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Adventures in [A]Synchrony: Tools and Strategies for the Network Arts-Curious Music Educator

Seth Adams
seth.m.adams@u.northwestern.edu

Adventures in [A]Synchrony: Tools and Strategies for the Network Arts-Curious Music Educator

SETH ADAMS[1]

Abstract

Networked Music Performance (NMP) is ensemble music mediated by a network such as the internet. NMP can be usefully divided into asynchronous and synchronous formats. Prototypical examples of the asynchronous format familiar to music educators are Eric Whitacre's virtual choirs that began in 2009. A decade later, the virtual ensemble format exploded in popularity due to the COVID-19 pandemic. Although the format does not allow participants to interact with one another, virtual ensembles nonetheless provide ample opportunities for both musical and nonmusical benefits. Synchronous NMP is, by comparison, little known and rarely practiced by music educators. However, both types of remote musical projects are possible given the proper digital tools. In this article, I share the process and experience of leading two asynchronous music projects and one synchronous (i.e., low latency) music clinic. For each of the above, I will describe the objectives and method, name the digital tools used, and suggest strategies for implementation by educators. I will then discuss the bivalent nature of equity considerations presented by NMP and conclude with implications for the future use of NMP tools and pedagogy in music education.

Introduction

At the outset of the COVID-19 pandemic in 2020, educators were among those abruptly forced to exploit and push the limits of telecommunication. Almost overnight, the lexicon of professional life gained an entire new branch of vocabulary—"social distancing," "remote learning," "hybrid instruction," "Zooming in," and, perhaps inevitably, "Zoom fatigue"—as noted in a 2020 New York Times list.[2] Missing from that list were two words that are nonetheless crucial to both music and education: synchronous (at the same time) and asynchronous (not at the same time). These terms are not absolute. Artists in the field of telematics have exploited the "gray area" between asynchronous and synchronous for decades, embracing latency and other limits imposed by the form. The present

[1] Doctoral Candidate in Music Education, Center for the Study of Education and the Musical Experience (CSEME), Henry & Leigh Bienen School of Music, Northwestern University, seth.m.adams@u.northwestern.edu

[2] Tim Herrera, "The 20 Phrases that Defined 2020," *New York Times,* December 18, 2020, https://www.nytimes.com/2020/12/18/style/words-of-the-year-2020.html.

article, however, aims to provide music educators with examples and strategies for asynchronous virtual ensembles and low-latency synchronous "chambers" groups.[3]

The remote and distributed use of internet-connected computers for education is known as online distance learning (ODL)[4] or e-learning.[5] E-learning can be divided into asynchronous and synchronous formats. Asynchronous e-learning is characterized by Stefan Hrastinski as "commonly facilitated by media such as e-mail and discussion boards, support[ing] work relations among learners and with teachers, even when participants cannot be online at the same time."[6] By contrast, "learners and teachers experience synchronous e-learning as more social and [can] avoid frustration by asking and answering questions in real time. Synchronous sessions help e-learners feel like participants rather than isolates."[7] These definitions were written with a broader educational context in mind, but they point to feelings and features musicians might experience in a remote, internet-mediated setting. While asynchronous virtual ensembles use tools other than e-mail and discussion boards, their ability to enable musicians to connect when they are neither present nor immediate (i.e., unmediated) is a potent one. Similarly, remote synchronous music does not necessarily involve the asking and answering of questions, but the potential for musicians to feel they are "participants rather than isolates" is a common and crucial point. These definitions serve to contextualize asynchronicity and synchronicity for music educators as both members of the broader education field and practitioners with specific needs.

I have observed as a music educator and proponent of these technologies that many of my fellow music teachers have not considered or otherwise been exposed to the idea of synchronous music-making over the internet. Of course, both formats are possible given the proper digital tools, and successful synchronous Networked Music Performance (NMP) has been demonstrated on numerous software platforms.[8] In what follows, I will describe two completed asynchronous NMP projects and one synchronous NMP clinic performance, using these examples as vehicles for suggesting tactics and strategies music educators might employ in pursuit of similarly mediated projects. For each, I will describe the objectives and methods, name the digital tools used, and suggest potential strategies for implementation by educators.

[3] A chamber group plays music together in a single room; a chambers group therefore plays music together from numerous remotely-located rooms via network.

[4] Phillip M. Hash, "Remote learning in school bands during the COVID-19 shutdown," *Journal of Research in Music Education* 68, no. 4 (2021): 382.

[5] Stefan Hrastinski, "Asynchronous and synchronous e-learning," *EDUCAUSE Quarterly* 31, no. 4 (2008): 51.

[6] ibid., 51-52.

[7] ibid., 52.

[8] Dana Kemack Goot, and W. Scott Deal, "A Spectrum of Online Rehearsal Applications: A Potential Means for Cultural Connection," *Journal of Network Music and Arts* 4, 1 (2022), https://commons.library.stonybrook.edu/jonma/vol4/iss1/4.

