. There, it seems to me that the creative process and the mechanics of cutting the rolls were entirely inseparable —- that he could not have done what he did without that. Even though he could have programmed a computer to have done the same thing in five minutes instead of a year, once you have the physicality of doing it, it made it possible for his mind to think about these patterns in some way that, someone else who had chosen to have automated the process, would not have thought of.

TR: What I find interesting in his theory, and where I have my own contradictions, is that Max probably wanted to illustrate, that with the computer, you do not have a selective niche of people who can play and who cannot play. Instead, you can develop something where conceivably *anyone* has the capabilities to formulate their own type of creative output and fully master it. This is something that I have strived to do in my own work. On the contrary, you can see the kind of complacency that exists in relying on a computer in compensation for the lack of practicing, self-mastery, and self-

discipline, which is easily demonstrated in a lot of modern music. Further, you can see this effusive industry where people are overflowing with the same type of music — the same type of digital output — lacking the capabilities of musicians from previous generations because the computer is giving them the tools that they do not have to think about.

MP: Right, the Ableton effect (*laughs*)

TR: Yeah! And I think it's interesting because I see myself using these programs but also approaching them differently, at least I hope so, than I think most other people approach them. I can understand how easy it is to click a button, have the computer "work its magic," and then instantly get it to repeat this process. It has allowed me to think about the question, which people seem to constantly argue: "Is the computer going to replace human made music?"

In my opinion, a computer could theoretically rewrite an entire score that somebody else wrote with autonomous action. In another instance, you could place a person behind the computational operation in order to fulfill the same process. I find that one would still be able to tell the difference between which one was mechanical and which one was organic, or in other words, coming from some human source.

Even though there is an infinite amount of tools that exist now, there still needs to be some form of intense critical thinking, intuition, passion, and physical mastery that has to accompany musical input in whatever fashion it might be. I believe that no matter how complex tools might become, they need to support an existing idea. At the end of it all, they are just tools.[3]

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[3] Editor's note: this point can be carried over to self-generative instruments and programs; a certain level of understanding and creativity must be used in order to create these types of software. This point is not intended to take their credibility or validity away or to belittle that form of artistic expression.

MP: And the other difference between Max Mathews and some 13-year-old with Ableton Live, is that Max actually *did* project his aesthetic ideas onto the tools he was using in order to allow himself to make music. Take the electric violin for instance. He spent years working on those violins and making one that was ergonomic in a way which allowed him to play it better than classical ones. In a way, he got around the limitation of "push-button" amateurism simply by proceeding from something that he had thought about and built up from scratch — he built it from thesis.

This is not what you see the "push-button" crowd doing. There is a question of how deeply you actually get into the thing that you are doing, to what extent you allow the software to tell you what to do, and to what extent do you take control over it. That is one dimension. But there is also another dimension which is independent of that: "Do you do the 'classical' approach?" where you obtain a rote skill at something, or "Do you acquire the 'modern' approach?" where you acquire a conceptual idea and work to realize that concept while still being able to operate within your own range of skill. I believe it is a continuum between these two.

Modern Technology
TR: That actually leads me into my next question: with the vicissitudes present between the invention of the home computer and the year, month, and day we are experiencing now, how do you see our relationship with technology unfolding? What cultural and collective behaviors can you see that have manifested over the years? Do you think that our development of proper technologies has stunted or slowed down, or do you think that we are at a great time with what we are using? What are your opinions on the vast radical changes we have had in human history with the digital information age?

MP: Yeah...(*laughs*)

TR: I mean that is a huge question! (*laughs*) And it can be in terms of computer music or just in general.

MP: One aspect of that is that things have gotten a lot easier to do, so people actually *do* more now. For instance, somewhere between the 17th and 18th century, communication was persistent through letters. People like Voltaire had friends who lived in England who would write letters to each other. They would wait for months and then receive a response. And yet, there were networks of friends who did things by writing letters back and forth even though the timeframe was marginally longer in comparison to now.

When I was a kid, the way software spread around — as soon as it was too big for you to type out code in your small PC magazine — was a process, which would cause you to send physical distance around. I actually had a period of time when I was distributing the ISPW software on discs and physically handing them off to people in 1992 or 1993. It is magic to not have to worry about the physical means of communication anymore.

At the same time, the relationship between people trying to *do* things, and the corporations and governments who are trying to control *what* people are trying to do, is always in a state of flux. There is always a tug of war going on between ordinary citizens who are just trying to get what they want to get done and corporations who are either trying to extract money from them or corner them into situations of dependency. That has always been going on, it always will. The dispute simply moves from one plane to another.

It also has been true that there have always been a network of hobbyists and independent people who experiment outside of the mass-production mold. For instance, there were amateur radio operators in the US, Europe, and various other countries around the world. Recently, I found out about a woman from New Zealand, born in 1920, who was a radio operator and built short-wave radios out of parts she found in car junkyards — there have been people like that throughout history. There is nothing new about there being a "hacker" network of people who build their own cell phones or whatever it is the next thing will be. It seems to me that because of the ease of communication now, those networks are maybe somewhat stronger than they were 20 or 30 years ago — and that to me is a good thing.

TR: I know that our devices have had a huge impact on our lives. You cannot walk down the street without seeing people with headphones in their ears or looking down at their phones. I even have to schedule in times in my calendar when to turn my phone off airplane mode so that I don't constantly look at it! I have even come to characterize most screens now as "electric seducers" as there is an inherent necessity to always be titillated by what you are looking at. I was wondering if you think that people have become over reliant on technological developments and are becoming complacent? Or, do you think that our relationship needs to be corrected?

MP: I don't know...I cannot think of a period in history where people were not complacently over reliant on whatever technology was offered at the current time. I do not know where to go in terms of value judgments. It is just the thing it is...I am not even sure if you can fight it effectively.

Future Developments in Computer Music
TR: In an interview with Dr. Tae Hong Park, Mathews stated in regards to his question concerning the future of computer music that the question which will dominate the future is: what *kind* of sounds do we want to produce? This is going to revolve around psychoacoustics; It is much easier to teach a composer the teachings of modern psychology rather than teach a psychologist about music. We need to understand people's reactions to various sound sequences, harmonies, chords, etc. to further understand our depth of music. [Paraphrased from Park 2009, 19]. How might you react to that viewpoint? What is your understanding of *where we are going* and *what the future might hold* with our current developments?

MP: I actually do not think that psychology has much of a use to teach us about music at all. I just plain disagree with Max on that one. If you look at the papers that psychologists write about music, they are pretty depressing. They are making a fake melody that has more sharps and flats, do that with another corresponding melody, and ask someone, "Does this more

strongly identify with the key of C or the key of F#?" And the answer is: "I don't know, use your ears goddammit!" (*laughs*). Or another way of saying the same thing is that you can pick off tendencies and find average behaviors but you can never find specific behaviors, and there is no way to measure them and no way to know about them.

TR: So, you think it's just a really abstracted field that is folding into itself?

MP: No, I actually think it is just a bill of goods like artificial intelligence in the 1960s, where they thought, "We are going to understand intelligence and make intelligent computers that can do things that people do..." No! That was just a way to get research grants from DARPA. Psychology too I think — "Oh of course we are just going to understand everything about the human brain and cure all the ills and improve our situation in the world" — it's not going to happen.
Brains are not things that lend themselves to scientific understanding. In fact, they are not things that lend themselves to any kind of understanding except very intuitive ones. I believe in a lot more intuitive approaches to trying to find new musical ideas than I do in scientific and methodological ones.

TR: I find it interesting that you say that because a lot of my focus in school is in identifying topics in 3-D sound and psychoacoustics that could push forward musical thought and musical immersion. With the up-and-coming adaptations in 3-D audio and virtual reality, do you think that they are too esoteric of a field for people to conduct research in, or do you think that there really is something that could pave a new standard for music from understanding these areas? Also, in a psychoacoustic perspective in reference to spatialization, we may not be influencing our emotions directly, but at the very least, we are changing the way in which we perceive things in distance and in depth of field, which creates a more immersive experience. Is this something that we will ever figure out completely?

MP: That's a very complicated question...here is a very off the cuff answer: if you are listening to music on headphones or on ear buds, as opposed to listening to music on stereo or on a 5.1 system, the things that you can hear are different; you hear different levels of detail. But also, the spatiality is different because the space moves with your head instead of staying in one place. As a result, presumably a piece of music which was optimally produced for listening with speakers is going to be different when listening to a piece, from the same person, with the *intent* of it being listened to through headphones. When you use headphones, you do not get a virtual sound-field in the same way. In other words, you do not hear sound and place it in physical places.

First, you have a tendency to hear things inside of your head as opposed to having them externalized. People have not figured that out yet; they might never get there. Second, you can get a wealth of detail that you do not get through speakers. Third, you hear things that no one else is able to perceive potentially when you are listening to a piece of music that can be customized for your own listening moment, in a way that you cannot, if you are designing it for speakers. In other words, the delivery of music should be, or could be, a much more active process when it is headphone based rather than speaker based.

Those are things that seem to me, as interesting avenues to look into. At the same time, what bores me, and where I do not think there is much promise, is in the attempt to take a headphone-based system and then create the illusion of an auditory space — a physical place that has space in it. It is interesting in kind of a cute way! It is never really quite convincing.

There are two things people are questioning: can you create a convincing sound field even if it does not move with your head? Can you track head motion and rotate the sound field so that it stays stable even though your head is moving? This is what people are working on now — Google, DBX, and Dolby — all those media companies are in a cut-throat race to get their standard to be the best.

TR: You seem not so happy about the effective input of corporations into their musical research.

MP: Well the whole purpose to corporations getting in there is to get a lock on some file format or lock on some patented codec. I am very distrustful of that. We have seen this exact situation happen with MP3s, which were unplayable on Linux systems for years because the patent had covered them. I do not want to have to pay someone a tie-in order to listen to music or to decode music on the web. I am very leery of people locking things up into proprietary audio formats.

TR: So, then what do you think of John Chowning's work in developing FM Synthesis and patenting it for Stanford? Does this align with the collective mindset of researchers in the early 20th Century, and if so, how is it different in how research is rewarded now? Based on your relationship with companies, do you think that the way in which ideas are distributed could/should be any different?

MP: If you compare the MP3 patent and the FM patent, the MP3 patent was much more pernicious because the FM patent prevented you from selling a device that made FM synthesis without licensing it from Stanford. But Music 11 had an FM generator, and that was cool because it was not hardware, thus, it was not covered by the patent. But for the MP3, the patent law had expanded at that point, and it was actually a container for audio as opposed to a means for generating audio. If you cannot do FM you can just do something else, but if you cannot hear an MP3 you cannot share what you have recorded — it is a much more limiting situation.

