Listening in Code: Process and Politics in Interactive Musical Works

by

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## Abstract

As everyday musical experiences move further into software platforms, an interest among musicians in taking fuller advantage of computational media produces a strand of interactive, software-based musical works I call *open mediational music*. This phenomenon stands apart from other types of creative work centered on music and interaction by valorizing the listener's responsibility for instantiating musical works. It also advances an agenda of openness with respect to interactivity as a principle of new media. I center four case studies on a set of interactive musical works that exemplify this phenomenon: *Reflective* by Reiko Yamada, *Thicket* by Morgan Packard and Joshue Ott, *Jazz.Computer* by Yotam Mann and Sarah Rothberg, and *Baggage Allowance* by Pamela Z. Each of these works takes shape out of unique motivations and in different forms and settings. Collectively, they advance a notion of *platforms* as objects of critical awareness and propose *listening* as a model for mindful participation in algorithmic environments. Illuminating the distinct claims that sound and software hold on one another as creative domains, open mediational music invites listeners to rehearse a conscientious engagement with the sites and conditions of computationally mediated cultural encounter.

Thesis Supervisor: Ian Condry
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## Introduction

In this thesis I examine four interactive musical works that evidence a phenomenon I call *open mediational music*. Exploring software-based modes of interactivity while building upon the conventions of musical composition, the creators of these pieces valorize the mediational responsibility of music listeners and advance a principle of openness within new media. In the particular ways each piece exhibits these characteristics through its textual and technological layers, the figures of *platforms* and of *listening* emerge at the center of open mediational music's politics. Considered as a musical phenomenon in the climate of algorithmically treated cultural materials, open mediational music proposes listening as a critical mode of attention and adopts the notion of platforms as an organizing focus for that critique.

I gather these four works, all developed between 2010 and 2015, in order to take stock of a present impetus behind the particular line of software-dependent musical creation they exemplify. Reiko Yamada's *Reflective* occupies a bounded space within a gallery, into which listeners are invited one at a time to experience a four-minute sound piece that responds to their movements. Morgan Packard and Joshue Ott's *Thicket* weaves shifting audiovisual terrains that react to the listener's touch. Yotam Mann and Sarah Rothberg's *Jazz.Computer* fills a web browser window whose visitor scrolls to influence the energy of a song. Pamela Z's *Baggage Allowance* web portal presents an array of musical elements that behave both like objects in a gallery floor and like sampler instrument, forming a link among this and the two other versions of the work. These pieces deploy interactivity in strikingly different ways and toward unique ends. In their implementations, they depend on different infrastructures: Max/MSP, Adobe Flash, and original software libraries for C++ and JavaScript variously underpin these four works. No one particular technological change event has precipitated them, nor do they collectively form a break from past explorations of interaction in music. They evidence a turn in creative agendas

away from any vision of participatory media that strives singularly toward the eradication of distinctions in an artwork's authorship and reception, moving instead toward productive commentary on new platforms for musical encounter as well as established modes of listening.

The theoretical unit of the *musical work* emphasizes mediation as one significant characteristic of this phenomenon. Georgina Born argues that too little has been done in treatments of the work-concept in music to account for its destabilization in new technological situations. She advances a focus on mediation as the key to identifying "shifts in the dominant historical forms of musical assemblage."[1] Applied comparatively to the production of distributable music pieces in the recording apparatus of rock music, as an example, and to the development of an interactive musical work, a mediation-centered account identifies a reduction in the layers of intermediation between a musical idea and its entry into the space of reception. It also, however, makes clear that in both cases, the listener bears a final responsibility for activating an inscribed object and thereby instantiating the work as a sound-structure. Interactive musical works, by transforming and individuating that moment of activation, valorize an act already familiar to listeners. Declining the distinction-erasing project of some participatory media and instead orienting its conception around this mediational moment of listening, open mediational music offers one kind of re-stabilization for the work-concept through the same technologies that contribute to its destabilization.

The use of "interactivity" risks becoming a truism in its applications to music and to computational media alike. The nature and aim of interactivity in the works studied, however, elevates openness as an agenda that unites multiple arguments about interactivity. Digital recordings contain inherently interactive properties; that listeners do not typically experience

[1] Georgina Born, "On Musical Mediation: Ontology, Technology and Creativity," *Twentieth-Century Music* 2, no. 01 (March 2005): 8.

them as such suggests a concealed potential in recorded music that interactive musical works seek to expose and employ. The metaphor of the *black box* as an algorithmically inscrutable process-container, and its attendant call to break open that container, links the computational design of these works to broader new media traditions. At the same time, the deviation of musical interaction mechanisms from those of hypertext narrative point toward a type of interactivity that Lev Manovich designates as "open," characterized by structural as well as elemental rearrangement.[2] George Lewis contributes a third meaning of "open" in calling attention to the danger that interactivity might be subsumed under commercial purposes.[3] The infrastructural layers of interactive musical works, often formed in keeping with open source software principles, are thus joined with the works' textual layers in the politic of openness they mutually advance with respect to computational media.

Having established *open mediational music* as a framework for assessing exemplary projects, I begin that investigation with a case study of *Reflective*. Originating in a moment when Yamada was simultaneously feeling frustration at the lack of audience engagement live performance afforded and recognizing a collaborative relationship with the Max/MSP programming environment, *Reflective* shows the process and product of a composer's movement into the field of installation work. Having selected movement as a parameter by which listeners could influence and thereby engage with the piece, Yamada made sure *Reflective* retained certain formal aspects of a musical composition—namely, that it had a beginning and an end. The dark, solitary enclosure where the individual listener encounters the piece suggests an isolation of sound from sight, but Yamada reveals that the darkness was in fact her latest approach to a challenge she continually faces in her interactive pieces: people probe at the piece, frantically

[2] Lev Manovich, *The Language of New Media* (Cambridge, Mass.: MIT Press, 2002), 40.

[3] George E. Lewis, "Too Many Notes: Computers, Complexity and Culture in Voyager," *Leonardo Music Journal* - (December 1, 2000): 36.

testing the extent of their control, when she wants them instead to experience the piece with a more patient, reflective mode of attention. A manifestation of Yamada's career-spanning interest in the aesthetics of imperfection, this state of listenership differs sharply from an exchange predicated on control; rather, the startling changes in *Reflective* are transportations from within the seemingly protective space of the installation piece outward into a reality where decisions are required without ever being fully informed.

Where *Reflective* demonstrates how interactivity can play a motivated and thoughtful role in a musical conception, the next case study highlights the special status of a software platform as the setting for that work. *Thicket* narrates, in the combination of its own cross-sensory mechanism and its infrastructural constitution, the trajectory by which Packard migrated from a drum and bass scene into software-based music and in particular into his collaboration with Ott. Packard and Ott were prompted by the advent of the Apple iPad to seize on that particular platform as a means of transposing their unique process of parallel technical work and audiovisual co-improvisation into a container that could be distributed to audiences—a container that recorded media did not provide. In the process of making *Thicket*, Packard co-developed a software library for audio synthesis called Tonic. The symbols present in Tonic's source code reveal individual choices—methods of conceiving and managing sound in software—in transmission from the SuperCollider programming language to Tonic through Packard. We can see *Thicket* as a point where Packard's musical practice and SuperCollider's development merge. Assembled in the software object of the musical work, these two substrates for cultural signs meet with the additional presence of iOS, the platform that in supporting *Thicket* imposes its own set of embedded values.