Asynchronous Networked Music Performance

Network artists have a rich tradition of working with varying degrees of naturally occurring latency as well as other forms of synchrony and asynchrony.[9] For music educators, the specific asynchronous medium I wish to explore is commonly known as the virtual ensemble—a term popularized by choral composer Eric Whitacre's virtual choirs.[10] The virtual ensemble model is one of many technology-based remote learning practices that gained traction during the COVID-19 pandemic.[11] An informal internet search of these multimedia products on Vimeo and YouTube showed that they typically involved a pre-existing ensemble and a pre-existing piece of repertoire,[12] but virtual ensembles need not be so constricted.[13] There are many ways conductors and educators can exploit the multidisciplinary and multimedia potential of this asynchronous medium. The choice to center pedagogies that survive the jump from in-person synchronous to remote asynchronous music making can in turn serve to center the student's musical experience. Put another way, teachers can foreground the experience of the process rather than the finished product. For both asynchronous projects covered in this article, I will concentrate on four pedagogical strategies: creative agency on the part of the players, multiple modes of conductor engagement, the curious phenomenon of musical reaction as opposed to interaction, and opportunities for interdisciplinary connections.

Eric Whitacre's virtual choirs, the first of which was conducted in 2009, are perhaps the prototypical examples of asynchronous NMP known to music educators. Whitacre characterizes the virtual ensemble as "a user-generated choir that brings together singers from around the world... Singers record and upload their videos, [then] each one of the videos is synchronised and combined into one single performance."[14] This is a serviceable definition but omits how technical and labor-intensive such synchronizing and editing can be. It also omits the distinctly anti-ensemble fact that not a single singer could hear the other voices "around" them while they sang, despite the eventual video product showing an enormous grid of faces united in song. Instead, each singer would record while

[9] Sarah Weaver, "Synchrony: Music of Sarah Weaver and Collaborations (2006–2019)," *Journal of Network Music and Arts* 2, 1 (2020), https://commons.library.stonybrook.edu/jonma/vol2/iss1/6.

[10] Mary K. French, "Online Music Education: The Fuel Education Virtual Choir Project," *New Music Concepts* 4 (2017), http://www.studiomusicatreviso.it/icnmc/library/Paper_35_2017.pdf.

[11] Other digital tools music educators reported increased use of include SmartMusic, music notation applications, and digital audio workstations. See Phillip M. Hash, "Remote learning in school bands during the COVID-19 shutdown," *Journal of Research in Music Education* 68, no. 4 (2021): 381-397.

[12] Among some of the most viewed of such videos in 2020 were: Associazione Decanto, "Helplessly Hoping;" Salt Lake Symphonic Choir, "Somewhere Over the Rainbow;" Milwaukee Symphony, "Nimrod;" New York Philharmonic, "Bolero;" 12 Cellos, "The Swan Project;" Chicago Lyric Opera, "Ride of the Valkyries;" Chicago Civic Orchestra, "100th Anniversary Virtual Concert;" Twin Cities Youth Symphonies, "Jupiter;" National Symphony Orchestra,"Dvořák's 9th;" Boston Pops, "Summon the Heroes."

[13] Christopher Cayari, "Creating virtual ensembles: Common approaches from research and practice," *Music Educators Journal* 107, no. 3 (2021): 38-46.

[14] Eric Whitacre, "The Virtual Choir," accessed April 10, 2023, https://ericwhitacre.com/the-virtual-choir.

watching a prerecorded video of the conductor and listening to an ultimately discarded backing track.[15] Participants, however, do not necessarily feel isolated from each other under such circumstances. A study comparing traditional in-person choir to virtual choir members' self-reported feelings of belonging, connection and community found a greater average sense of social presence in a virtual choir compared to a live choir.[16] Anecdotally, virtual choirs organized by music educators may also aid in the development of a sense of community and genuine social bonding.[17] More research is needed to understand the subtleties of the human experience of making music under remote asynchronous conditions.

Considering the dearth of such research and the mixed nature of extant findings, several questions persist for prospective leaders of remote asynchronous ensembles. What are the benefits, musical and otherwise, of such projects? How are these benefits distributed amongst composer, performer, and audience? What are the pedagogical goals, advantages, and disadvantages of undertaking such projects? Here, I answer these questions based on my own experiences as a musician, ensemble coordinator, and technology enthusiast.

Conductors and ensembles had little incentive to prioritize asynchronous NMP projects during the 2010s, but with the arrival of the COVID-19 pandemic in 2020 came an explosion of virtual choir, band, and orchestra videos posted on sites like Vimeo and YouTube.[4] In an effort to learn how approaches to the format might vary, I watched as many of these videos as I could find. After two dozen or so I noticed a consistent feature: almost all used pieces of music originally intended for a shared stage in person. Perhaps, I thought, there are other ways to approach the virtual ensemble that might yield richer rewards both musically and pedagogically.