What I see is that patent law has gone very much too far in the direction of protecting large corporations, which are essentially rent seeking, as opposed to protecting inventors who actually are making things of value. The MP3 was not really an invention of value; it was simply a particular configuration of existing ideas.

TR: Do you think that there needs to be a development for a certain tool that should be focused on for the future?

MP: There is this long-standing conflict that I have between the integration between real-time

systems like PD and score manipulation or document manipulation systems like ProTools or Sibelius; those connections are very weak. There ought to be a much stronger paradigm for getting back-and-forth between the documenting and real-time processes. And that was not in fact my original goal in starting PD. It was trying to come up with something that did not privilege the real-time factor over the data structure format. However, the data structure idea never got fully developed to attract full usage.

The Internet
TR: A lot of people have told me that the internet has created an environment where every artistic idea has been fully expressed. Where in my opinion, I deem that ideas have just been dichotomized and compartmentalized in a very organized and extreme away. This information and these ideas that people are talking about have always existed, but now it is just *available.* For everyone, it is overwhelming to see all of this information being accessible at once.

In my perspective, from looking at a vast array of music — and I am pretty sure your knowledge base doubles or even triples mine — I think that there are a lot of restatements and regurgitations that are not in fact "new," which many other people view as novel. On the other hand, I do not think it is impossible for new ideas to be created. Has the internet fostered or diminished creativity in your eyes?

MP: I don't know if the internet has much to do with it. There was a tremendous amount of creative ferment in the years 1945 to 1980 where people really were having radically new ideas and were pushing them as far as they could be pushed. I feel like the music in the last 30 years has not really moved in any really fundamental way. I don't hear things coming out of grad students now at their recitals that I would not have expected to have heard 20 years ago when I just started at UCSD. I do think we are not in a state where something recently has "broken wide-open" and people are trying to make sense of a new situation that people previously experienced right after World War II.

I think that is a cultural thing, I don't believe that has to do with the internet at all. And unfortunately, I do not think that will change

until there is some major disaster, whether it is social, political, or economic. It seems like it was the political turbulence in the early part of the 20th century which really engendered the artistic ferment of the second half of it.

TR: I would have to agree. With the advent of any disaster and with situations like war, there is a boom or some trade off in correlation to that extreme scenario. In this way, you are exactly correct because the idea of being a musician and an artist completely changed during World War II. There were even programs where people would just recruit farmers, who had never been exposed to much art or much music before, and tell them to play music or to create art. In turn, they would do *weird* things; a lot of it was bad art, but there was some material that was very fascinating, new, or different because they were not surrounded by the same archetypes that many people grew up with.

MP: Another period of great ferment was the very beginning of the 20th century, the time when Einstein wrote his three papers in 1905, Freud created his idea of the unconscious — things like that. That corresponded loosely with atonality in music but not exactly; that was not brought on by war that was brought on by the collapses of the intellectual structure.

So in the 19th century you could actually believe that things were completely deterministic and knowable, but then all these incompleteness results, like quantum theory and Gödel's incompleteness theory (etc.), all existing in the first half of the 20th century, poked holes in people's positivism. The revolution was well under way before the First World War. Therefore, I do not think it requires a war or genocide for things to change. What seems to happen is that an old model cannot seem to function anymore and then, as it begins to crumble, innovative thinkers recreate certain structures and rebuild the foundations.

TR: Yes...and in relation to what you are saying, Professor Tom Beyer even outlined the overall process of music recognition and its current way of "innovating" over time. The basic trend in how music is made is that it begins with a

person who idolizes or falls in love with a particular artist, learns all of their music, and then proceeds to creates their own stylization of it. Afterwards this process is repeated for some arbitrary amount of different people. If you are really good at this, you become famous, win a Grammy, and your work is seen as "new music." When in reality, all this person is doing is creating a re-stylization of *x artist(s)* and *y influence(s)*. It is a restatement in a refurbished way. And if you look at a lot of music now, it is just a reconfiguration of various different cultural and musical conventions that were already created in the 1940s, 1950s, or any other period in human history.

MP: Right, and I do think that things are in a sufficient stasis right now. I have a feeling that if some people come up with some radically new approach now that actually makes some sense and has some sort of coherency and integrity to it, that people would rush to the idea.

Personal Question
TR: This is my last question, and it is more of a personal question. There are a lot of amazing characters I have met who have been in both the general music or computer music field for a while. I'm curious about understanding the initiative and passion you have for your work. If you care or feel comfortable to discuss with me...what made you want to create the work you have made today? In a very simplistic question: what is, and has been, your inspiration?

MP: I think in general, it's just a dissatisfaction within the tools in computer music. I think all the computer tools I see out there are pretty clunky. And there is this tradeoff between how much you want the computer to do for you versus how much freedom and independence do you want to carry out your own ideas. And it is still a bad trade. Either you go into ProTools and you sound like multi-tracking or you go into PD and you try and perfect FM. It is not easy even now to make compelling electronic music, I still feel like tools are clunky and need to be improved a lot. They could be if people had the right ideas, but it is hard to come up with the right ideas.

Conclusion
As I reflect now on my conversation with Dr. Puckette, I find that today's current obsessions revolve around the tools we reliantly cling onto. Further, the technological far-reaching hand has become pervasive within many of the multifaceted aspects of our lives. Even within this conversation between Dr. Puckette, and me this opinion was often elucidated. Take, for example, the complacency found within people who now completely rely on software to create music for themselves; the impact computers have had on art and our interpersonal relationships; the significant role that devices, such as our phones and computers, play in our sentimentality; the infinite unending information which consistently streams from the internet. All of these factors relate to the mass and exponential developments we have acquiesced in these past few decades — music is just one of the affected areas.

Our relationship with technology is developing because of the information boom, which has been occurring for over the past 20 years. Although a wealth of ideas has been able to flourish, I do believe there has been stagnation, which can easily be exhibited, not only through the trends within artwork, but also within the behavior shown by the majority of people. Although these tools offer great advantages for quicker solutions, people appear to be coaxed into creating ideas, which still align themselves to convention. As stated by Puckette earlier in this interview, "software, when you use it, guides you to do the things that it makes easy to do and guides you away from the things that it makes hard to do." In turn, perhaps we should take into consideration how we *approach* our tools and devices to ensure our creative goals do not become swayed by easily achieved outcomes.

I believe the question we will have to deal with in the near future will be, "How do we *moderate* our usage and not fall into artistic complacency?" The musical resources and contrivances, which exist now, are incredible. Nevertheless, the same conventions keep being recycled. I trust that there will always be incredible thinkers, innovators, and artistic thinkers in any point of time. Max Mathews is representative as a definitive example of this.

Nevertheless, as stated previously, "Even though there is an infinite amount of tools that exist now, there still needs to be some form of intense critical thinking, intuition, passion, and physical mastery that has to accompany musical input in whatever fashion it might be. I believe that no matter how complex tools might become, they need to support an existing idea. At the end of it all, they are just tools."

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The power of the name IRCAM (l'Institut de Recherche et Coordination Acoustique/Musique) is evident in the enthusiasm with which composers talk about successful projects and fruitful relationships developed there, and conversely a general reticence to talk in detail about experiences at the organisation that may have been less than positive. The composers interviewed for this paper spoke with some reverence about the idea of IRCAM, and of the ivory-towered prestige built very deliberately by the late Pierre Boulez to secure his own Serialist ideas, his reputation, and ongoing funding. Yet for all the publicity, Boulez remains enigmatic, having composed very few electronic works whilst heading one of the most prestigious computer music institutions in the world. A trained mathematician, he was a strong proponent of empiricism in music, and with the influence he gained through his career conducting major orchestras, Boulez became a leader in the ascendancy of Serialism and a kind of intellectualist conceit in composition. At an artistic level, this culture pervaded IRCAM in the 1980s when Boulez was at its helm, and rewarded composers who worked within the limits of Serialism whilst rejecting or ignoring those who did not fit the mould. In the 1990s, as Boulez's influence waned, IRCAM opened up to a wider group of composers, including both those commissioned to work within IRCAM, and a network working at other institutions or independently in electroacoustics.

Since 1980, IRCAM has employed composers as technical assistants to teach computer music and to assist resident composers. This article examines the culture of IRCAM and how it has changed over time. In doing so it inquires into the role that musical assistants have played in building the catalogue of IRCAM compositions, and in the difficulty of composing one's own work while employed to assist established

composers creating their own. The article also considers compositional style in relation to IRCAM, and its role in altering the prevailing approaches to both form and technique as well as the perceived importance of how a piece sounds. Finally, the article touches on the value of IRCAM to its community of composers today and considers what the future of computer music may look like.

Boulez: A Cult of Personality

Pierre Boulez was instrumental in the establishment of IRCAM in the 1970s as the musical wing of the Centre Pompidou in Paris, returning to France at the behest of then-Prime Minister (and later President) Georges Pompidou after a long period overseas conducting the New York Philharmonic and the BBC Symphony Orchestra. Boulez's strong personality left a deep imprint on the institution and culture of IRCAM which is felt to this day. When interviewed for this paper, renowned Finnish composer Kaija Saariaho said that,

> IRCAM was like some extremely well-protected castle of Boulez — he was the king — so I just knew that it would be something very impressive, and it was of course […] (Saariaho 2015).

As a student, Boulez had first trained in higher mathematics before studying music in Lyon and later entered the Paris Conservatory. Vaunted now as a key figure in the development and dissemination of electronic music, Boulez was disappointed with his own experiments with tape music in the 1950s, and in an interview in 1992 with Andrew Carvin and Joshua Cody for the *Paris New Music Review*, he said,

> I began the plans for IRCAM in 1969 or 1970, quite a long time ago. […] I [was in] contact with Max Matthews, who was at Bell

Laboratories at this time, in New York. […] He made me aware that having a room for computers was very important. That's all that I knew, both intuitively and through speaking with him. But I was careful, because at the beginning one can't be sure; I was careful not to give everything to the computer. But progressively, and much more quickly than we had ever thought, the computer invaded everything, from the analysis to the synthesis of sound to the manipulation of instruments: everything. It's a tool which is very general and which can be used in very different ways. The evolution of IRCAM is thus closely tied to the evolution of computer technology (Carvin 1993).

The common narrative today is that Boulez planned IRCAM as an institution in which composers and scientists would collaborate and experiment in what would be a natural extension of the composer's strident rejection of traditional forms of music. Andrew Gerzso, who has been on IRCAM's staff since 1977 — beginning as a researcher and tutor and today heading the pedagogical department — suggested in a 2013 article for *Contemporary Music Review* that,

> Arguably, IRCAM's main goal from the beginning has been the expansion of the musical vocabulary — understood in the widest sense of the term — available to the composer via the new possibilities offered by new technologies, with the inevitable impact on the various musical languages and styles of today (Gerzso 2015).