The case study of *Jazz.Computer* further unpacks the encounter between a work and its platform. Like Packard, Mann maintains an open source software library for making these kinds of pieces. The library, titled Tone and written in JavaScript, is tailored for building music that will be experienced in the web browser. Beyond providing the means for pieces to run in a listener's browser, though, Tone includes a special interface not intended to be seen by listeners that Mann uses to sculpt his songs in the browser. That compositional interface completes what he considers a valuable linkage among production, distribution and reception by way of their mutual location in the same technological site. Tracing the beginnings of his experiments with interactive music to the release of the Web Audio API, Mann reveals that his interest in the web and his interest in interactivity originate together and remain closely intertwined. The centrality of the web browser as platform to Mann's creative process in general is emphasized by *Jazz.Computer*, which itself takes up a critique of that platform. Mann chose to isolate scrolling as the audience's sole mode of influence over the piece, asking listeners to reflect on the meaning they lend that action in other parts of the web. For Mann, the specific platform of the web browser has been crucial in shaping the impetus, the technological capability, and the subject of his work all at once. Interactivity, *Jazz.Computer* argues, is not just a tool, but something to be wrested back from interfaces that abuse it and brought through music into a more conscientious exchange with the listener.

Finally, a case study of the web portal to *Baggage Allowance* advances the focus from the politicized platform to an ecological understanding of platforms and software-situated artistic work. In this interface, hovering and clicking, rather than scrolling, activate the piece, making *Baggage Allowance* less an exchange with the web browser itself than with a set of musical objects. These virtual objects have physical counterparts: the web portal is one iteration of

*Baggage Allowance*, which also takes the forms of a gallery installation and a live performance. Z conceived of all three iterations of *Baggage Allowance* from the outset, and her construction of each involved translating elements first realized in one setting into the others. The web portal reflects this translation in the correspondence of its objects, arranged in a browsable hierarchy, to pieces Z built for the gallery installation. However, its mechanism of hovering, where moving the cursor quickly over the menu of objects triggers a stereo spread of Z's vocal recordings, evokes the use of the sampler—a central tool in Z's live performances. The web portal thus completes a triangulation among all three versions of the piece. In doing so, it calls attention to the differences between their three contexts and, through their figuration as platforms, their differences not just in form but in material conditions. One material condition for the web portal that Z points out is the encroaching obsolescence of Flash, the proprietary software language with which she built the piece. By both showing a work reiterated across multiple platforms and demonstrating a danger particular to one of those platforms, *Baggage Allowance* provokes consideration of the platform ecosystems where artworks take shape and meet their audiences.

Open mediational music thus suggests the *platform* as a figure extending from a computational setting outward to broader significance for discussions of artworks' social and technological attachments. Tarleton Gillespie identifies "platform" as a contemporary rhetorical device by which new media interests loosen a strictly computational sense of the word and draw upon its other senses as architectural, figurative and political.[4] In holding this device up to the concert hall and art gallery as well as to the web browser and touchscreen device, aspects of critical awareness of algorithmic systems can take root in pre-software institutional contexts. Interactivity is only one means by which musicians further that cause of infrastructural critique,

[4] Tarleton Gillespie, "The Politics of 'platforms,'" *New Media & Society* 12, no. 3 (May 1, 2010): 347–64.

as musician Holly Herndon demonstrates by composing and framing her recorded work with an explicit orientation toward the notion of platform.[5] Open mediational music guarantees a participation in this same critical drive, inasmuch as it insists on the continuation of computational platforms as open hosts to other software applications and not just as endpoints for centrally controlled flows of fixed content. It also advances an argument, in the construction of interactive spaces, that musical experience should include the mindful formation of a relationship with the music's container.

The moment of that conscientious entrance—or decision against entrance—returns the focus of open mediational music's political agenda to the act of listening. In the face of a dichotomy between passivity and participation increasingly bent toward the logics of consumerism, these works offer a way forward through interactivity rather than away from it. As the artifacts of interactive music and of recorded music come into closer proximity with one another, the contrast between the two grows more dramatic rather than approaching a merger. This disparity arises from the institutional politics with which musical creation must contend; embedded in platforms as a manifestation of those politics, the interactive/non-interactive divide enforces a passivity on the reception of recordings while simultaneously inhibiting the presentation of interactive works as artifacts geared toward non-utilitarian artistic encounter. Taking up a careful combination of properties from musical composition and from new media, interactive musical works reorient listeners' enacted conceptions of what musical experience in computational media might be. By the same stroke, they reach beyond the musical domain, proposing listening as a model for how we can attend to the variously knowable and concealed algorithmic forces that

[5] Alex Williams, Holly Herndon, and Mat Dryhurst, "Re-Engineering Hegemony: Glass Bead in Conversation with Mat Dryhurst, Holly Herndon and Alex Williams," *Glass Bead* 1, no. 0 (2016), http://www.glass-bead.org/article/reengineering-hegemony/.

help to structure our cultural environments. Finally, these works construct spaces in which to rehearse that auditory mode of critical attention toward computational conditions.

## Chapter One: Interactive Musical Works

In shaping the framework by which this study assesses interactive musical works, I begin from the two component terms delineating that broad category: the *musical work*, as an aesthetic unit long debated in the philosophy of music; and *interactivity*, as a contested principle of computational media. By drawing on these terms and their attendant debates, I identify how the particular works taken up here as case studies act upon anxieties in the domains of music and software and arrive at a model for understanding the phenomenon they constitute. I call this phenomenon *open mediational music*, emphasizing two characteristics that emerge from the theoretical consideration: first, that these works valorize the listener's mediational role in instantiating musical works; and, second, that they unite directions for the use of interactivity in new media under the logic of openness. Having established open mediational music as a delineation of these works, I distinguish that phenomenon from other types of interactive musical undertakings—instruments, data sonification and games, in particular—while highlighting the contact points between these categories and open mediational music. This treatment sets the stage for an assessment of the case studies themselves according to the characteristic emphases on mediational listening and open interactivity, which will in turn reveal the figures by which these examples of open mediational music shape an argument about music and the technological climate of new media.

## The Musical Work

The question of a *musical work*'s existence as an object independent from other entities attached to a composition or song, and in particular the destabilization of the musical work concept by technological change, illuminates mediational listening as a significant characteristic of experiments in interactive music. While the authors of these works do not among themselves

establish a common lexicon or shorthand for such projects, their descriptions generally orbit the work-concept. *Jazz.Computer* is an "interactive song,"[6] *Baggage Allowance* features an "interactive web portal" component in a larger "intermedia work,"[7] *Thicket* is a "generative art and sound app" containing "song-like audiovisual pieces called modes,"[8] and *Reflective* is an "interactive sound-art installation and electro-acoustic composition."[9] The uses of "song" and "composition" anchor *Thicket, Jazz.Computer* and *Reflective* to a musical domain and invoke music-world conventions in structuring the listener's expectations, such as a rough sense of the time needed to experience one unit of the work and the extent of its aesthetic coherence and variation. Since these pieces generate both audio and visual content in response to user input, their presentation as musical works in the first place is tightly coupled to their borrowing—and breaking—of conventions from the song. Z opts for less convention-bearing terminology in her project's framing, specifying that *Baggage Allowance* is part of a "work" but leaving unspecified its orientation toward music; the listener, whom Z ushers into an exploratory role, is left to infer the centrality of music to the project's authorship by way of Z's self-identification as a sonic composer and by way of the settings for other versions of the piece, namely the concert stage. Her careful avoidance of terms like "song" reinforces the potency of conventions and expectations attached to even nebulous musical concepts.