Project 1: *In C-Dorian*

With my own performance calendar suddenly bare, in the summer of 2020 I decided to put together a virtual ensemble. I did not like the idea of trying to mimic the experience of musicians in a shared location and time. Instead, I wanted to make music that fit the remote music world in which I had suddenly found myself—a stranger in a strange land. I named the group the Temporal Displacement Orchestra (TDO) and proceeded to recruit musicians from my personal and professional networks. In the following description of our first project, I will explore four pedagogical strategies: centering musicians' creative agency, varying conductor engagement, exploiting musical reaction (rather than interaction), and making multimedia and interdisciplinary connections.

[15] Daisy Fancourt and Andrew Steptoe, "Present in Body or Just in Mind: Differences in Social Presence and Emotion Regulation in Live Vs. Virtual Singing Experiences," *Frontiers in Psychology* 10 (2019), https://doi.org/10.3389/fpsyg.2019.00778.
[16] ibid.
[17] French, "Online Music Education."

Musicians' Creative Agency

As the identity of the TDO began to take form, one clear priority for the ensemble was to consider musicians as creative partners and not just performers. The creative possibilities built into Frank Ticheli's 2020 work *In C-Dorian* made it both a timely and natural fit for the TDO. This piece engages musicians' creative agency by explicitly giving them the power to make decisions that affect the cumulative piece. Like the piece it was inspired by—Terry Riley's *In C* (1964)—*In C-Dorian* comprises a few dozen short musical phrases each with an indeterminate number of repetitions, and it can be performed with practically any instrumentation. The musicians get to effectively co-write their own piece of the musical tapestry by deciding how and when to proceed to another phrase of music. This allows for nearly infinite potential manifestations of the piece with no two performances alike, giving rise to a creative energy and excitement that can transcend the leap from a traditional co-located performance to an asynchronous medium.

Conductor Engagement

Another issue faced was how to imbue the conductor's role with immediacy and interactive communication despite the asynchronous performances. I went beyond the mandatory click track to add two further elements: a xylophone part and vocal cues. Of course, these elements are not in the final product, but each provided important information for the isolated musicians as they recorded their contributions. The click track, for which I selected a clavé sound, provided the obvious: tempo cohesion. The xylophone track provided several useful cues: a secondary quarter note click with a strong downbeat,[18] a C Dorian tonal center (the four repeating quarter notes were pitched C, G, B-flat, G), an octave jump higher as the piece approached its climactic end, then added eighth-note subdivisions to prevent rushing the final gestures. My voice cues included: an invitation to the musicians ("Let's make music together!"); three count-offs for pressing record on their cameras, clapping once for audio/video synchronization, and beginning the piece, respectively; and a countdown to the ending of the piece indicating the number of measures remaining (16, 8, 4, 3, 2, 1). The latter was crucial for *In C-Dorian* because of its open-ended nature.

Equally important to me as a conductor was convincing a group of musicians—many of whom had never met one another—that they were an ensemble, a team. In service of this goal, I used skills and strategies that will be familiar to music educators: score study; communicating musical and technical goals both verbally and in writing; carefully planning my words ahead of our meetings (videoconference calls) to incite enthusiasm and camaraderie; and joining the team myself as one of the twenty-one performing musicians.

A notable difference from the process Eric Whitacre uses for his virtual choirs is that I did not create a video of myself conducting the piece, a decision based on the idiom and the specific musical

[18] Unlike Riley's *In C*, Ticheli's *In C-Dorian* remains in one meter (4/4) throughout the piece.

selection. A fair question follows: is what I was doing in fact conducting? An argument could be made that "producer" would be a more fitting moniker than "conductor." In the words of music educators Will Kuhn and Ethan Hein, producers "program beats, sequence MIDI, play instruments, run recording sessions, and edit and mix audio. Producing is a category of behavior, not a category of person. A producer creates, using whatever medium, in whatever style."[19] With an asynchronous project, these tasks may also be shared by more than one person, as was the case with this project. This flattening of hierarchy may seem discordant with the traditional composer-to-conductor-to-ensemble model, but I believe such tension offers a valuable site of exploration for the forward-looking educator.

Musical Reaction

In the asynchronous format, there is no way to achieve the immediate negotiation of pulse and pitch which typifies traditional, co-located music making. But, in lieu of such interaction, reaction to previously recorded musicians' choices is still possible. This dichotomy echoes Simon Emmerson and Kenneth Fields's discussion of presence and re-presence: "We take presence absolutely for granted in the local situation, but in distributed performance re-presenting becomes an outstanding feature."[20] In person, we can present and be present; we can act and interact. In a remote asynchronous context, we instead must represent (re-present) and react.