In this narrative, composers would be freed, with the help of scientists, from any inherited rubrics of form and tonality and would be able to apply mathematical procedures using empirical data from the scientific exploration of sound. Paul Griffiths describes Boulez's Serialist crusade in terms of the composer's experience in Paris during World War II as a resistance fighter, writing that music,

> […] had been held in check not only by the Nazis' proscriptions, especially of Schoenberg. […] Neoclassicism had been a distraction, the new symphonism of the last

fifteen years an unworthy capitulation to public laziness. […] Serialism, with which its inventor had instilled order, could and must be used in a totally different way, critically, to disrupt music's inclination to settle into familiar patterns (Griffiths 2006).

Boulez, then, saw IRCAM and Serialism as the key to an historical correction that would allow music to move forward in the way it would have without the interdiction of the Nazi regime and its rejection of non-traditionalist artwork, and without what Boulez saw as Schoenberg's false steps in combining 12-tone techniques with traditional musical forms and approaches. It was not merely a place for music at the cutting edge of technology. After his first forays into writing electronic music in the 1950s, however, Boulez moved away from it for a long period. In her book on the institutional culture of IRCAM, *Rationalising Culture*, Georgina Born writes that, after studying with Pierre Schaeffer at the Groupe de Recherches Musicales (GRM), Boulez and Stockhausen,

> Both left dissatisfied and became in different ways rivals and critics. Stockhausen became involved in the GRM's main European rival, the studio of the West German Radio in Cologne, which generated an alternative approach to electronic music in this period known as Elektronische Musik. Boulez, by contrast, did not continue an involvement in electronics and made known his strong reservations about the GRM. He created a stir by denouncing Schaeffer's approach to electronic composition as unsophisticated and inadequate. The main criticism was that musique concrete was untheorized and empiricist (Born 1995).

In 1984, seven years after IRCAM had opened and by which time Boulez was the sole director of the Institute, Dominique Jameux wrote in an article for *Contemporary Music Review* that,

> Boulez seems truly suspicious of the world of music and "machines", in the general sense of the use of tape alone, or of the combination of electro-acoustic media and "live" musicians (Jameux 1984).

The French composer Marc Battier, who worked with Boulez at IRCAM, describes a more faceted understanding of Boulez's problematic relationship with electroacoustic music. In an interview for this article, Battier said electroacoustic music will increasingly involve,

> More and more integration of electronics into live performance. This is what IRCAM has been about since the beginning. This is what Boulez wanted, and he has achieved that. In fact, Boulez was never interested in MUSIC 5, MUSIC 10. He was interested in the 4A, the 4B, the 4C and the 4X, before it became something else, because they were real-time machines, and starting with the 4C they could interact with performers, and that's what he wanted, and that has changed my way of thinking in many ways (Battier 2015).

Yet Boulez remains a figure of paradox, at once denouncing musical tradition whilst very firmly placing himself within the context of historically important composers. (Born, p. 172.) In *Rationalising Culture*, Born writes that,

> Boulez is remembered in the late '40s and early '50s in Paris as a student leader who engaged in "terrorist" actions and wrote polemical articles against the musical establishment. His denunciations attacked many major figures […] Boulez's early polemics attracted public notoriety, augmented his charisma, and drew followers around him (Ibid, p. 81.).

A rift grew in Europe in what was already an extremely esoteric field. John Diliberto interviewed Pierre Schaeffer in 1986, who told him,

> One day we had the visit of a young and unknown musician, Pierre Boulez. At the time, I was involved in trying to create a solfège that could include many sounds and timbres. I thought we should classify the sounds in terms of their effect on the listener, of their psychological effect. We would classify them in high, low, hard, harsh sounds. Boulez objected to that. He refused to collaborate and left after composing one piece, as boring as usual, with one single sound (*Etudes*, 1952) (Diliberto 1986).

One possible explanation for Boulez's return to electronic music after composing only a few works in the 1950s and 1960s is that, because he found the technology of the time so unsatisfactory, he became determined to bring about the formation of a research institute for composers to work with leading scientists to develop live electronic music as opposed to the tape music with which the GRM was concerned. Jameux writes in his article for *Contemporary Music Review* that, "Boulez's no to the results he obtained meant a yes to further research." (Born p. 17) It is also possible to view Boulez's antagonism of rivals as purely a method of building his own notoriety, for in fact, IRCAM was later to draw and build upon exactly the kind of research that Schaeffer and the GRM had begun.

Identity and Community

The IRCAM building, across a footbridge from the Stravinsky Fountain to the south of the Centre Pompidou, is itself a very quiet place, with more than 150 staff members stationed in offices and working across the Institute's education, commissioning, presenting, and scientific research projects, as well as in its administration and the Médiathèque library. Israeli-American composer Chaya Czernowin described her initial impression of IRCAM, saying,

> It is almost like a physical feeling that I had when I walked into the building. I didn't feel comfortable when I came in 2003, even though all the people that were surrounding me were really great and lovely and very accommodating, and we had a very wonderful work relationship. But nevertheless, the building, the whole institution, it didn't have the same type of welcome (Czernowin 2015).

Boulez consolidated his power at IRCAM in the early 1980s. He was able to handpick composers to be invited to study and work at IRCAM, and, according to Battier,

We had at first very few women. There was Barbara Kolb who came – also, Kaija Saariaho followed the composer's course in 1982 and soon after composed works with the IRCAM software, like *Io*, for the 10th anniversary celebrations of the Pompidou Centre. That goes to show you that we had a lot of problems inviting composers. The awareness of the need to involve women was just not there. The artistic director was not interested in this question at all (Battier 2015).

There was gradual cultural change after Boulez stepped down in the 1990s, and the cultural change was paired with a structural change in the way the IRCAM interacted with its composers. Battier recalled that,

There was a need in the 1990s to have a broader view – more composers, younger composers, women composers – so that meant that the research period went away, and this is when we started to have a one-year-long course. We had quite a few women in each [course] beginning in the 1990s (Battier 2015).

Saariaho described the status that Boulez had cultivated — after years as a celebrated orchestral conductor — in his role as director of IRCAM, and the prejudice she experienced as a female composer from outside of continental Europe.

I have no special feelings about it, but for sure, I never had any kind of relationship with Boulez. Maybe he would have been differently interested in me if I [had been] a talented young Finnish man, as he was about Magnus Lindberg for example, but I happened to be a young woman. I think he had a problem with that, and then yes, I was a shy person, and I had come from Finland, and I didn't realise that France was still a kingdom and you're supposed to go and make your special compliments for the king when you arrive. I just didn't have that kind of knowledge so that's maybe one reason […] he must have found it offensive that I didn't do it. I met him many times of course because I

was working in his institution, but we never ever for more than thirty years said anything which made sense (Saariaho 2015).

As one of the most internationally successful composers to have had a substantial involvement with IRCAM, and one of the first women to study there, Saariaho offers a unique insight, highlighting both the positive and negative aspects of the early years of the institution, and the cult of personality around Boulez. She was constantly stimulated by the new ideas being developed and experimented with at IRCAM, though in many ways, she felt like an outsider. Describing her initial impressions of IRCAM, she said,

[…] naturally there were very few women, and even if I had been working a lot with technology, I was never a "technofreak". I didn't have that kind of vocabulary and even mind for all the gear and all the programming and all that – I had a bit of a hard time being taken really seriously (Saariaho 2015).

Saariaho's experience at IRCAM was, fortunately, not shaped by the lack of acknowledgement from Boulez. Rather, when talking about her time there she recalled a sense of freedom and feeling inspired by research into harmonic spectra and psychoacoustics. Saariaho found a comfortable niche within the Spectralists and especially among the team working on CHANT. She described IRCAM in the 1980s as,

[…] super fun. This was very much because of David Wessel who was very free-spirited and who brought in jazzmen, and Diamanda Galás, and all kinds of wild people were working there. It was very, very creative and a lively place, and then it became more and more like a production institution, and a lot of that freedom disappeared (Saariaho 2015).

Tod Machover wrote in his article "A View of Music at IRCAM" for the Contemporary Music Review in 1984, that

[…] one of the most important features of IRCAM as an institute is that it provides a

common meeting ground not only for scientists and musicians (a fact which has been much discussed) but one for composers and their colleagues (which has been discussed less) as well. The second seems to me to be at least as important as the first (Machover 1984).

While Machover wrote positively about "composers of many different stylistic backgrounds" and "an open-minded invitation policy [which] has made them all, I think, feel equally at home," in the early 1980s, there were in fact very few composers invited to IRCAM who were not men of European heritage. Today there is more diversity between the invited composers and also the Cursus students, but difficulties remain. The 2015-2016 Cursus I class comprised six students from Europe, one from China, one from Mexico, one from Chile, and one from Iran. Of the ten, only two are women. As Austrian composer Karlheinz Essl pointed out in an interview for this article, the lingua franca at IRCAM is French, which is a major barrier for many composers. He explained,

I lost contact with IRCAM a little bit; it's a language problem. I [don't speak] French and there was a law that French must be spoken for people who work at IRCAM. This was one of the reasons I was not invited to give lectures or talks, because it had to be in French (Essl 2015).

The same is true of Cursus – all the instructions are in French. Czernowin described an ineffably forbidding culture at IRCAM when she was first resident there in 2003, though she talked of her personal experience composing there in generally positive terms.

I worked on *Wintersongs I* with Eric Daubresse who also composes and teaches in Geneva and he was also wonderful, but I am aware that not everybody's been so lucky. I've heard various stories about various relationships and I think it can be very volatile at times. People did not understand what I was looking for and there was not the feeling that they would like to engage. There

is so much engagement now and I do feel that [Director of IRCAM] Frank Madlener made quite a conscience effort to open the institution (Czernowin 2015).

In 2014 Czernowin composed a new piece for string quartet and electronics at IRCAM. The piece, *Hidden*, was premiered by the JACK Quartet the same year in Paris. In the years since her first experience at IRCAM, Czernowin has become an internationally recognised and well-established composer, receiving commissions for large-scale works and taking up a professorial position at Harvard University. Czernowin described the differences between her recent residency, during which she wrote *Hidden,* and her first experience at IRCAM over a decade earlier.