Locating what is most accurately meant here by "song," when musicians do choose the word, sheds light on the aspects of the work-concept applicable to interactive music. The song, in one sense, seems to stand in for the musical work in the Platonist formulation, which Lyda Goehr elaborates as a "distinctly existing object" whose creator is more than "the original generator just

[6] Mann and Rothberg
[7] Z, "About Baggage Allowance"
[8] Ott and Packard, "Thicket"
[9] Reiko Yamada, "Installation," April 13, 2016, http://www.reikoyamada.com/Reiko_Yamada/installation.html.

of a chain of performances and score-copies."[10] At the same time, the term "song" also figures heavily in the material logics of music's recording, distribution and playback. A listener describing a song, in the rock music milieu for example, can fluidly refer to it both as that which precedes the performance and that which follows from the performance: the inscribed recording, or even the inscriptive object that contains it. The song takes part in a one-to-one mapping between units in a conceptually grouped set of works and divisions in an inscriptive storage system—that is, each track in an album corresponds to one band of a vinyl record or one sub-length of tape or one audio file, and "song" can refer to those material recording segments just as readily as to the compositions themselves.

In this latter sense, the song is bound via the recording's "sound-structure" to a particular performance in a way that the musical work, per the Platonist view, is specifically not bound.[11] The performance, however, is a site of far greater flexibility than the song whose twin formulations flank it. In the case of the studio recording, the professional engineer privileges the moment of mediated playback rather than the moment of performance: the performance undergoes adaptation through methods like overdubbing, while separately mastered versions of the recording are often made for the immutable playback formats in which the recording will be distributed. A typical listener to commercial pop radio in the United States, for example, would not feel that a studio recording is counterfeit when told that the recording has in fact been patched together from multiple performances or takes. Furthermore, in many musical traditions a recording can be generated in software without any synchronous moment of recorded performance and still maintain its song-ness in the understanding of the listener. A one-to-one mapping between performance and recording, in other words, is clearly not part of the song

[10] Lydia Goehr, *The Imaginary Museum of Musical Works an Essay in the Philosophy of Music* (Oxford; New York: Clarendon Press ; Oxford Univ. Press, 1992), 45.

[11] Goehr, 45.

concept. The performance is an abstract event synthesized by the figure of the recording in order to channel the musical work into its inscriptive object, which along with the listener co-instantiates the work.

While the ambiguity of "song" complicates an effort to establish the term's bearing on interactive musical works, its dual reference actually provides a crucial clue toward reconciling these musical works with their constitutive software programs. For an interactive musical work to present itself as a song or as song-like, all that needs to happen to the two-pronged notion of the song is for the already flexible figure of performance to slip outside its central post between the work and the instantiation. Parts of the performative act become bound to the formation of the work: the collecting of sonic materials and the writing of code are new stages of composition, not acts to be repeated like the generation of scores and performances. Other parts are bound instead to the act of listening: in *Thicket*, for example, the listener manages surface-level structures of rhythm and dynamics within a deeper progression of musical sections determined by the program.

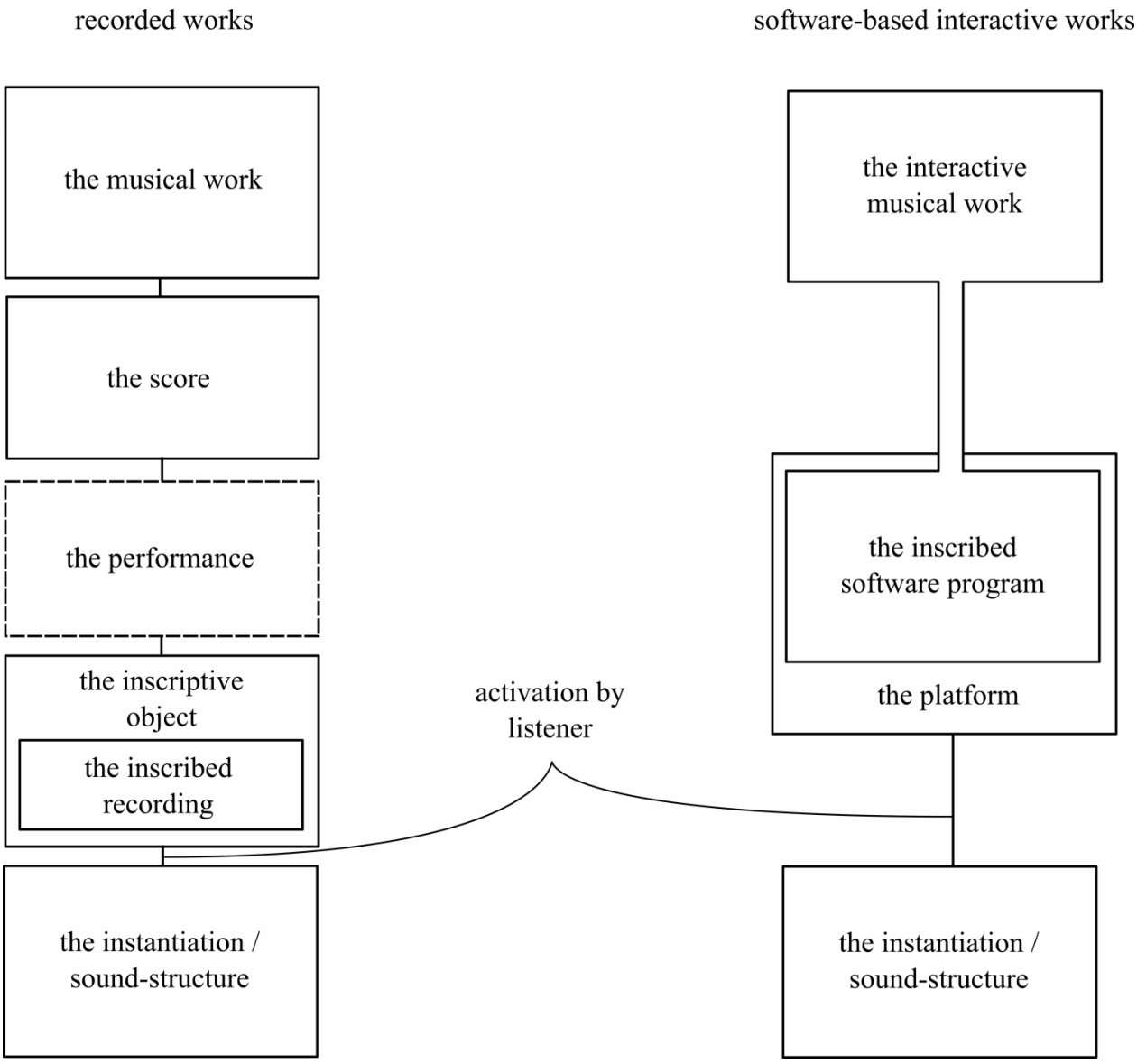
An interactive musical work replaces both the score and the inscribed recording with an inscribed software-object. This program is not itself an instantiation of the work, but it is the object that the listener activates to instantiate the work. The same could be said of a recording inscribed in a physical medium or a digital audio file, as Tom Roberts points toward with his phenomenological treatment of digital audio in relation to the metamedia concept. Unlike the object of the recording, though, interactive music situates action within the object rather than outside it: while the object of a digital audio file is a concretized "vessel for data"[12] whose activation by a media player produces the sound-structure, the object of the song-like application

[12] Tom Roberts, "What's Digital in Digital Audio?" (Goldsmiths University, 2015), http://www.tjroberts.net/papers/2015/11/9/whats-digital-in-digital-audio, 7.

itself produces, as a sub-process of a larger containing platform, the environment from which a sound-structure emerges. Materially, both objects are bundles of data. The key difference is that the audio file's data are interpreted as measurements, while the application's are interpreted as instructions.