To realize the logistics of musical reaction, I created a 21-day submission calendar for each of the 21 musicians to record their respective part, starting with tuba and roughly moving upward in instrument range from there. Every day, either I or my mixing engineer Tom Bergeron created a new mixdown to reflect the growing tapestry of sound, sending an updated backing track for the next musician to use on the following day. This way, in addition to the conductor tracks, each musician could listen and react to their predecessors, resulting in a more musical experience for participants. Taken together, these strategies helped us to generate a finished product with which everyone, including the composer,[21] was pleased (Audiovisual 1). We considered a two-pass strategy under which a second round of daily recordings and mixdowns would allow everyone, particularly those at the beginning of the cycle, a chance to hear and react to yet more voices in the orchestra. This idea was abandoned due only to time constraints and warrants consideration for any virtual ensemble project.

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[19] Will Kuhn and Ethan Hein, "Toward a Creative Music Curriculum," in *Electronic Music School: A Contemporary Approach to Teaching Musical Creativity* (Oxford University Press, 2021), 4.

[20] Simon Emmerson and Kenneth Fields, "Where are we?: Extended music practice on the internet," in *The Routledge Research Companion to Electronic Music* (Routledge, 2018): 249-271.

[21] Ticheli writes, "You managed the slow, steady growth beautifully, right to the end. Bravo to you, Seth Adams, and to these talented musicians. Looking forward to the day when we can perform this and anything else live." YouTube comment on "In C-Dorian by Frank Ticheli - performed by Temporal Displacement Orchestra," YouTube, uploaded September 1, 2020, https://youtu.be/3NJ27P4BZh8.

Multimedia & Interdisciplinary Connections

Because the finished product is typically a produced video, asynchronous NMP projects are ripe for interdisciplinary collaboration both inside and outside of formal education settings. The Temporal Displacement Orchestra has no formal ties to any school or institution, so involving other disciplines was not as simple as going across campus to the media arts department or putting up a flier in the break room. Instead, as with the musicians, I recruited from my personal network. Ray Kingston from Earthtone Digital Lab agreed to take on both the graphic design and video editing for our virtual premiere of *In C-Dorian*. Along with input solicited from musicians during our videoconference meetings, Ray and I developed a visual aesthetic for the TDO, which Ray then spent many hours honing as he designed, assembled, and edited our first video (Audiovisual 1).[22]

Figure 1: Still image from virtual performance of *In C-Dorian*, composed by Frank Ticheli and performed by the Temporal Displacement Orchestra.

A related discipline difficult to avoid when constructing a virtual ensemble performance is that of audio mixing. This is a skill I have some experience with, but I was nonetheless thrilled when our TDO trumpeter Tom Bergeron volunteered to take on the final mix. By this point, there was a synergy taking place among the team that felt serendipitous. Thanks to the video wizardry of Kingston and the meticulous mixing of Bergeron, I was able to focus on "conducting" the piece and coordinating the process.

[22] The audiovisual excerpts listed in the essay can be found on the article home page under "Additional Files."

Project 2: *Emergent C*

As the TDO's identity began to take shape, I considered the lineage of closed-form indeterminacy, from Riley's *In C* to Ticheli's *In C-Dorian*. What might come next? How could we continue to leverage musician agency, creative conductor cues, and the ability to react but not interact? And how could our second project advance the mission of the TDO to explore the possibilities of collaborative music making across time and space? In response to these questions, I wrote a brief document based loosely on scores from the Fluxus movement, which was started by George Maciunas in the 1960s.[23]

Emergent C
for twelve musicians

Required:
1. Compose one phrase apiece, then perform it.
2. Don't compose your phrase until it's your turn.
3. Call the first phrase Twelve and use all twelve pitches.
4. Subtract one pitch from the collection and call the next phrase Eleven.
5. Proceed this way until Phrase One, when the lone remaining pitch must be *C*.
6. Permit or promote chance or choice so that expectations are elastic and boundaries become blurred.

Recommended:
7. Pick a particular emergency as the inspiration or subject of the piece.
8. Do something about it.

Optional:
9. Stick to twelve subdivisions per measure (e.g., 3/4).
10. Record one musician per hour/day for 12 hours/days (asynchronous option).
11. Use a twelve-tone row to predetermine the sequence of pitch eliminations.
12. Increase the tempo by twelve BPM each phrase (e.g., total range 48 – 192bpm).

Seth Adams
November 2020

Figure 2: The algorithmic "pre-score" to *Emergent C*. For its first iteration, the twelve composers agreed to follow all guidelines except the final two.

Like a Fluxus score, this piece consists solely of prose and suggests the political. In a departure from Fluxus, it calls for a second score, potentially in traditional notation, to be composed. One could call it a pre-score, an algorithmic score, or simply a filter into which input X goes and out of which output Y emerges. The objective of *Emergent C* was to take the musical creativity of twelve composer-performers, pass it through this filter, and let the result be whatever it would be. And similar to *In C-Dorian*, I wanted to prioritize the creative agency of musicians, multiple forms of conductor engagement, the phenomenon of musical reaction, and the potential for multimedia and interdisciplinary connections.