I think that [IRCAM] has opened inside and out. I feel that the people are more connected there now. It's still very hierarchical but it's a bit less hierarchical than what I had experienced in the past. I know that *Hidden* — when it was performed — was very different than anything IRCAM-y, and it was viewed as a big advantage, which is something to think about. *Hidden* was so foreign in a way to IRCAM, it was viewed as something good. People didn't say, "That was terrible," but, "That is so different! That's great!" That was my feeling (Czernowin 2015).

Essl talked similarly about feeling as though his musical practice was outside the norm at IRCAM, but that nevertheless his music was very well-received. Essl was first at IRCAM in 1992 and most recently had his sound installation *Seelewaschen* presented there in 2004. Explaining how the Institute had changed in the intervening years, Essl said,

The biggest change was due to the fact the technology became so available to everybody. IRCAM, when I came, was a studio with big infrastructure which supplied working space that nobody had at home. But nowadays, with cheap, powerful home computers, you're not required to go to IRCAM to have a studio and hardware. Many things you can do at home.

The role of IRCAM changed of course. It started when I left and it became a sort of research institute and a think tank which develops software and builds up a community (Essl 2015).

Battier noted a similar evolution, saying that by the early nineties, "We started to have powerful home computers, so actually I didn't need IRCAM anymore (Battier 2015)".

Composers as Musical Assistants
The tradition of musical assistants — who are usually composers with highly specialised knowledge of and extensive experience in computer programming — working with composers in residence began in the 1980s and continues today. The work of the assistants has been fundamentally important to many composers working at IRCAM both in interacting with the technology but also in having a technical and creative sounding board.

The learning curve for the *tuteurs* (who later came to be called *assistants musicaux,* and are now called *RIM*s – *Réalisateur en Informatique Musicale*), was — and remains — steep, allowing little time to compose. When interviewed, Battier, who was a researcher and tutor, recalled,

> We spent our time learning. When IRCAM first opened in 1977 we got the same computer as Stanford – while CCRMA [Stanford's Center for Computer Research in Music and Acoustics] got another computer, but they had developed software for the PDP-10 and we also got all the software from Stanford. There were a lot of people from Stanford who came to France and stayed there. Andy Moorer was one of them. John Chowning came very often.
> That software I had to learn – all the FFT stuff we didn't know before – and then IRCAM got into developing its own software for the 4X and also we had special computers developed in the 1980s. That was a time when we had to hand-wire the computers and the technicians did that. We were kept on our toes all the time (Battier 2015).

The France-based American composer Tom Mays became a musical assistant at IRCAM 1994 (the year Miller Puckette left), working with composers like Michaël Lévinas and Luis Naón. Having first studied electronics, Mays discovered contemporary music in his twenties, and went on to study music at San José State University, which had just developed one of the first official electroacoustic undergraduate courses. After his undergraduate studies he left the United States for France and found work composing and teaching in electroacoustic composition studios in Paris and Reims. From its inception, Mays was a member of the IRCAM Forum, attending research seminars and meeting people involved in electronic music in France. He helped to run the concerts at the 1992 ICMC in San José, and there met Miller Puckette, Cort Lippe, and others who worked for IRCAM at the time. In 1994 he interviewed for a position at IRCAM and was given a role within the production team. Mays worked at IRCAM shortly after Boulez had stepped down as director. Talking about the difficulty of managing a career in composition while working for IRCAM, he said,

> Composing while working at IRCAM was possible with much difficulty. It had to be separate. It never came up whether you were *allowed* to; it was just that you wouldn't get the work done. You know when a composer comes back the next day and you're supposed to have something ready. If you don't because you spent half the day working on something else, you're not comfortable with that. It was never stated whether you could or couldn't compose (Mays 2015).

Mays obliquely suggested that IRCAM unfairly benefitted from the uncompensated extra hours its musical assistants poured into the projects they worked on, but also referred to the general personality type that research institutes like IRCAM attract, explaining,

> There was extreme independence — maybe it's trust, maybe it's just more practical that way — but you're left with complete freedom and responsibility too. You're the one that's responsible for that piece working, and if you

can foresee that there's going to be some big problem and you know in advance, you get other people in the production team to try to deal with the problems that are going to come up. Basically everybody's motivated and they're working all kinds of extra hours that you don't even count, and the institution in a way benefits from that. They're all so passionate about it and everybody's totally geeky and wants to find solutions and so they're going to work their butts off. There's no checking up; it's just, does the thing work in the end? (Mays 2015).

Mays emphasised the sense of autonomy the musical assistants had during his time working at IRCAM, but his years working on projects for resident composers were intensive and left little time for his own compositional practice. The pay-off was instead a rigorous self-education in real-time audio programming. He said,

> I don't think even a month went by before they put me on the first production. You're pretty quickly thrown in the deep water, and you've got to make do. It was just an incredible learning experience to spend 60 hours a week locked up in a studio doing everything you could do with computer music, basically, but mostly I focussed on real-time so I was kind of specialised in that from the beginning. I'd already learnt Max – you know it was Max for Macintosh at the time, and at IRCAM it was Max FTS for the NeXT computers, and it did all this audio, so all of a sudden everything was programmed in. I spent lots of late nights composing saying, "Well now I'm going to work on something here." (Mays 2015).

Battier described his introduction to computer music and his path towards a role at IRCAM working as a project leader soon after the Institute was founded. With friends, he had begun composing electronic music at university as a hobby, but after the student uprising of 1968, he transferred from studying architecture to studying music.

> I started in 1970 using computers. There were no sounds, but with my friends I was writing LISP programmes to generate scores. In 1968 [the student uprising happened] in France and my school, L'Ecole des Beaux-Arts, closed down. In those days they had an architecture section and that's where I was, and it closed down and never opened again. So we were lost. A friend of mine told me there was a course in urban design at [the University of] Paris 8, so we went there. The course in urban design was really not interesting — they were really leftist teachers — and we didn't really study. There was a music department and I was already doing electronic music at the time, so I switched.
>
> It was a very small circle and I had friends at GRM and friends at IRCAM and I was curious. We went to conferences, for instance in 1977 there was an ICMC [International Computer Music Conference] in San Diego, and that was pretty much one of the first. There must have been at least 40 people from all over the world. I went there and met people from GRM and IRCAM and we knew each other because such a small group of people in those days – it was nothing like ICMC today of course.
>
> I was hired [by IRCAM] in December 1979. At that time I was already teaching and I was also working at GRM as an assistant to François Bayle. GRM had just got a computer: a PDP 11/60, and they developed some software which was in fact turned into the GRM Tools, so it's the same software basically. So [at IRCAM] they needed a young guy who could use computers, and in France in those days there weren't really any, but I knew [how to use them], because I had worked with MUSIC 5 before and I [had been] working with computers since 1970, so I was pretty much the only one in France (Battier 2015).

In the 1980s, with the departure of his four co-directors, Boulez became the sole director of IRCAM and reorganized the Institute according to his own wishes and with the realisation that by this stage, IRCAM was fully a computer music research institute. Boulez also understood the necessity of producing successful compositions and expanding the role and reputation of IRCAM in order to maintain the

extraordinary level of funding it was receiving from the French government. Battier described the situation, saying,

> In 1980 IRCAM changed its politics and opened up. They started to invite composers; they needed to build a repertoire. Until 1980 IRCAM had only been open for three years and there were a few pieces, but they were mostly pieces done within a research context. In 1980 all the guys like Berio [who was a co-director of IRCAM in its early years] – they all left.
> IRCAM wanted to build a body of people they would call *tuteurs* who would teach the classes we had every year. We had two classes: one in winter and one in summer, for one month each, and we would invite about a dozen professional composers, and we would teach them computer music. The first group of composers were composers from L'Itinéraire, so Dufourt, Grisey, Murail, and that was really very nice (Battier 2015).

While it was not explicitly stated, some high-level IRCAM researchers and executives were able to work on their own pieces during Boulez's era. "It was never written in the contract," Battier said, "But it was considered that we would do 50 per cent research and 50 per cent music." In 1984 Battier was commissioned by IRCAM to write a brass quintet and electronics piece, *Encre sur polyester.*

> IRCAM was very open when Boulez was the director throughout the 1980s. I was asked by IRCAM to compose a piece — I did a piece for brass quintet — and I had a piece for tape which I started at GRM and ended at IRCAM, and it's pretty much the only one labelled IRCAM-GRM… That changed in the 1990s when Boulez left (Battier 2015).

That Battier was the only composer to officially work on a piece between IRCAM and GRM is indicative of the rivalry between the two institutions, but also Battier's unique position in having worked with enthusiasm and success at both centres.

Resident Composers and Musical Assistants
The open and collaborative environment newly fostered at IRCAM included the relationship between composers and musical assistants. Mays recalled with fondness the relationships he had with the composers he assisted at IRCAM as well as the value of being able to work at a very detailed level within the composers' works-in-progress. He suggested that the relationship worked best when both the resident composer and the musical assistant could learn from each other, and that his technical support role allowed a certain psychological insight into the well-respected and established composers with whom he was working.

> I don't think you could live a day without something influencing you. It was like taking composition lessons from great composers, and on a close level, because you're really getting inside of their music and also seeing their fragility too, which is something I really like. "How about this? I kind of want to do this – how would that sound?" I mean that in a good way – that you get inside of different composers' processes, and I think that helps you be more comfortable with your own too. Everybody works differently. Definitely that exposure and that close association with other composers influenced me – I don't see how it couldn't, but in the sense of finding my own voice (Mays 2015).

In discussing the significance of IRCAM today, Saariaho said that her husband, the composer Jean-Baptiste Barrière, who was a key IRCAM employee during the 1980s and 1990s, "[…] often says that the most important machine at IRCAM is the coffee machine, because that's where all the most important, interesting discussions take place." (Saariaho 2015)

Musical assistants were expected to be extremely technically proficient and would often be required to hit the ground running on the composers' projects. Battier explained how the first IRCAM tutors were hired.

> The first *tuteurs* were Stanley Haynes, Andrew Gerzso, and me, and then we hired someone from Canada, Denis Lorrain,

because he had experience with MUSIC 5. We had to find young people from wherever we could (Battier 2015).

Gradually more tutors were hired as the projects being developed by resident composers required more and more complex technological solutions.

> We were finishing a piece by York Höller and it was complicated. The computers were very, very slow. We would programme the computer, lounge around, and then go home and come back the next day to listen to the result. There was too much coding because we were also using the score programme by Leland Smith to compute scores for MUSIC 10 and it was too much work, and I couldn't do everything, so we hired Thierry Lancino who was a young composer, I guess in 1981 or 1982 (Battier 2015).