Interpretation as instructions, of course, suggests that an interactive musical work's software-object should be considered a score. The figure of interactivity does not diminish that similarity, since musical traditions like jazz have created conventions by which a score can instruct performers to improvise for a section, managing the same kind of negotiation that interactive works manage between control of select elements. What most clearly distinguishes these software-objects from scores is instead their relation to the musical work. Precluding the possibility that scores could in themselves be musical works, Jerrold Levinson asks, "Did Beethoven compose a score? No, since many are familiar with Beethoven's composition who have had no contact with its score."[13] Levinson's distinction of score from work breaks down with respect to interactive musical works, which are fully realized only through the direct mediation of the software-object. It is impossible to gain familiarity with the interactive work without the immediate presence of this score-like object. The figure of the score thereby becomes absorbed by the musical work, and the software-object can only be understood as attached to, rather than separately proceeding from, that work. This understanding clarifies the coupling that occurs in "interactive musical work"—the term does not denote a subset of musical works whose instantiations are interactive, but rather a fundamentally different kind of creation with a referent in the work-concept.

[13] Jerrold Levinson, "What a Musical Work Is," *The Journal of Philosophy* 77, no. 1 (1980): 5.




*1*: *Musical mediation*. Objects form different mediated chains from musical work to sound-structure, for musical works in the studio recording apparatus vs for interactive musical works.

As Georgina Born notes, musical situations that predate software-based interactive pieces have already done a great deal to destabilize the work-concept, whose philosophical formulations lag behind out of a "reluctance to pursue the significance of technologies of music production and reproduction for the shifting ontology of contemporary music."[14] Emphasizing mediation as the key to identifying "shifts in the dominant historical forms of musical assemblage,"[15] Born prompts the question as to whether technologies that invert links in the chain from work to sound-structure—for example, MIDI transcription software that generates a score from a performance—have upended the work-concept altogether in its meaningful application to how music comes into existence and encounters listeners. At the far reach of her investigation, following a case study of "digitized music and South Asian diasporic flows," Born finds the

> potential for a new music ontology, as anticipated in jazz and implied by Latour: from the modernist logic of universality and identity – the musical 'I' who, isolated and apart, appropriates and frames musical others within the musical work – to one of the weaving and spinning of musico-social relatedness. This is a music in process, predicated on the suspension of any master discourse – an aesthetics of mutual encounter, of bridging and negotiation, not an aesthetics of appropriation and subsumption of an other. It augurs a relational aesthetics, one with roots in the movement between performance and reified object and the dialogical musico-socialities of jazz.[16]

This new ontology comes into consonance with the broader push of participatory media, which figures digital infrastructures as means of leaving behind hierarchical modes of cultural transmission and, in their place, shaping and reshaping systems of egalitarian exchange. In some senses, interactive musical works testify as well to this potential, forging grounds for fluid negotiations among performances and software objects. At the same time, they decline to erode the musician-listener distinction in the way that participation-centered ontologies indicate. In other words, interactive works are still works; they ask listeners for activation but, imposing carefully defined bounds of sonic and interactive possibilities, they retain the author's status as

[14] Born, 10.
[15] Born, 8.
[16] Born, 30.

the initiator of a dialog and the listener's role of willfully joining it. As much as interactive musical works echo the call to re-evaluate the destabilized mediational relationships that carry a musical idea into existence as a sound-structure, they also help to re-stabilize the work-concept and to propose an updated but continuing role for authorship and for listening.

Rather than replacing or reinventing the act of listening, open mediational music valorizes the same responsibility for instantiating musical works that listeners already hold in the apparatus of recorded music. These works lend considerable new complexity to the mediational moment of listener activation, taking charge of and subsuming under the purpose of listening the elements of tactility and visuality that the recording apparatus delegates to playback formats. To finally address the question, "What do musicians mean when they describe interactive works as songs?" it can be understood that these musicians want not only to conscript established formal conventions as guide rails for listeners, but also to prepare listeners for a recognition that an act already familiar to them has been made newly significant. In eliciting that recognition, these pieces not only explore new possibilities for music and listening, but ask their audiences to reconsider the responsibility that attends and has attended listening in other, longer extant settings. In open mediational music, the interactive musical work establishes a counterpart to the musical work, distinct from it but engaged in both its past and its continued vitality.

## Interactivity

As with the term *musical work*, the use of *interactivity* to characterize the projects studied here summons a fraught and long-running line of conversation—and again, that debate contributes to the framework by which we can identify this strand of musical creativity and its significance. Cautioning against buying into a tautological "myth of interactivity," Lev Manovich asserts that the term on its own does not bear enough specificity when applied to computational media: "Once an object is represented in a computer, it automatically becomes interactive."[17] At first glance, this reasoning posits a firmer boundary between digitally and non-digitally stored musical recordings than between interactive and non-interactive musical works, so long as both are digitally encapsulated. Such an arrangement, though, is strongly disputed by Manovich's similar cautioning against the term "digital." Jonathan Sterne also defends against digitally as a basis for distinctions in the particular case of sound, citing the "practical considerations" of cultural use and convention: "Even in the *most* digital situations—where the music is completely composed and recorded on computers, reproduced electronically, and published on the Internet—most of the actual musical event still happens as sound in the nondigital parts of the social world."[18] Taking up Sterne's question of "What's Digital in Digital Music?," Roberts finds the digital audio file's interactivity in subsurface layers exposed by digital audio workstations and network logics; yet, still, "The average technician, listener, receiver of digital audio in contemporary software is either unaware, due to the black box nature of software, or unmoved by the processes under which audio has been modulated in its

[17] Manovich, 55.

[18] Jonathan Sterne, "What's Digital in Digital Music?," in *Digital Media: Transformations in Human Communication*, ed. Paul Messaris and Lee Humphreys (New York: Peter Lang, 2006), 106.

digitization."[19] The digital audio files categorized as songs and recordings, in other words, cloak their own interactive characteristics.

A line of investigation that works from the data structure upward, then, suggests that interactive musical works reveal, rather than invent, interactivity in digitally mediated music. The notion of revelation from within a computational system's concealing boundaries resonates with the metaphor of the black box: a problematically opaque container whose inputs and outputs can be observed but nothing else, as in the title of Frank Pasquale's 2015 book *The Black Box Society: The Secret Algorithms That Control Money and Information*. Michael Murtaugh writes that "Interaction is linked to a tradition of engineers, mathematicians, and software hackers looking for a way to break out of the rigidity and the strictness of their systems—out, as it were, of the black box."[20] While noting the overuse of the terms "interaction" and "interactivity" in regard to computational media, Murtaugh ties the multivalent creative impulse toward interactivity into a more technical history through the act of breaking out of the metaphorical black box. Applied to the musical domain, the black box is not just the digital audio file, but the whole apparatus of recording in which the audio file figures and for which it serves as a synecdoche. Interactivity, as artists convey when they describe a software platform as a more natural vessel for their musical ideas than a recording would be, does not augment a musical piece as a layer grafted onto its manifestation as a recording; rather, it is conscripted in order to maintain the openness of a dialogic channel between musician and listener that the recording apparatus would obfuscate.

Interactivity, in Manovich's definition of it as a popularly held notion about new media, manifests a hypertextual mode of participation where "the user becomes the co-author of the

[19] Roberts, 15.