[23] Natilee Harren, "Fluxus and the Transitional Commodity," *Art Journal* 75, no. 1 (2016): 44-69.

We used many of the same strategies described for *In C-Dorian*; rather than reiterate these, I will focus on the novel challenges of *Emergent C* and how they were addressed (see Audiovisual 2 for the full performance of *Emergent C*).

Figure 3: Still image from *Emergent C* video. The number in the center (4) indicates how many pitches remain in the collection, counting down from 12 to 1.

Musicians' Creative Agency

Perhaps the biggest difference between our *In C-Dorian* project and *Emergent C* was the mandate for participants to not just perform but compose as well. After obtaining commitments from eleven multi-talented musicians, I assigned composition of the piece's twelve sections by alphabetical order, and volunteered to compile the work into a single score. The twelve sections were composed, at least principally, in sequence and rolled into one collaborative score, in traditional left-to-right order. (Recalling the ensemble's name, this is one type of temporal displacement.) As for removing pitches one at a time (requirements 4–5), we decided collectively that rather than use a predetermined tone row (optional guideline 11), we would let each composer elect the pitch class they wanted to remove, furthering the need for a certain amount of left to right pre-planning.

Conductor Engagement

As with *In C-Dorian*, it was important that the click track be as functional as possible. With "C" being the most important pitch class and the only one remaining by the piece's end, I set the metronome tone's pitch to C6 for beats one and C5 for beats two and three. I also added a verbal invitation for the

oboist to give an "A" tuning pitch and let several seconds elapse for musicians to tune up. Requirement 6 of the algorithmic pre-score asked that "boundaries become blurred," which proved an interesting challenge when creating a fixed backing track. Because select phrases of our collaborative score had amorphous boundaries, I added verbal cues, e.g., "Begin transition to Ten," followed a few measures later by "Now everyone's in Ten," with the word "Ten" landing squarely on the downbeat.

This project also required assembling the work of twelve composers into a single score (horizontal compilation), then editing and printing the twelve individual parts (vertical extraction). I received a collection of Finale files, Sibelius files in XML format, and one handwritten score, and I compiled them in Finale. The pre-score does not mandate any of this; another iteration of *Emergent C* could just as easily include iconic notation, verbally agreed-upon improvisation parameters, or a series of text instructions.

Musical Reaction

The asynchronous format required us, once again, to focus on the different affordances of the medium. Interaction was impossible, so instead performers reacted to that which had already been recorded. Several of the composers opted to leave wide latitude to performers. For example, the third phrase (called "Ten" for the ten pitches included) included instructions such as "ad lib, 3 consecutive 16^{th} notes of E-flat minor pentatonic (any register, anywhere in the bar)."