The pressure on young tutors to provide complex coding for extremely time-sensitive IRCAM projects remained intense into the 1990s. Although he was told it would take about a month to get comfortable with the software, Mays recalls an introduction to working at IRCAM that was an extraordinary trial by fire. Describing one of the first projects he was asked to work on, Mays said,

> There was a Luca Francesconi piece – *Animus* for trombone and live electronics – that wasn't able to be premiered in its electronic form because the last weekend before the premiere they had a rehearsal and the Max/FTS patch wasn't working. It was a total failure, and the musical assistant left and didn't tell anybody where he was going. The concert was on Tuesday and on Monday they still hadn't heard from him, and so they decided to just premiere it as an acoustic piece. Afterwards, they gave me the patch and said, "Here, make this work." I totally tore it apart and rebuilt the user interface for Mac and had it communicating with the NeXT to do all the DSP, [and] it was solid afterwards, and it worked. That was one of the first things they gave me to fix (Mays 2015).

Essl was already a computer music composer when he was invited to IRCAM. His experience studying and working there was a positive one, though perhaps also one that highlights the necessarily symbiotic relationship between composer and musical assistant for the reason that Essl didn't actually need much help.

> It was really funny because I was the crazy guy at IRCAM. Normally the musical assistant would have a lot of work but in my case I was quite independent (Essl 2015).

Unusually, Essl declined to work with the IRCAM software in favour of the programme he had developed himself to run off his own Atari computer. He explained,

> I had a commission to write a piece for the IRCAM musical workstation with live electronics and an instrumental ensemble, *Entsagung*. I insisted on bringing my own Atari, but they completely disliked the idea because they had their own computers. I said, "No: this is a working system and I don't have the time to start everything on the new platform with new technology," so I brought my own private Atari computer. I worked at IRCAM between 1991 and 1993. In 1992 I was in the summer course and then I composed the piece in several working periods where I had studio time for several weeks with a musical assistant, Serge Lemouton. In the course of two years the piece developed. The only thing that Serge had to take care of was to make a data connection between my Atari and the NeXT computer. This was not easy because there was no data compatibility so we had to develop an RS232 serial bus protocol with a certain UNIX shell. We made a cable connection between the Atari and the IRCAM workstation to transfer the data. Although it was just text, it took hours for the text file – just the score I'd created – to transfer bit by bit to the other machine. Then I had to go on the NeXT and where I could use this score for synthesising the electronic part.
> We had a really friendly, good relationship as Serge was never intermingling with my compositional ideas. For him it was probably not the most inspiring job. It was good that he was there and he helped me to solve some

basic technical problems but in fact I was more or less completely on my own (Essl 2015).

Czernowin and Saariaho both work with musical assistants as programmers in creating the electronic parts of their works inside and outside of IRCAM. Describing her connection with IRCAM once personal computers became mainstream in the 1990s, Saariaho said,

> What became interesting of course were the assistants — to have somebody who would help you — so I still went to work at IRCAM for some bigger pieces like my first two operas. Composing an opera is such a huge thing that even if I had a lot of that material at home, it was very helpful to have somebody being in charge of the electronic part, even if we were working on that together, of course (Saariaho 2015).

Czernowin spoke about the fortuity of being paired with IRCAM RIM Carlo Laurenzi, with whom she had a synchronous creative bond, and described the kind of advice that he provided which refined her vision for her piece.

> What was so amazing was that the person who matched me and Carlo really had a good sense of our musical personalities. We have similar sensibilities. In many cases things sounded in the end either very close to what I imagined, or better. Maybe there is one place where we didn't yet do it as ideally as it could but in general we worked very hard… It's a very interesting thing to think about because on the one hand one has to have a very concrete imagination of what one is looking for. On the other hand, once you get very close to what you are looking for you might realize that you can make it even better and there is something else hidden there that you can sharpen, so it's not like there is a picture and you just need to reproduce the picture. It is a kind of interactive conversation, and that's why I tell you that the result was as good or better because the conversation was very substantial with the material.
> I was so happy about working with [Carlo] because it was like finding a partner who

enabled me to fly. He gave me suggestions but they were all so much in the spirit of — or a continuation of — what I was looking for. There was a place where I wanted very, very low sine tones and I wanted on top of those sine tones to have a very slow wind that will meld with those sine tones. What Carlo did at that moment was to take the wind down so that it was touching on the family of pitches of the sine tones. That was such an improvement of my vision. The wind being above them, it wouldn't have been at all as interesting, but the wind was a part of the sine tones and it gave them a moving texture that was very organic and very persuasive in its flow and that was really lovely (Czernowin 2015).

The evolution of technology and its growing accessibility has certainly shifted the role of IRCAM within electronic music. When describing the creation of Jonathan Harvey's piece *Mortuos plango, vivos voco*, Battier talked about the talent and skill of Stanley Hynes, who was Harvey's technical assistant at IRCAM.

> Stanley was a brilliant person who knew very well MUSIC 5, so Harvey did not really need to understand to the technology, but Harvey had very clear ideas about what he wanted to achieve. […] The shape of the piece was composed and then Stanley Hynes did all the technical stuff. How to make it – that was complicated – you had to know how to use MUSIC 5 but also how to invent new processes with MUSIC 5, especially with PLF [Program Logic Formulation] (Battier 2015).

The composer and IRCAM computer music designer Grégoire Lorieux spoke about the same piece and noted that, "Today it would be very easy to create this piece technologically. (Lorieux 2015)

In 1989 Curtis Roads described Harvey's use of a bell and recordings of a boy singing in Mortuos Plango as, "a general trend among composers: an increasing affection for natural sound, recorded and processed with digital techniques." (Roads 1989) IRCAM had not only become by this stage a dedicated computer

music institute, but one that had adopted many of the GRM's concrete techniques that had initially been dismissed by Boulez.

Both Mays and Battier are composers in their own right, and both eventually left IRCAM for teaching positions within universities. They recalled their years working as musical assistants with warmth and humour, but also the realisation that in order to have their own musical careers, they had to have left IRCAM. Battier joked that at the completion of *Mortuos Plango*, each of the *tuteurs* were presented with discs of the piece. "We had big discs with *at least* 30 megabytes of memory: huge! Each one of us had our own disc. We were very proud; we received a disc, just like a slave who receives a dish!" (Battier 2015)

IRCAM Today and Into the future
While the value of IRCAM changed after the advent of personal computers in the 1990s is its power to attract highly trained and brilliant computer programmers and composers that persists and ensures its unique place. It continues to do this because it is still very well-funded by the French government, and because of the global reputation it has built since its inception. Mays described IRCAM as

> […] a hotbed of ideas and energy, sharing, and the freedom to experiment with new and sometimes unstable technologies, so that they may become less new, and more stable (Mays 2015).

Reinforcing the idea that IRCAM's value is in its staff and visiting composers, Mays said,

> […] the close proximity of research and production – and teaching – is a huge benefit to developing new ideas about how to make music, or how *not* to make music. Anyway, it's more about the community than about specific technology (Ibid.)

Saariaho also believes that IRCAM's main value today is the community which it affords.

> I think for young people the interesting thing

is the coffee machine. To meet other people, to meet other people of your generation — to discuss your ideas — and maybe that way create more clearly your own profile and have your name in circulation. Then of course the tools, but in my mind that's almost secondary now (Saariaho 2015).

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).

In talking about the future of electroacoustic music, with Saariaho and Battier there was a sense of gazing into the unknown. Battier said,

> 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 10 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).

Saariaho echoed Battier's sentiment, saying that,

> Technology is advancing so quickly that I

think that twenty years ago we could not imagine that we are here today as we are. We had no idea how we [would be] living today — how we have these iPhones, and all that we can do with that — so, concerning the music, I wouldn't dare to imagine what will be going on. Also, will the music as we define it with classical instruments and symphony orchestras – will it still exist? I don't know if our kind of music will exist, or in some kind of much less prestigious place than IRCAM, because it doesn't bring money to anybody. I mean big amounts of money, and that's how everything is defined today. And unless there will be a real revolution or some kind of slow change as there has been concerning ecology — just before we have destroyed the whole planet — I think there is a little grain of hope that things could change, and that way those people who present this part of Western culture can survive. Maybe then also some more refined ways of using electronic instruments can survive and be developed. The commercial interests are at the moment ruling so much of the world that the situation is very sad, but we can always hope that things will go better (Saariaho 2015).

The democratisation of audio programming has challenged IRCAM's core purpose, though it is still a leader in developing new technology like 3D audio. But just as Boulez never intended for the Institute to focus solely on technology, the organisation and the network of musicians, programmers, and scientists who interact with it will continue to adapt to forge a place for their work.

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Abstract
Click tracks can be highly advantageous to a professional musician working in an electro-acoustic stage environment, but usefulness and adoption for this method of synchronization are often diminished by poor implementation and misunderstanding of creative potentials. As a live performance solution for time-keeping in absence of an obvious beat, to maintain precision with rhythmically complex music, when synchronizing to electronically generated content of any medium, or in situations of problematic audio monitoring, the case is made for a click track. Creative opportunities and technical solutions, as well as potential pitfalls, are also enumerated. Lastly, best practices in design and implementation are outlined, including possibilities for bone conduction technology in click transmission.

Introduction
The click track expertly used onstage, as a pulse representing the music's tempo and heard via earphones, may not only relieve a musician from inordinate distraction when synchronizing to other performers and electronically generated content, but can even provide creative opportunities and enhance performance musicality. Asserting potential for a click track to free oneself musically runs contrary to conventional wisdom, that coordination via in-ear audio of the beat is inevitably a mechanistic constraint to performance. This widely held belief is especially true among acoustic instrumentalists, perhaps due in part to prior experience with unsophisticated click tracks or assumptions that it is simply equivalent to practicing music with an audible metronome. However, dismissing the possibilities of this tool could be shortsighted in circumstances where a set drummer or conductor is absent, especially when coping with exacting synchronizations to

electronic sound and visual sources. As a "collective metronome," it has found acceptance in recording studios for decades, and especially in light of newer technologies, click tracks could more frequently benefit live electro-acoustic performance, offering creators a broader array of musical possibilities while attending to practicalities of a musician on stage.

Isolated from the audience, an in-ear representation of the tempo may untether a musical work from necessities of embedding, *into the compositional content itself*, practical considerations of keeping a human performer aligned to the electronics (such as writing into the electronic portions of the music an audible cue or beat pattern purely for practical reasons). The use of a click track may also allow performers to take risks in musical phrasing, supported by the confidence of knowing where the pulse and timing ultimately lies. But in a live setting, a particular sophistication is required, which goes beyond necessities for a controlled recording studio. There is scant evidence that industry or academic research has attended to this need. As is discussed later, one must be even more attentive to sound sample, relative volumes, and various other parameters of the click for the live stage.