[20] Michael Murtaugh, "Interaction," in *Software Studies: A Lexicon*, ed. Matthew. Fuller (Cambridge, Mass.: MIT Press, 2008), 143.

work."[21] The works studied here advance modes of interactivity that at times overlap in their conventions with those of hypertext, especially in the case of *Baggage Allowance* and its cursor-based navigation of hierarchically structured objects. Yet even this work does not point toward co-authorship. Espen Aarseth, in his typology of non-linear texts, indicates two variates of the traversal functions that can help explain sonic works' distinction from hypertext. One variate is determinability: if any given combination (scripton) of textual units (textons) is always navigably adjacent to the same scriptons.[22] The conventions of a hypertext narrative fit the criterion of determinability, as does *Baggage Allowance*; the three other musical works studied here each incorporate some element of indeterminacy through random value generation. Another variate, though, is transiency: "If the mere passing of the user's time causes scriptons to appear, it is *transient*, if not, it is *intransient*. If the transiency has the nature of "real time" it is *synchronous*; if the relationship between the user's time and the passing of fictional time is arbitrary, we call is *asynchronous*."[23] Here the contrast between interactive narrative and interactive music is sharpened: sound's adherence to temporal structures guarantees synchronicity in *Baggage Allowance*, yet at the same its possibilities for interlayering within a synchronous temporal space outstretch those of visual media. *Baggage Allowance*, in synthesizing aspects of a gallery installation with aspects of a sampler-centered music performance, merges the sound *resulting from* navigation with the sound sought *through* navigation, and this merger is realized in the gestalt sound of many vocal samples intersecting one another as the visitor moves the cursor from one element to another. The encounter is only completed by the combination of multiple synchronous elements into a new texture with its own transience, a layer of the sonic encounter

[21] Manovich, 55.

[22] Espen J. Aarseth, "Nonlinearity and Literary Theory," in *Hyper/text/theory*, ed. George P. Landow (Baltimore; London: Johns Hopkins University Press, 1994), 61.

[23] Aarseth, 62.

that detaches from the indexical relationship between clickable object and sample. These moments emphasize that time inside the space of the piece, though synchronous, is not "the user's time" but an aspect under negotiation between the piece and the listener.

These interactive musical works, though fostering an augmented listenership where the responsibility for activating and individuating an instance of the musical work is heightened, do not invite listeners to consider themselves as co-authors in the way that the creator of a hypertext work might intend. The lack of resonance between the forms and principles of interactive music and those of the hypertextual mode suggests a categorization apart from branching interactive structures: in contrast to this "closed interactivity," Manovich demonstrates an "open interactivity" wherein "both the elements and the structure of the whole object are either modified or generated on the fly" through approaches "including procedural and object-oriented computer programming, AI, AL, and neural networks."[24] The figure of AI, though absent from the technical implementations studied in this scope, connects these musical software-objects to the improvisational systems devised by George Lewis; moreover, the code underpinning these works recurrently shows principles of object-oriented programming and structural mutability to be central to their creation.

Lewis, writing about his work in developing the improvisation-oriented interactive musical system Voyager, spotlights interactivity as a productive concept in danger of becoming fixed within the confines of commercial purposes. He finds that "Interactivity has gradually become a metonym for information retrieval rather than dialogue, posing the danger of commodifying and ultimately reifying the encounter with technology."[25] Lewis sees his work on Voyager as resisting that trend by importing an African-originating "aesthetic of variation and difference"

[24] Manovich, 40.
[25] Lewis, 36.

into computational settings more often characterized by expressions of control in European traditions. Works like *Reflective*, meanwhile, exhibit a great deal of attention toward bringing the listener into a meaningful conversation with a carefully designed mode of interaction. The specific musical properties of *Reflective*, such as its fixed duration, ensure that the encounter is not a one-way retrieval of sensory information but a sustained experience. In joining Lewis' push against the imposition of corporate logics onto interactivity, these works bring another meaning of "open" into their approach to interactivity, one consonant with the anti-proprietary values of the free and open source software movement.

Openness elaborates a path by which artists' decisions in interaction design connect to the choices that frame the infrastructural implementation of these pieces, namely the valuation of working in and upon open source code. These pieces frame interaction as an interpretive and imperfect process. By releasing and documenting substantial portions of the code they write in realizing their musical works, exposing the functionality that underpins their works to other authors, artists like Morgan Packard and Yotam Mann integrate the revelation of digital music's interactive possibilities in the plane of listenership with the presentation of those same possibilities in the site of production. As texts, to adopt Aarseth's distinction, the informative and interpretive aspects of these works are linked in their mutual push toward openness. The aim of breaking open the black box of musical paradigms, particularly the recording apparatus, brings the works of Reiko Yamada and Pamela Z into alignment with this same impetus toward openness, as does the suitability of Manovich's definition of "open" rather than "closed" interactivity toward the ways all four works deploy interactivity. The study of these works, while drawing on typologies of interactive media developed outside an auditory context, proposes that

musical works bear a unique claim on interactivity when they adopt it and that this claim centers on openness.

## Scope, Precedents and Methods

The phenomenon of open mediational music excludes adjacent categories in which both musicality and interaction play similarly important roles. The field of instrument design constitutes one such category, particularly as it undergoes a movement into software domains. Instrument makers share many of the same pursuits and practices as the authors of the works in question, including deep attention to user interface design, multi-sensory modes of input and response, and the codifying of gestural expressions as language. In more concrete terms, music technologists often aim explicitly to disrupt the distinction between composition and instrument: for example, Brian Eno and Peter Chilvers describe their iOS application *Bloom* as "Part instrument, part composition and part artwork,"[26] a segmentation that manifests within the app through separate "Listen" and "Create" modes of a singular interface. The same divide, predicated on instrumentality, structures Toshio Iwai's *Electroplankton*, an interactive musical experience for Nintendo gaming platforms that offers a choice of "Performance" and "Audience" modes.[27] Instrument makers provide the ground for Mark Butler's ethnographic inquiry into the linkages between performance and interface design, in which he connects the need for new instruments in electronic dance music to an "unmediated ideal" that arises, by way of *liveness*, in opposition to recording.[28] Similarly driven by the recording apparatus' constraint of musical expression, creators of software instruments help drive the development of the same infrastructures and populate many of the same platforms as do interactive musical works, such as web browsers and mobile operating systems. Furthermore, their proliferation in many cases helps

[26] Brian Eno and Peter Chilvers, "Bloom," accessed April 12, 2016, http://www.generativemusic.com/bloom.html.

[27] "Electroplankton," *Nintendo of Europe GmbH*, accessed May 6, 2016, https://www.nintendo.co.uk/Games/Nintendo-DS/Electroplankton-270649.html.

[28] Mark J. Butler, *Playing with Something That Runs: Technology, Improvisation, and Composition in DJ and Laptop Performance* (Oxford University Press, 2014), 87.

to establish the conceptual space on these platforms under which other interactive works fall—for example, as of this writing, the iOS App Store features a category for Instruments but not for Artworks. Instrument design moves outside the scope of this study first in that the artifacts themselves, by virtue of their instrumentality, take on a production-oriented aspect not inherent in musical compositions. Their more meaningful distinction from open mediational music, though, is in their treatment of mediation: instead of pursuing a moment of unmediated production, makers of open mediational music emphasize the receptive listener's role as mediator.