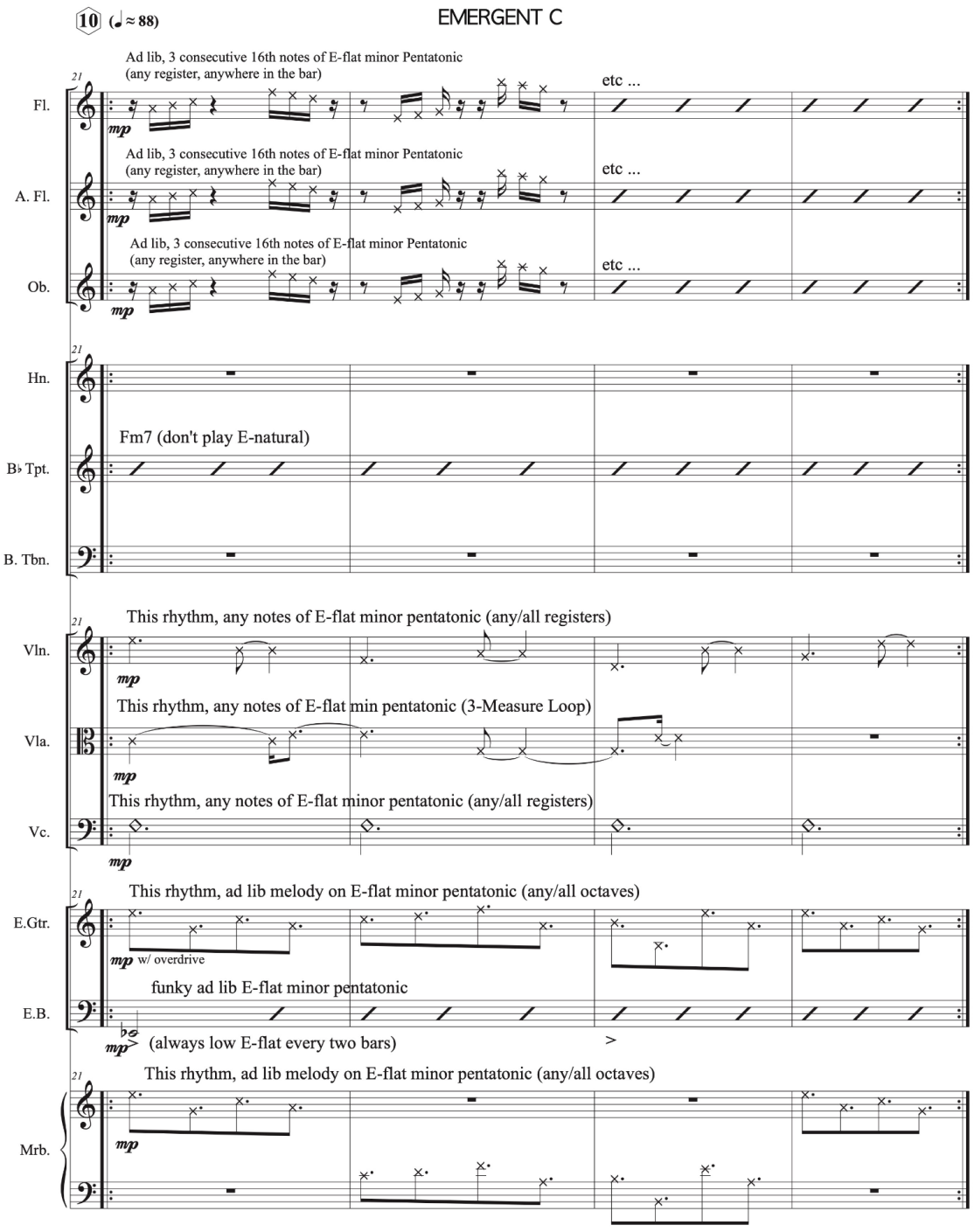

Figure 4: Excerpt composed by Tom Bergeron from compiled *Emergent C* score.

Such freedom was exciting but presented a conundrum: how could we play off of the choices made by other musicians, particularly those of us earlier in the recording calendar? In short, how could we still make music together? This time we decided that more than one round of recording would be needed, but due to time constraints we were unable to complete two twelve-day rounds. We agreed to record all twelve individuals in a single time frame, compile these recordings into a rough mixdown, make adjustments to the score, and only then begin our twelve-day recording calendar. While not ideal, this allowed all twelve composer-performers the chance to both tweak their portion of the score and to perform their individual contributions in response to an actualized, if partial, recording rather than an imagined auditory picture.

Multimedia and Interdisciplinary Connections

While the video produced for *In C-Dorian* employed a standard grid format to combine the musicians' individual recordings into a composite, the video for *Emergent C* (in which the composition process relied heavily on the number twelve) instead showed the musicians in pie wedges, evoking a clock or the circle of fifths. The video also shifted slowly from color through sepia tones to black and white, reflecting the decreasing number of (chromatic) pitches used over the course of the piece's twelve sections. Such visual tactics just scratch the surface of what is possible. One can imagine the incorporation of any number of contributing creative voices to complement a virtual ensemble's music, from the obvious technical fields of video editing, audio production, and graphic design to perhaps less obvious domains such as painting, theater, dance, or poetry. Events like the annual NowNet Arts Conference showcase the vanguard of what is possible in the multidisciplinary field(s) of network arts.

Synchronous Networked Music Performance

While synchronous NMP has so far rarely been attempted outside the telematics and network arts communities, it is now theoretically as widely achievable as its asynchronous sibling. Synchronous remote projects may remain uncommon among music educators due to the specialized tools required, but have become increasingly accessible over the past several years with, at this writing, at least a dozen software applications offering the promise of high-fidelity, low-latency audio streaming, sometimes with minimal ancillary hardware.[24] I have personally made music with others using the programs JackTrip, Soundjack, Jamulus, FarPlay and JamKazam.[25] In a recent clinic presented with my colleague David DeAngelis at the 2023 Illinois Music Educators Conference (IMEC), we used the

[24] For a helpful comparison of JackTrip, Jamulus, JamKazam, SonoBus, and Deck 10 Studio, see: Dana Kemack Goot and W. Scott Deal, "A Spectrum of Online Rehearsal Applications: A Potential Means for Cultural Connection," *Journal of Network Music and Arts* 4, no. 1 (2022): 4. For a review of two more recent and intentionally user-friendly applications (FarPlay and Soundjack LITE), see Ian Howell, "Is Real-Time Online Music Making Easy Yet? A First Look at FarPlay and SoundJack LITE," January 23, 2022, https://www.ianhowellcountertenor.com/is-real-time-easy-yet.