Much as a metronome's function is to keep a musician true to tempos and rhythms, a click track provides precise time alignment when multiple sources of expression must be unified and one or more of those sources is human. This statement could also be used to define roles of a conductor, drummer, or the physical gesturing in tempo with which performers often engage. It is recognized that these traditional means of "staying together" are sufficient for many circumstances. However, electro-acoustic music often steps outside the bounds of where these traditional time keepers are appropriate. Instead, musicians utilizing earphones to monitor the sound of a click, in accordance with the music's

tempos and cues, may be more appropriate.

This discussion specifically considers situations of coordinating both acoustic and electronic elements in performance of rhythmically challenging music and/or difficult staging. This can be a very different circumstance from 1) rock, pop, jazz, or other high stage volume settings with a set drummer as primary means of beat keeping, 2) studio recording or large onstage commercial productions, or 3) when a conductor is before a large ensemble. The three latter situations have fairly mature practices for time keeping on a complex stage. Whether resistance is borne from conservatory training biases or misunderstanding of what is available through modern audio monitoring technologies, it is this former realm of performance that could more frequently benefit from the use of a click track. Exacerbating the click track's dismissal is the fact that existing hardware/software products are typically configured to meet the needs of a drummer or in regimented MIDI syncing schemes. Indeed, priorities for a click track when syncing electronic-only sources or for a live drummer can be quite different, as enumerated by Gavin Harrison for *Sound on Sound* in one of the few articles exploring click tracks with any depth (Harrison 2003).

One senses that electro-acoustic music is often regretfully constrained by this performance reality of what can be created between computers and humans. The vast rhythmic variety that electronically generated sound can produce strains the bounds for what is reasonable to expect when coordinating to the human element, and thus inevitably inhibits a creator's process. Without a click track, electro-acoustic works often fall into categories, seemingly to cope with the issue. This includes music assigning an obvious beat to electronically generated sound for the performer to readily monitor, music that only infrequently demands specific synchronization in which cue points are highly obvious, or music simply asking of the live performer to "play over top" a soundscape requiring little precision in time alignments. The constant reference point of a click track to the ear, while certainly not a panacea for every situation, can help relieve synchronization issues, thereby removing an encumbrance upon the music's composition. We create and perform the music our tools allow for, and a click track is one more item to include in an onstage toolbox, as it has unique artistic possibilities relative to other performance coordination methods.

Situations for Use

Setting aside for a moment how one should technically design and employ a click track, first to be addressed is when one might choose to use a click track. A smartly designed click track may actually allow performers to take musical risks knowing they have this grounding in and out of which to move. The collective understanding of the beat becomes so very obvious to all on stage, that there need be little worry of a performance falling apart. Ironically, what may be more inhibiting to live performance freedoms are musicians so concerned with the practicalities of issues in "playing together," with each other or with electronically generated content, that musicality takes a back seat. This manifests in performances with over-accentuated notes occurring on the beats (especially downbeats), through stage configurations designed more for musician sight lines than acoustics or visual benefits of the audience, or just simply a needless conservatism in performance style. As far back as the article *Programmed Signals to Performers: A New Compositional Resource,* Emmanuel Ghent recognizes that a musician, after perhaps a minor adjustment period, can in the presence of a signal for coordination have lower cognitive burdens while performing. Ghent also imagines this approach to time alignment allows unique compositional freedoms through its inherent possibilities for live performers (Ghent 1967).

Below are ways in which a click track has advantages to the onstage musician that leave him or her freer to concentrate upon higher-order musicianship.

1) No other method of synchronization will provide greater rhythmic accuracy in music demanding precise timings between live musicians and fixed electronic sound or other electronic mediums.

2) The preparatory beats of a click track greatly assist in anticipating points of coordination with playback audio files, video feeds, lighting, and other theatrical cues.

3) At-the-ear click monitoring may diminish contortions in musician stage placements to combat overreliance on performer to performer sight lines (particularly true when contending with pianos, percussion, microphone stands, stage monitors, PA systems, and lighting).

4) When insufficient rehearsal time is the reality, click tracks provide a more efficient process towards performance. Even in the most professional of circumstances, and with the very best musicians, performances too often receive less than an optimal number of hours in preparation. Some of that deficit could be erased in the efficiencies of a click track.

5) When the music needs assistance of a timing coordinator, but is artistically diminished by the visual patterns of a conductor or a percussionist sounding out the beat, a click track will handle the issue. Some music is best served when an audience does not have the pulse visually imposed upon the music. One also has to wonder how often a drummer (or an audible beat in general) is included in a performance only for necessities of keeping musicians together.

There are also potential liabilities to be mindful of before choosing a click track for onstage musical coordination.

1) The click track may become audible to the audience. Particularly in small theaters and concert spaces with an audience relatively close to the stage, there could be a fine line between click volume set loud enough for effective use by the performers, but not so loud as to have sound bleed from the headphones and heard by the audience. Techniques described later assist in preventing this problem.

2) For many instrumentalists, the presence of wired headphone can be a distraction or performance impediment. This is especially true for those with instruments close to the head or requiring overt body motions, such as violin, trombone, or percussion. Wireless monitoring is an option, but only expensive professional grade wireless transmission is reliable to a degree necessary for onstage performance (Bluetooth headphones are not recommended).

3) If something goes wrong onstage, requiring a hard stop or pause during the performance, a click track may just keep plowing forward until a human intervenes. And, after an incident it may be difficult restarting the click track, and therefore the performance itself, at an appropriate place. This inflexibility to mid-performance realities may be a real liability without precautions in place.

Design and Implementation
To exploit advantages and mitigate liabilities addressed above, numerous design elements should be considered. Outside of very large and loud stage environments, the most challenging issue in choosing the sound of the click itself is providing musicians a pulse at a useful volume, but one still unheard by the audience. This balance point requires thoughtful selection of sound sample, equalization, volume automation, and headphone choice.

Most any modern DAW (digital audio workstation) provides click track functionality with some variability of playback sound (based on the sound sample itself), as well as equalization and volume options. However, these software programs tend to be limiting for live performance click tracks, with just basic functionality geared towards recording studio or loud volume pop music circumstances. This lack of user friendly and on-the-fly sophistication for adjusting tempo, meter, and moment to moment click volume hinders adoption. It is an especially pronounced issue for musical performances of complex music (when of great variation in loudness or rhythmic/metrical content) and for music in small venues. It is therefore recommended a musician fully work through all sound aspects by constructing the click track in

advance and rendering the "performance version" to a fixed audio file (a topic further elaborated upon later).

As to the best conditions for the basic click pulse (rehearsal marker clicks and downbeat accentuation will be discussed later), a percussive sound dominated by low-midrange to bass frequencies will provide a pulse perceived as high enough in volume, while limiting "bleed" of the click from headphones to audience. Higher frequencies in a click timbre, perhaps necessary for very loud environments, and certainly providing a crisp sense of attack, also have the downside of more likely reaching beyond the headphones to the audience or microphones (sometimes the problem isn't how much click sound the audience is hearing directly, but it's the click getting picked up by a microphone and then feeding through the PA system!). In short, regulating how much high frequency is present in the click sound may be as important to regulate as the overall volume.

It is impossible to provide a single best recommendation for timbre or relative pitch of a click sound file, or its attendant equalization, given differences in works of music, the collective on stage sound, and the type of headphones in use. These parameters will all call for subtle adjustments to maximize clarity against the specific music and staging circumstances. Indeed, instruments of different pitch registers, and in performance of different pitch ranges onstage, may need individual adjustments in click playback equalization (or at the extreme, the relative pitch level) based upon keeping a click sound stratified to the sound range of instruments performed upon. Most stock click presets (such as woodblock or cowbell) found in digital audio workstations are geared to high SPL environments or when there is a set drummer playing. In circumstances relevant to this discussion, those sound choices may be overbearing.

But irrespective of specific sound choice, the waveform must have a very fast attack to be maximally effective. The produced sound should also be no longer than full volume of the initial attack, for two reasons: First, the longer the sound envelope, the more perceptible the click may be to the audience, and two, the sound will be more likely heard as pitched by the performer

(Figure 1). This latter point is important, as the more specifically pitched, the more problematic it is for a musician when that pitch is dissonant to the music they are in performance of. And conversely, if the click sound is tonally consonant, it folds into surrounding music and will seem lower in volume. A good starting point for click sound selection is the UREI sound font. This click sound comes from the legacy of hardware created by United Recording Electronics Industries (UREI), which provided recording studios a click track sound attenuated to be relatively high in volume for the performer, while less likely to carry beyond headphones and get picked up by any nearby microphones. This was accomplished with a waveform of a high frequencies possessing immediate decay and a substantial low end.

Figure 1. the quickly decaying waveforms of a downbeat accentuated click followed by three internal measure clicks

It is possible to design a click in audio software via use of MIDI or other means of digital trigger sequencing, but an actual rendered sound file (.wav, .aif., .mp3) is somewhat more reliable for live performance playback, given possibilities of computer processing anomalies. It is recommended that, unless electronic elements of the work require real-time synchronization adjustments, after crafting a click track within an audio workstation program, one should then render it to a fixed audio file for actual performance purposes. However, one potential hindrance to this recommendation of a fully fixed click track audio file is the difficulty in starting, during rehearsals or otherwise, at a place internal to the piece of music. For example, how does one handle rehearsing a piece starting with the click from measure 59? This is addressed by 1) embedding additional rehearsal marker preparatory sounds into the

click track file just before and at the downbeat of each of these measures (Figure 2), and 2) noting the minute/second track timing of the click audio as it corresponds to rehearsal marker measures.

Figure 2. examples for relative pitch formations of basic click, downbeat accentuated click, and rehearsal marker clicks

These rehearsal marker sounds are a secondary sound sample emphasizing arrival into important moments of the music. In practice, using a sound of relatively higher pitch than the basic click (typically an octave or so in relative pitch) is recommended for the two preceding beats before each rehearsal marker in the music, and then an even higher sound on the downbeat pulse of the rehearsal marker measure itself, as is demonstrated in Figure 2. This is not only useful in rehearsal, but also during individual musician practice sessions when employing the click track, and, as an added safety during live performance situations. And to an especially underappreciated point, musicians will be more confident of having counted the music correctly, or, have better capacity to get back in the right spot if lost, not only for the presence of the click itself, but for the added guidance of rehearsal marker sounds embedded into the click track (this again points to how a click track may assist musicians to more fully concentrate on musicianship over practicalities of performance). The final step is to print rehearsal marker minutes/seconds timings on all sheet music, thereby allowing musicians a simple reference to all points of coordination.