Data sonification, as an undertaking that deploys both interactivity and musicality, also adjoins open mediational music through aspects of its inspiration and construction. The category of sonification can include, by Jonathan Sterne and Mitchell Akiyama's definition, any "use of nonspeech sound to convey information,"[29] including in sonic interface components like operating system alert sounds. By analogy to its counterpart of data visualization, the term identifies as well a more specific type of endeavor to represent data through generated audio; and as is often the case with the end products of data visualization, sonification may culminate in an interactive environment, whether that be a virtual interface where data may be sonically browsed or a physical installation whose audience influences the data and experiences a corresponding change in sound. As Sterne and Akiyama point out, sonification projects exemplify the new media principle of transcoding in their mapping of data objects from one sensory domain into another. As an auditory practice, sonification demonstrates how transcoding into sound alters perceptions of the basis phenomena, and in particular indicates features a phenomenon or data object can hold in order to be comprehensible through sonic transcoding. Since transcoding

[29] Jonathan Sterne and Mitchell Akiyama, "The Recording That Never Wanted to Be Heard, and Other Stories of Sonification," in *The Oxford Handbook of Sound Studies*, ed. Trevor Pinch and Karin Bijsterveld (Oxford University Press, 2011), 548.

figures as a central process in software-based creative work, that illumination helps make sense of what materials musicians who work in the software domain find in the world as bases for artistic commentary and what logics attend their use of cross-sensory objects in their music. Even though data sonification projects in many cases aim not just toward the production of sound but toward its arrangement into what listeners will experience as music, their informational purpose acts as a convening and mediating layer among these practices, separating sonification from the type of interactive music authorship studied here.

A third category, less easily disentangled from interactive musical works than instruments and sonification pieces, can be found in games. Game design firms like Harmonix Music Systems, who produce the *Guitar Hero* and *Rock Band* game franchises, have advanced popular notions of the possibility for interactive media to adopt musical experience as a foundation. The distinction between such music-centered games and interactive musical works often rests more on rhetorical framing than on conception or form. Fernando Ramallo and David Kanaga call their creation *Panoramical*, for instance, a "videogame-like interactive experience where you manipulate *abstract musical landscapes*" (emphasis original).[30] The description noticeably resembles those given for *Thicket*, where "song-like" replaces "videogame-like" and the notion of music as a physical space is likewise invoked.[31] Ramalla and Kanaga go on, though, to invite the user to "Immerse yourself in synaesthetic alien vistas and control them like an ambient disco-god." The promise of control, more than anything else, sets *Panoramical* aside from works like *Thicket* and indicates the best heuristic available for drawing a line between these interactive musical works and games. By applying the word "game" to their musical artifacts, creators

[30] Fernando Ramallo and David Kanaga, "Panoramical," accessed April 12, 2016, http://www.feelpanoramical.com.

[31] Joshue Ott and Morgan Packard, "Thicket," accessed April 12, 2016, http://apps.intervalstudios.com/thicket/.

summon an expectation that the mechanism of interaction will afford a mastery resulting in a reward of heightened control within the virtual environment. Despite deploying virtual environments and interaction, musicians who frame their pieces primarily as artworks invoke the expectations of the musical composition, orienting the audience more toward interpretation than toward control—even if the means of interpretation laid out for the audience are the same, for instance exploration, as their means for acquiring control in a differently framed setting.

Musical works locating their instantiation and interpretation in software-mediated encounters join a tradition of listening-centric compositional experiments. This tradition, in fact, both predates and anticipates the special significance of software to such musical ideas. Works by composers Yoko Ono and Pauline Oliveros, joining the tradition of event scores developed by George Brecht, are made audible through the interpretive reception of audience members; in some cases these sound-structures are internal to the participant's imagination, and in many the physical or imagined sound-structure is less vital to a realization of the piece than is the meditative exercise undertaken by the participant. Even without involving computer programming, this type of work resonates, through its use of instructions as material, with software: Oliveros denotes this category of her compositions as "Software for People." Describing one of these works, she writes,

> The program, or software, for the generating group [of brass instrument players], is as follows: On cue from the conductor, play a very short tone. Each player's partner then tries to react with exactly the same pitch as quickly as possible. Both players must be open to each other, as well as to the conductor, in order to accomplish this task. Either player might receive a visual cue from the respective conductor or an auditory cue from the respective partner. The ideal attention state for the player is global, which would be characterized as readiness to move, or respond, without being committed to a particular response until the cue comes.[32]

[32] Pauline Oliveros, *Software for People* (Barrytown, N.Y.: Station Hill Press, 1984), 187.

Oliveros' aims with the work appear not only to follow a logic of instruction and structured interchange familiar to computer programming, but moreover to pursue a movement on the part of the participant listener toward becoming a software object: software objects have mutable states, can be global, and respond immediately to a non-predetermined input. She hones her piece not just toward the synthesis of a particular aesthetic sensation but toward a uniquely conceived state of listening in whose formulation and agenda the figure of software plays an important role.

To better understand that role, a close examination of the interchange between the creative domains of software and music is in order. The binding of a musical work to a software-object calls for a careful attention to the labor that constitutes both elements. The attachment of these two objects happens not just in concept but in the actual labor of musical invention and software development, and it is through the juncture of these modes of labor that observers can witness the migration of creative values between them. To understand these moments of migration, it is productive to look to the individual maker of a software-based musical piece as enacting multiple roles in what Howard Becker coins an *art world*—coordinating "the activities by which work is produced by referring to a body of conventional understandings embodied in common practice and in frequently used artifacts." Where in the original sense an art world is an "established network of links among participants,"[33] attending to the non-human participants—to the very different conventions and artifacts of music and software among which artists construct links—can illuminate the interdisciplinary labor constituting these works at both social and individual scales. Susan Leigh Star calls for an "Ethnography of Infrastructure" in approaching such networks, advising,

[33] Howard Saul Becker, *Art Worlds* (Berkeley: University of California Press, 1982): 34-35.

"Study an information system and neglect its standards, wires, and settings, and you miss equally essential aspects of aesthetics, justice, and change. Perhaps if we stopped thinking of computers as information highways and began to think of them more modestly as symbolic sewers, this realm would open up a bit."[34]

An investigation of open mediational music should look at every available layer of the works—conceptual, formal, infrastructural—as inhabited by interpretable symbols, and at the bonds between these layers as sites of particular vibrancy. In cases where artists have composed and made open original software to enable their creations, a textual reading of that code supplements interviews with the artists and close readings of the works themselves; even in the cases where source code is unavailable, the stories of artists' relationships with the software structures they use provide crucial insight into the process and politics with which their musical work takes shape as interactive media.

[34] Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (1999): 379.

# Chapter Two: Case Studies in Open Mediational Music

## Reflective

Reiko Yamada's *Reflective*, a musical installation piece, originated with a desire for more engagement from her audiences. Trained as a composer, Yamada felt a mounting frustration in noticing "the audience not being totally engaged."[35] At the same time, she had been incorporating custom software into her live electronics performances using the visual programming language Max/MSP. As she continued to learn more about the capabilities of Max, she found that her own understanding of the software acted as a kind of collaborative voice, offering "another view, another perspective" on her work that helped her advance into new possibilities but did not dictate the directions she took. *Reflective*, which was her first work to rely on Max outside of a live performance setting, came about not through the implication of the software's affordances but through Yamada's longstanding curiosity about musical engagement. "When people realize that they can affect the work itself," she says, "they are a lot more engaged all of a sudden. So that's why I thought about what can I do to engage the audience, how can they participate in the sound when they don't actually play musical instruments, for example? So I came up with the idea to use the movements of people." Having selected movement as the parameter by which listeners would influence the piece, Yamada went about designing a participatory installation work that retained the formal constraints of a musical composition.