[25] A more comprehensive list of available software, although not peer-reviewed, appears in "Comparison of Remote Music Performance Software," *Wikipedia*, accessed April 10, 2023, https://en.wikipedia.org/wiki/Comparison_of_Remote_Music_Performance_Software#.

relatively new application FarPlay, which was developed by Dan Tepfer and Anton Runov and emerged from beta testing into a tiered "freemium" structure in July, 2022.[26] The free version of the program allows 45-minute two-person sessions, includes native video, and requires no firmware changes or additional software.[27]

Project 3: Remote Synchronous "Chambers" Music

For centuries, chamber music has been a staple of the Western art music repertory. NMP now allows us to consider the same phenomenon in a distributed nonlocal form: chambers music, which can be defined as remote, network-connected small ensembles. In this project, we demonstrated synchronous (i.e. low-latency) music to a live audience from three separate chambers: a bassist in a conference hall at the Peoria Civic Center in Illinois; a violinist in his home office in Lincoln Square, Chicago; and a pianist in his studio in Brooklyn, New York. Using FarPlay, we achieved a peer-to-peer connection with between 20–25 milliseconds of latency, which is near the maximum musician tolerance for delay in live performance and is equivalent to the time it takes for sound to travel 20–25 feet in a shared physical air space.[28] Notably, the fastest connection was not between Chicago and Peoria but rather Peoria and Brooklyn, highlighting the fact that distance is not always the primary contributor to latency.

We opted to demonstrate the unique abilities of low-latency contexts with a spontaneously chosen jazz standard. Picking the Rodgers and Hart song "My Funny Valentine," I counted us off and we played, interacting in a mixture of half- and double-time feels, the sounds of all three instruments mingling in the nearly cubical fifty-foot space in front of a live audience of music educators in Peoria (Audio 3). This successful demonstration of the current state of play for synchronous NMP portends a host of new educational applications.

Educational Applications for Synchronous NMP

Compared to asynchronous virtual ensembles, synchronous projects will typically require more planning and troubleshooting around the digital tools used. Accordingly, I will forego a list of artistic strategies in favor of more practical considerations for educators considering synchronous NMP, including descriptions of potential uses and ethical considerations of access.

Numerous applications of NMP using low-latency software are possible, including private lessons, small group practice sessions, jam sessions, chamber music rehearsals, or sectional rehearsals prior to state or regional festivals. The first question one should ask when planning a synchronous NMP session or project is: how many musicians will be participating? If the answer is eight or fewer, then a peer-to-

[26] Dan Tepfer and Anton Runov, *FarPlay*, V. 1.0.7, PC, accessed March 02, 2023, https://farplay.io.
[27] ibid.
[28] Christopher Bartlette, Dave Headlam, Mark Bocko, and Gordana Velikic, "Effect of network latency on interactive musical performance," *Music Perception* 24, no. 1 (2006): 49-62.

peer software architecture (e.g., FarPlay or Soundjack LITE) may be the best option. Projects with more than eight musicians might be better served by a hub-based program (e.g., JackTrip). The following suggested applications of synchronous NMP can work regardless of this distinction and are offered here in the spirit of generating ideas for music educators to consider.

One-on-one Lessons

For private lessons, many teachers have had success with Zoom or similar videoconferencing platforms, particularly during the pandemic. However, low-latency audio programs—many of which now include the option of live video—allow for behaviors that are simply not possible on a higher-latency videoconferencing platform like Zoom or Google Meet. Consider the difference when a teacher can accompany, clap, sing, or play in unison with the student rather than relying on the one-at-a-time model necessitated by more prevalent softwares.

Practice Buddies

Music teachers are always looking for new ways to encourage students to practice. With low-latency applications students can team or "buddy" up for music practice as easily as doing algebra over FaceTime. The time-honored practice of pairing advanced students with those who need extra help need not take place in a cacophonous music room or require coordination of after-school rides.

Chambers Music

The ability to make chambers music is rapidly approaching the ease of its predecessor, chamber music. I recently jammed with my septuagenarian father on some Stevie Wonder songs from his home in the mountains of Western Massachusetts, over 750 miles away. In another instance, I played original music with a drummer across town and a guitarist 850 miles away. Educators can now consider the possibility of chamber groups composed of members across city, state, or even national borders. Besides musical benefits, such collaborations hold the potential for new cultural exchanges, broadened social awareness, and rich cross-curricular applications. For example, it is now entirely feasible that fine arts teachers at a high school in San Antonio could organize an online concert and art fair with a partner school in Chihuahua.

Sectionals at a Distance

State and regional music festivals are an important experience for dedicated music students, and a prominent feature of many educator associations. In my home state of Illinois, students can live as much as an eight hours' drive apart, making any pre-festival section work unfeasible for the annual all-state ensembles. When using low-latency digital tools, however, students—for example, the all-state orchestra's four horns—could meet remotely for a practice session prior to festival weekend, fostering both social bonding and a sense of musical ownership. Students engaged in such remote sectionals could also gain literacy in new digital tools and build their musical problem-solving skills.