By extension, any work with a click track needs "prep clicks," typically one measure of click beats preceding the first actual measure of music, or preceding any other starting point after the click track has been absent (Figure 2). And it should be noted that during these moments that are otherwise musically silent, the volume needs to be extremely low to prevent audience from hearing the clicks. Some software programs default to providing not one, but two measures of preparatory beats. This is not advised for live onstage use, as it only increases the chance the audience picks up on the presence of a click, and is likely more preparation than the musician needs.

While on the subject of click track volumes, some music requires these levels to be tailored, even on a moment to moment basis. In pop/rock music of consistent volume and a heavy presence on each and every beat, all readily masking the click sound, this is an unnecessary consideration. But, for other genres of music, after the basic click track has been crafted, it should be reviewed throughout for specific moments needing volume adjustment. Especially with music that does not consistently have a strong beat involved, it is often the case that the difference between musicians adequately hearing the monitored click, yet successfully masking its presence from the audience is a fine line. It is true that the music itself will likely mask the click from the audience most of the time, but when the music's volume goes substantially lower or in moments when true silence occurs onstage, a click track's volume must be reduced proportionately to avoid an audience perceiving the click. This adjustment of click track output level relative to the music's ever adjusting volume is best done using the track automation features of a DAW, contouring click volume for any given measure or passage (Figure 3).
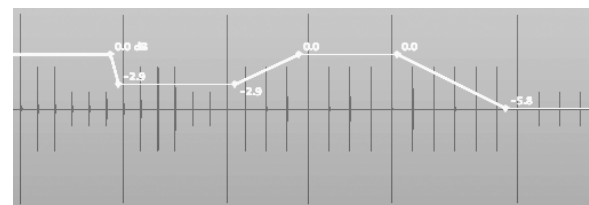

Figure 3. volume automation of a click track in waveform view

It is also recommended that when using a click track, it should be in use throughout the whole of the piece, or at least major sections of a piece, not just in moments deemed most necessary. It can be disorienting for a musician to adhere to a click for a period of time and then experience its absence. However, if an extended portion of the work would benefit from a lack of

click (for example, a freely improvised section), and, there is time in the music (such as an extended grand pause), then perhaps it is workable to leave the click out for a period (with the additional assumption that prep clicks can be employed to "restart" the click). Also, sending click to only a subset of musicians onstage is usually a poor idea. A possible exception to this is when one particular musician (such as a set drummer) performs a readily apparent beat throughout and is heard by all onstage.

Monitoring Hardware Onstage

Desirable volume levels and balances onstage, whether of a click track or audio monitoring in general, is vitality important to a musician's capacity to be in sync with all other performance elements, as a matter of timing and often of tuning as well. This can be especially hard to achieve in the presence of amplified sound through a PA system, which can cause great disparities between sound balances onstage vs. those for the audience. In other words, amplification set to best levels for the audience are frequently terrible levels for the monitoring needs of musicians onstage. The option of floor monitor speakers can help focus sound to a particular performer, but may also contribute to the swirling mess of sound found collectively on a stage (and obviously, one would not wish to use open speakers like this to send a click to the performers). Large and loud stage productions now quite frequently use "in-ear" monitoring to get away from the sonic downsides of "floor wedges" and compensate for poor stage acoustics. But, this at-the-ear monitoring could also find more of a place in less grandiose stage situations. Whether one or more acoustic instruments are unamplified, or in combinations between amplified and electronic sound sources, use of a thoughtfully designed click track on the smaller stage is an exacting means of providing audio synchronization and tailored sound balances, all while avoiding disturbance of the sonic environment, both onstage and in the audience.

As to hardware, this is of course a matter of selecting headphones for the click to be delivered directly to the ear (and it is beyond this scope of this discussion, but certainly other audio sources may be delivered to the ear as well). But, a very real issue exists with headphones. That of musicians onstage, particularly in lower volume circumstances, wishing to avoid anything covering or plugging up an ear, especially those with instruments very close to the head (such as flute or violin). It is disorienting, particularly for tuning, to diminish the natural and direct hearing of one's instrument due to an absence of the full ambient sound going into the ear. In compensation, it is possible to have the musician's instrument signal routed back to the earpiece, but it is very difficult for an acoustic instrumentalist to achieve natural perception of one's sound-making this way (and microphone placements onstage may not lend to this possibility). Some musicians will try to use headphones not fully sealed to the ear canal, but that only increases likelihood of click sound heard by the audience, either directly or by way of nearby microphones. In highly amplified stage contexts this practice of in-ear monitoring is less objectionable and now very commonplace. However, in lower volume rehearsals, studio recording environments, and in lightly amplified stage productions, better monitoring methods, such as the solution described below, are needed if broader adoption of click track monitoring may be expected.

It should be noted at this point that in circumstances of this discussion, where stage volumes are not excessively high, it is likely to the advantage of a performer to monitor a click in only one ear, not both. This of course means "one-sided" headphones, either by actual hardware design, or by cutting sound to one side of conventional headphones. It is also going to be less physically intrusive to contend with a single ear piece apparatus. Additionally, a performer may have very legitimate preferences for which of the two ears the click monitoring best occurs in, dependent on instrument type and stage placement.

Bone Conduction

A low cost and simple solution to some of the above hardware concerns is employing *bone conduction* headphone monitoring for click track synchronization onstage. Bone conduction headphones transmit vibrations of an audio signal from the surface of the device to a small

area of skin just in front of the ear (Figure 4). The big advantage to a musician is the ear canal itself is not at all covered, therefore no diminishment of ambient sound (from their own instrument and sounds onstage generally) will occur. And unless listening volumes are very high or exceptionally bass heavy, sound quality can actually be very accurate, pleasing, and seemingly natural. In other words, the performer receives the audio monitoring they wish, unheard by the audience, while still retaining full and natural use of both ears. The sonic nature of bone conduction transmission also tends to less likely bleed click into nearby microphones (at least relative to typical headphone monitoring), making the method especially advantageous for low decibel stage situations (and by extension, recording studios).

Figure 4. bone conduction headphones in use

Unfortunately, there is not yet a commercial bone conduction monitoring product available designed specifically for a musician. Until that day comes, an adequate product readily accessible and inexpensive is the Aftershokz AS400 Sportz 3 headphones (Figure 5). *Vibrotactile Notification for Live Electronics Performance: A Prototype System* (Schumacher, et al. 2013) does an excellent analysis of limitations that arise for performer coordination onstage, but its solution of a haptic-based system for cueing musical events, when applied to the constancy of a click track pulse, is cumbersome and less beneficial relative to a bone conduction hardware device in close proximity to the ear.

Going further, sending the click via a professional grade wireless transmitter to headphones (either traditional or bone conduction) is recommended if budgets allow.

This removes potential impediments and distractions of being tied to a lengthy audio cord, particularly for those musicians standing or highly mobile in performance.
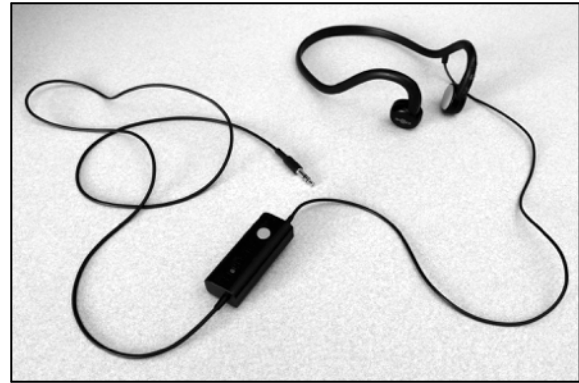
Figure 5. Aftershokz AS400 Sportz 3 headphones

Summary
Design and use of a click track onstage is not a simple matter, but the potential benefits are achievable with relatively minor technical expertise and expense. And given relative advantages and disadvantages of other options for coordination in electro-acoustic performance, it deserves broader consideration. After becoming accustomed to using a click, a musician may even find its presence freeing from the mundane necessities of time alignments in performance, allowing one to more fully concentrate on higher-order musicianship.

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Reviews of Events, Recordings, and Publications

riveting performance by the ECCE Ensemble culminates in some brutally gorgeous moments – moments that are also studies in how to effectively write for difference tones.

My favorite work on the album, *Of Dust and Sand* is scored for alto saxophone and the electromagnetically-prepared piano, and is a striking work not for its brashness or raucous grunge but for its gentleness. Bloland's spectral world is perhaps the most economic here, with more focus on undulation and subtle shifting rather than abrupt jumps. The timbral forces are complementary, with the saxophone becoming a grand foil to the piano's warmth. Percussive elements become dialogic between the saxophone and the prepared piano, with distortion fields arising from rulers and other piano string preparations and effective saxophone writing. Philipp Stäudlin gives a sensitive, evocative rendering of the piece, a performance that verges on the affectionate while keeping one foot securely in the grit of the rest of the album. The work breathes, perhaps respiring the dust, and moves imperceptibly, perhaps alive, perhaps something on the verge of having the breath of life kissed into it.

Pheromone
By Meerenai Shim, flute

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Her third solo album, and first album on the Aerocade Music label, flutist Meerenai Shim offers up in Pheromone a diverse array of works for flute and electronics. Spanning nearly all of the flute family, Shim brings muscular, agile, and sensitive interpretations to works for alto flute and delay lines, contrabass flute and TI-83+ calculator, and flute and computer. Across six works, by six composers, the styles (and performances) range from sensual and borderline-romantic, to quirky, to a zone

between psychedelic and dislocating.

Eli Fieldsteel's work *Fractus III: Aerophoneme* begins the album, a work with an attractive form and sense of gesture. Shim sails through the rhythmic and more technically aggressive moments in the piece with aplomb, lucidly bringing out the more brilliant, satisfying arrivals in the work while maintaining a fullness and warmth in the lowest octave of the flute that is rarely ever head. The next work on the album, *Huge Blank Canvas Neck TaRoo* by Gregory C. Brown, is for alto flute and digital delay. The brilliance in this piece is the manipulation of the delay lines and the creation of appealing textures, interesting harmonic shifts, and a shifting sense of rhythm. The piece is a far cry from whatever someone may pejoratively think when they see "…and digital delay" – absolutely no awkward shifting of the feet or trying to remember the next patch. Some of the changes in the delay lines are reminiscent of Piano Phase, and a few others are sudden, abrupt departures that upend the harmonic landscape, sending the listener into a short tizzy, unsure where and how they are.