*Reflective* as installed in its third iteration—at the Radcliffe Institute in Cambridge, MA during February 2016—exists in a darkened space bounded by curtains. One visitor enters, and a four-minute piece begins. Pianist Vijay Iyer performed the recorded material that Yamada's program, using a Kinect motion sensor, intermixes dynamically in response to that visitor's

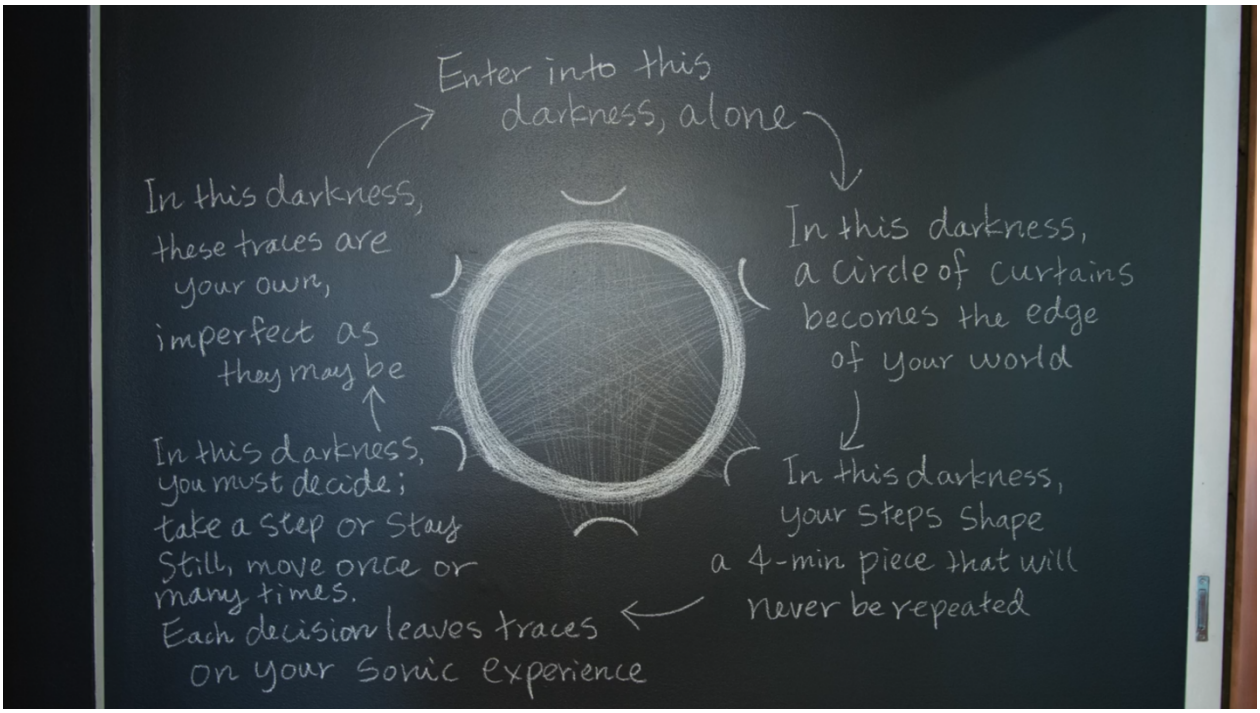
[35] Reiko Yamada, interview by author, March 23, 2016.

movement within the space. Taking a step or even moving a body part inside the small, private space of the installation triggers a subtle change in the arrangement of three persistent layers of piano sound, each with a clean and processed version, as well as the repetition of shorter, independently positioned clips that Yamada and Iyer created as motifs. Working in her mindset as a composer, Yamada says, "it was very important for me that the piece has a beginning and end, and not just this perpetual group of sound events happening one after another." In addition to gaining control over that piece, she wanted users to experience it as an intimate encounter: "in order to make things a lot more personalized, I invited one person every time to come into the installation space so that it would be a very private experience and each participant will get his or her own version of the piece." Processes beyond the visitor's influence shape the piece, so that even a duplicated series of movements will result in unique experiences. For Yamada, intimacy in an engaging exchange with the listener lies more in the individuality of the artwork's presentation than in its isolation.

The dark enclosure of *Reflective* suggests an intent of privacy and separation, both of sound from other senses and of the individual audience member from those waiting their turns outside the curtain. Yamada, though, explains that this aspect of the installation in fact came about as her latest attempt at solving a recurring problem: people move too quickly, probing a piece and its parameters too frantically for the piece to respond well or for them to receive its sound in the right frame of mind. In other iterations of *Reflective*, Yamada has used physical obstacles as a way to slow visitors down, and even, in stark contrast to the Radcliffe version, staged and illuminated the solitary listener as a performer; at Radcliffe, "this time I made the whole place very dark so that people have to be careful, so that they are scared." She reveals that the separation of sound from sight is meant not to reinforce the piece's status as a musical work, but

rather as a part of the affective preparation that forms a necessary stage of the listening experiences she designs.

Yamada also uses the word "scared" to describe audience participants in another work whose construction resembles *Reflective*'s very little. At an outdoor music festival, Yamada led a procession of musicians and audience members toward a wooded area in which she had secretly prepared a stage. "People got scared before going to the woods. Some people changed their minds and they didn't come in and they just waited there for a while," she says. The retelling highlights the role of non-participation in Yamada's participatory works: the choice of some not to participate helps cast others' entrance to the piece as deliberate and proactive, imbuing this decision with responsibility and care. In the procession piece, Yamada describes how "those who came in with us" performed their roles patiently and attentively, picking up small percussion instruments and contributing their sound as they proceeded, putting down those instruments when the group reached the stage in an understanding that a phase had begun where "we performed and they listened," and the whole time refraining from talking. Yamada seeks to find better ways of seeding this mindfulness toward participatory experience in visitors to *Reflective*, and continues to experiment toward that end. She remarks that "making all the visitors go through some kind of meditation room so that they're mentally prepared" for their turn with the piece is her ideal solution.




*2:* Reflective. This diagram appears at the front of the space where visitors wait for their turn to enter the installation's inner space where the sound piece takes place.

In lieu of such a meditation room, the hallway at Radcliffe which leads into the space of *Reflective* offers a transition into that darkened space, but also a good deal of framing material via diagrams and schematics drawn in chalk on its painted black walls. The first wall one encounters at the entrance displays the layout of the inner space and explains the basic role of movement in shaping the piece: "Each decision leaves traces on your sonic experience." As the queue of visitors progresses toward the inner space, it passes a longer wall inscribed with large-scale sketches that include graphical shorthands for speakers and sensors as well as words that follow the syntax of Max/MSP objects. Yamada explains that the content of this wall came about as a result of the gallery curator's interest in the large amount of sketches Yamada would make

during her preparation. Yamada used the wall itself as a notepad for these sketches during the final phase of her installation, her way of compromising between the curator's desire to exhibit the earlier sketches and Yamada's own discomfort with the idea. Part of this discomfort stemmed from her view that "if we want to show the process as part of the work, it has to be authentic;" another part, though, was likely that the showing of process could have exactly the opposite effect on visitors than Yamada's intent.

The obstacle Yamada faces in audience behavior with *Reflective* is not just a matter of speed versus patience, but of the goals listeners construct for themselves in approaching the piece. Many listeners concentrate foremost on discovering the exact linkage between input and change in the piece, or the mapping of movement to music, rather than experiencing the work. Yamada suspects this approach is unavoidable at some level:

> I was hoping that people wouldn't be so focused on figuring out the mapping, but I think it's necessary. It feels like everybody does that. I spoke to a neuroscientist here, and she said it's a part of our being human—animal—that when you enter a new environment, you will kind of sniff around and figure out until you feel like you know what's going on.