Applications toward Equity

While there is a technological barrier involving both infrastructure and hardware that could leave some on the outside looking in, educators should also consider how this technology could bridge gaps and provide increased opportunities for student access to music education. Synchronous NMP can facilitate live music making for student musicians who are immunocompromised, disabled, or who otherwise cannot be physically present. Unfortunately, a hybrid model in which an ensemble member "beams in" to an existing rehearsal with live, two-way audio is not generally feasible due to feedback issues caused by a microphone and loudspeaker sharing the same air. But for applications such as those listed in the preceding paragraphs, synchronous NMP provides the chance for richly interactive musical experiences, all possible from the comfort and safety of home. Simultaneously, the digital divide "limits those without ready access to the internet,"[29] and any serious effort in applying these new tools toward increasing equity must account for issues of access to both sufficiently powerful computers and sufficiently fast internet connectivity.

Mitigating the Digital Divide

In light of the promise and problems inherent when adopting new technologies, advocacy will continue to play an important role in mitigating the digital divide. There are several ways communities can do so, such as building publicly owned high-speed internet service,[30] investing in library computers and classes, or funding new initiatives at public schools. For the latter two, it would be ideal to offer private workstations with late model Ethernet-connected computers, microphones, headphones, and webcams, but as synchronous NMP software applications become increasingly streamlined and self-contained—as they have in the three years leading up to this article's publication—less ancillary hardware and software is necessary. The sharing of existing resources at public libraries or schools could provide a point of entry amenable to tighter budgets. What is needed above all is increased awareness and visibility of the practice of network arts and its potential to promote creativity and collaboration in music curricula and beyond.

Conclusion: Transforming Distance in Music Education

I was a first-year PhD student in music education when the COVID-19 pandemic struck. With the outlook uncertain for public performances or even private rehearsals, I saw both a need and opportunity to ask questions about alternatives to in-person music making. How could the use of

[29] John Lai and Nicole O. Widmar, "Revisiting the digital divide in the COVID-19 era," *Applied Economic Perspectives and Policy* 43, no. 1 (2021): 458.

[30] See, e.g., Jon Brodkin, "Comcast rejected by small town—residents vote for municipal fiber instead," *Ars Technica,* December 12, 2018, https://arstechnica.com/tech-policy/2018/12/comcast-rejected-by-small-town-residents-vote-for-municipal- fiber-instead/.

network arts transform our understanding of distance?[31] How can the internet and select digital tools mediate e-learning in fine arts education in the 2020s and beyond? What roles can creativity and collaboration play in a curriculum open to network arts? How can the inclusion of virtual ensembles or synchronous chambers groups complement the traditional band, choir, and orchestra model prominent in American secondary music education? I have begun to answer these questions through both practice and research. This paper has been an exploration of the former.

The asynchronous virtual ensemble can be a vehicle for diverse learning objectives. In the Temporal Displacement Orchestra we grappled with asynchrony by focusing on creative agency, conductor engagement, the multimedia nature of the medium, and the unique phenomenon of musical reaction rather than interaction. In addition to these four specific strategies, I have three broad suggestions for framing the intent of virtual ensemble projects in educational settings. First, instead of trying to simulate the in-person experience, seek methods suited to the virtual. Second, center the experience of the musicians rather than that of the audience. And third, look for ways either to reimagine existing repertoire or to co-create something new.

Synchronous NMP technology has numerous potential applications for music education including private lessons, practice buddies, student-led small groups, and sectional rehearsals. As was demonstrated at the 2023 Illinois Music Education Conference, to perform spontaneously with other musicians at considerable distance without perceptible lag time is an option no longer consigned to the remote future. Moreover, software developers' progress toward greater simplicity, speed, and signal quality has been considerable since 2020, when many musicians encountered a sudden and urgent need for such options. Concurrent with this technological progress, sustained social progress will be necessary to ensure equity of access to the kinds of musical experiences described in this paper.

I do not want to suggest that NMP is a substitute for the experience of making music in a shared physical space. But I do wish to highlight the new skills and abilities that many of us have gained in pursuit of navigating how to be together when we are apart. It would be unfortunate if, in our desire to return to how things used to be prior to the pandemic, we were to fail to build on those gains. Considering the pace and trends of technological progress, it is far likelier that we are at the beginning rather than the end of any so-called remote revolution. If first by exploring we can learn to embrace the new, a world of musical expression and artistic possibility surely awaits.

[31] Distance is transformed, for example, in the works of Paulo Chagas, in which intimate musical encounters can involve musicians thousands of miles apart. Cássia Carrascoza Bomfim, "Telematic Immersion: Performance, Technology, and Audiovisual Work in Virtual Studies (2020) by Paulo C. Chagas," *Journal of Network Music and Arts* 4, 1 (2022), https://commons.library.stonybrook.edu/jonma/vol4/iss1/3.

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