Two works on the album that inhabit similar sonic and aesthetic worlds, Isaac Schankler's *Pheromone* and Emma O'Halloran's *Pencilled Wings*, are both of a post-minimal disposition bordering on the neoromantic. Where

O'Halloran's work is buoyant and remains aloft, Schankler's work dives, rises, and plunges again, culminating in a bigness and grandeur that Shim navigates skillfully. Both works have a clarity and brilliance of soundworld that stand separate from the other pieces on the album. *Wings* is a shimmering, delicate piece that employs a sweeping filter perhaps just a little too long, and Pheromone terminates in a place very different from the onset, leaving (pardon the expression) an unanswered question after what was a long embrace of a piece: transported… but to where?

60.8% for bass flute and electronics by Douglas Laustsen is a quirky, perhaps kitschy, work for bass flute and electronics. The bass flute's strange, surreal, floating tone is beautifully controlled by Shim's playing, and in her hands, the instrument loses all traces of purported awkwardness, leaving only a shadowy and nimble voice interacting with the synthy, rhythmically jerky accompaniment. With wry humor, the piece moves back and forth between an unsteadied 808 (perhaps) and a Nouvelle-Vague-meets-Wire (*Manscape* era) sensibility. The last piece on the album, *Etude for Contrabass Flute and TI83+ Calculator*, is a short, rompish nugget of a work by Matthew Joseph Payne. The contrabass flute sounds enough like its own strange hybrid creation, an airy bark of a hound made entirely of shadow, but paired with a bent graphing calculator, we get a capricious, self-aware piece that Shim energetically beasts. My only complaint is that the piece could double in length.

Each of Shim's performances on the album is artful, robust, and technically brilliant, and her agility as a performer surfaces across the flute family. Despite a few instances where reverb was just a shade much, Shim's clear tone shines through and her playing demonstrates an unquestionable love of performance. As someone who has made a career of bolstering new music and electroacoustic music in particular, Shim is one half of the A/B Duo (with percussionist Chris Jones), who are at the time of this writing completing their first full-length album of works for flute, percussion, and various electronics, due to be released later in 2016.

Tips and Tricks

SuperCollider Tips and Tricks:
Managing a Sequence of Events

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Introduction

SuperCollider (SC) is a free, open source, cross-platform programming environment for audio synthesis and algorithmic composition, originally developed and released by James McCartney in 1996. SC is unique among peer platforms in that it provides an exceptionally tight coupling of high-level object-oriented syntax with a lean, dedicated DSP engine. It is perhaps this distinctive design that gives SC a notoriously steep learning curve, sometimes concealing introductory access points for new users, even those with experience in more conventional programming languages. The intent of the articles in this "Tips and Tricks" series is to demonstrate the power and flexibility of SC's design through simple code examples meant to stimulate further experimentation and growth, each focusing on a single topic or narrow family of topics.

This article will center on a basic approach for building and handling a sequence of events in SC, frequently encountered in electroacoustic compositions that involve sequentially-triggered cues. Max users may recognize this need as being served by the `qlist` object. Because the native SC class library provides no unified or otherwise obvious equivalent, new SC users may find it difficult to make the jump from tinkering with sounds to structuring a formal musical work. The ability to specify and manually/remotely trigger a sequence of musical events is desirable, as it provides temporal flexibility and additional creative options, particularly in comparison to a fixed paradigm.

Creating Sound Processes

Before we can write code to manage a sequence of musical events, it is necessary to first create one or more sound-generating processes that we wish to start, modify, and stop at various points throughout the composition. In SC, this is typically achieved by adding one or more `SynthDef` objects to the SC audio server. The code in Fig. 1 launches the audio server application and defines two simple stereophonic synthesis processes. For the reader wishing to code along with this article, a single statement of code (a sequence of characters uninterrupted by a return character) can be evaluated by placing the mouse cursor on that line and pressing shift-return, while a multi-line code block enclosed within parentheses can be evaluated by placing the cursor anywhere on the block and pressing command-return on Macintosh OS, or control-return on Windows:

```
s.boot; //shift-return here

(
//command-return here
SynthDef(\sin, {
   arg freq=880, gliss=1,
   atk=1, rel=1, gate=1, amp=1;
   var sig, env;
   sig = SinOsc.ar(freq.lag(gliss));
   env = EnvGen.kr(
     Env.adsr(atk,0,1,rel), gate,
     doneAction:2
   );
   sig = sig * env * amp;
   Out.ar(0, sig!2);
}).add;

SynthDef(\pn, {
   arg freq=880, q=10, atk=1,
   rel=1, gate=1, amp=1;
   var sig, env;
   sig = PinkNoise.ar(1!2);
   sig = BPF.ar(sig, freq, 1/q);
   env = EnvGen.kr(
     Env.adsr(atk,0,1,rel), gate,
     doneAction:2
   ); sig = sig * env * amp;
   Out.ar(0, sig!2);
}).add;
)
```

Figure 1. Booting the audio server and defining two synthesis processes

A detailed discussion of SC unit generators, busses, outputs, `SynthDef` architecture, etc. is outside the scope of this article, however, the

reader should be able to see that the `\sin` process outputs an enveloped sine wave, while the `\pn` process outputs enveloped pink noise that has been passed through a band-pass filter. The `arg` declaration at the top of each `SynthDef` defines synthesis controls, which the user may specify when a process starts and/or modify as a process runs.

A Synth represents the execution of a process defined in a `SynthDef`. By storing a Synth in a variable, it is possible to start, modify, and stop the process at arbitrary points in time. For example, the following code will start an instance of the synthesis process defined in the `\sin SynthDef`, with some initial user-specified values for control arguments (note that argument values that are unspecified in the Synth statement will default to the values provided in the corresponding `SynthDef arg` declaration):

```
x=Synth(\sin, [\amp, 0.2, \freq, 500]);
```
Figure 2. Starting a synthesis process

The `set` message allows modification of an existing process. For example, the following code triggers a three-second glissando from 500 Hz to 1 kHz:

```
x.set(\freq, 1000, \gliss, 3);
```
Figure 3. Modifying a synthesis process using a set message

Although it is possible to stop a synthesis process using the free message (e.g. `x.free`;), this is rarely considered desirable from a compositional perspective, as it is a hard stop and likely to produce a click. Instead, because we have included an envelope in the `SynthDef` code, we can once again use the set message to close the envelope gate and trigger the release transient, which in this case is specified to be five seconds long:

```
x.set(\gate, 0, \rel, 5);
```
Figure 4. Stopping a synthesis process using a set message

The code statements in Figs. 2-4 are activated by manual, line-by-line code evaluation, and this approach works well enough if the user wishes to simply execute a musical work by "shift-entering" through a code document. However, this approach is somewhat prone to human error and can be made more elegant with additional code.

The Function object (delineated by an enclosure of curly braces) allows the user to define and modularize blocks of code to be executed remotely at an arbitrary point in the future. In the following example, we define two functions that start and stop a `\pn` process, respectively, and thus give ourselves the freedom to execute these functions as separate actions at a later point in time.

```
(
~f0 = {
  x = Synth(
    \pn,
    [\freq, 1500, \amp, 0.5]
  )
};
~f1 = {
  x.set(\gate, 0, \rel, 2)
};
)


~f0.value;


~f1.value;
```
Figure 5. Encapsulating events as functions for remote evaluation

With these basic principles in mind, we are ready to examine an approach for handling a predetermined sequence of events.

```
0. Start a \sin process
1. Start a \pn process and modify the
frequency of the \sin process
2. Stop the \sin process and start a second
\pn process
3. Stop both \pn processes
```
Figure 6. Descriptions of simple musical events in an imagined composition

A Basic Approach to Event Structuring
The Array object is a logical choice for defining a sequence of events, as it represents an ordered collection of data. Arrays are delineated by an enclosure of square brackets, with items separated by commas. In many cases, an array holds a sequence of numerical values (perhaps frequencies of a cluster chord, or amplitude values for a breakpoint envelope), but an array may contain any type of data. By filling an array with functions that define musical events, we

can use an integer counter as an event index, and step through the array items in sequential order.

For the purposes of demonstration, we will imagine a simple composition that can be described by the following sequence of events as shown in Figure 6 above.

One possible expression of these events as SC code is provided in Fig. 7, in which we define the array *e* and fill it with functions representing our musical events:

```
(
e = [
  {   //event 0
    ~sin0 = Synth(
      \sin,
      [\amp, 0.1, \freq, 500]
    );
  },

  {   //event 1
    ~sin0.set(
      \freq, 1000,
      \gliss, 3
    );
    ~pn0 = Synth(
      \pn,
      [\amp, 0.4, \freq, 1200]
    );
  },

  {   //event 2
    ~sin0.set(
      \gate, 0,
      \rel, 3
    );
    ~pn1 = Synth(
      \pn,
      [\freq, 400, \q, 50]
    );
  },

  {   //event 3
    ~pn0.set(
      \gate, 0,
      \rel, 5
    );
    ~pn1.set(
      \gate, 0,
      \rel, 5
    );
  }
];
)
```

Figure 7. Events from Fig. 6 expressed as functions in an array

Once encapsulated in an array, we can execute these events by sequentially evaluating the following code statements as shown in Figure 8. If we stop here, our approach to performance still relies on manual line-by-line code evaluation, and is essentially identical to the approach in Fig. 5. However, as a final touch,

we can create a simple user interface that responds to spacebar presses and evaluates our array-encapsulated functions.

```
e[0].value;
e[1].value;
e[2].value;
e[3].value;
```

Figure 8. Code for executing events defined in Figure 7

This final step involves establishing a numerical counter representing our event index, creating a graphical window, and defining a *keyDownAction* to be evaluated whenever the user presses the spacebar. This action will evaluate the event stored in the array at the current index, and increment the counter, making sure to wrap the counter value to zero when it exceeds the number of events in the array. A simple implementation of this idea is provided in Fig. 9 (note that $ is used to delineate instances of the Char class, i.e. a dollar sign followed by a space represents the space character):

```
(
var w;
i = 0; //array index
w = Window.new.front;
w.view.keyDownAction_({
  arg view, char;
  if(
    char == $ ,
    {
      e[i].value;
      i = (i + 1)%(e.size)
    }
  );
});
)
```

Figure 9. A graphical interface that executes events in response to spacebar presses

Conclusions

As this article has attempted to demonstrate, it is possible to create a basic framework for an event-based composition in SC with a relatively small amount of code. From a musical perspective, the sound processes defined in this article are extremely simple and uninteresting, but have been intentionally made so in order to facilitate a clear and straightforward discussion of event management. Readers wishing to use this approach for their own works need only substitute the basic `SynthDef` objects provided

here with more interesting ones, and redefine the array of functions to reflect their desired musical events.

In addition to this article series, the author maintains an ongoing series of SuperCollider video tutorials hosted on YouTube, which cover a variety of additional topics.[1]

References

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[1] http://www.youtube.com/user/elifieldsteel

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