A listener's attention to mapping often becomes a struggle for control that can be hard to avert; in a previous iteration of *Reflective*, obstacles that Yamada placed in order to slow people down had the unintended effect of amusing listeners, to the point that they "treated it like a game." The same, she says, would happen if too much control over the sound is ceded to listeners: *Reflective* would become a game rather than a musical piece. This danger, though, is not one of category but of a larger aesthetic purpose behind Yamada's work.

Turning visitors away from the mode of inquisition into the mode of mindful, participatory listening is so important to Yamada because, she explains, only then can their experience further the exploration of *imperfection* that underlies her work.

> "What I want them to experience is this decision-making process. I've worked with imperfection as my very important aesthetic concept throughout the years, so I want people to make a decision

> and act upon it, and then there's some kind of resulting sound. And that can be very disturbing at times, it can be too loud or too distorted or something like that, and then people can step back to reverse the effect; or maybe they cannot reverse it anymore, and they have to deal with it for the rest of the time."

The confrontation of unexpected or alarming sounds, because listeners must accept them as the consequences of their decisions, is a confrontation with imperfection—a jarring transportation from within the seemingly protective aesthetic space of the installation piece into the messy, quotidian reality of uncertainties and ramifications.

Yamada's ongoing struggle to establish the right mentality in her listeners as they first approach *Reflective* suggests a generalizable problem that interactive works must face. In addition to the neurologically hard-wired urge to probe an environment that Yamada mentions, the notion of mapping—of precise correspondence between input and generated response—is entrenched in many software systems and in public familiarity with software interfaces. Designers typically steer users toward learning the language of an interface, using metaphors to guide viewers toward understanding what objects they can control and the most expedient ways they can exercise that control. This logic of utility counteracts the kind of exchange Yamada wants *Reflective* to have with listeners, one centered on imperfection. The most effective route toward that exchange, she has so far found, is for listeners to return to the piece a second time. "I hear over and over again from the people who went through the installation twice or more," she says, "that the second time is such a different experience than the first time." Repetition, in the case of *Reflective*, brings to fruition the intimacy Yamada has designed in her piece through the space and through the software processes. Returning to the piece means, for listeners, a fuller recognition of this intimacy, as well as freedom from the now satisfied urge to probe the piece's mechanism.

Repetition is deeply ingrained in musical experience, perhaps in the technological sense nowhere more strongly than through the figure of sound recording in music's mediation. Yamada, as of this writing, is composing her first work intended primarily for a recorded medium: an album of pieces derived from her work with broken accordions, another exploration of imperfection. Turning from a background in live performance and interactive works toward recording, Yamada highlights the challenge of fixing a series of musical expressions in a certain form when the terrain of their reception is so uncertain: "I'm assuming that people will just listen to one track at a time, and maybe randomized…. So I'm playing with something that can be listened to throughout and has some kind of narrative and also something that can be picked out a track at a time and also makes sense." Yamada sees a further lack of definition in listening practices, acknowledging the portable speakers and short bursts of listening that characterize her own habits in receiving recorded music and fearing that many listeners would miss out on the more subtle elements of her compositions. Yamada is exploring a solution through composing this recorded collection as variations on a theme, making changes in the sonic processes from track to track while maintaining a constant set of source material across them. Moving in the opposite direction of the path many musicians take—that is, moving from interactive work into recording—Yamada's perspective recasts constraints of the musical recording that, though taken for granted via recording's long-held privileged status in the landscape of musical experience, seem unnatural in the face of works like *Reflective* that, with their reliance on custom software, many would consider more technologically elaborate.

The contrast between Yamada's feelings toward the production of recorded versus interactive material centers mediational listening as the vehicle by which her aesthetic argument succeeds or fails in reaching the audience. The negotiation of Yamada's control over the listening

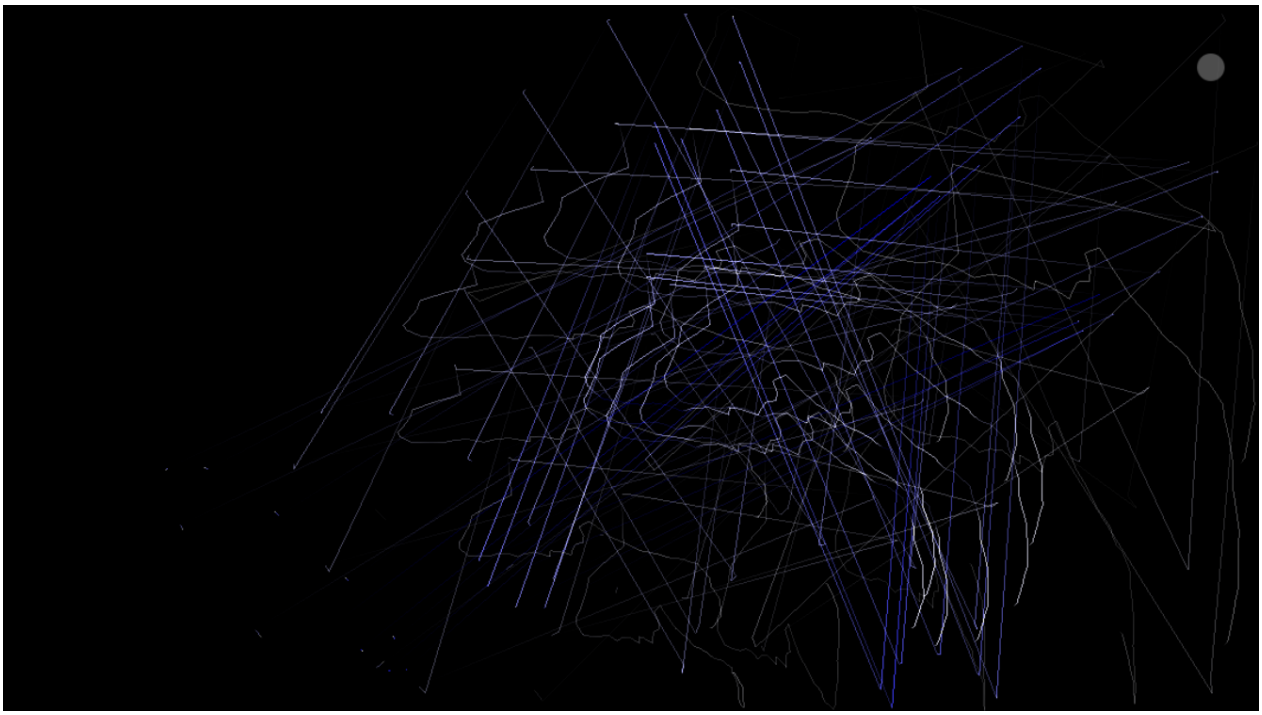
environment explains the disparity of her sentiments to some degree, inasmuch as the auditory details of her music are more at risk in the potentially low-fidelity arrangements at the end of the recording apparatus than in the high-fidelity space of the gallery installation. Yet Yamada notes her willingness to circumvent the fidelity problem, suggesting that she might use her laptop speakers in mixing the recorded work so she can compress those details into a more surefire range. The broader issue comes down to the listener's state of attention. The scrambling and division of the musical experience poses a major obstacle to transporting listeners into the role where they may effectively realize the piece; so, in a very different way, does the fact of interactivity when visitors respond to it as a challenge for control. With her interactive work, though, Yamada has an expanded chance to preclude this kind of obstacle with her influence over the framing elements of the work's setting—for example, the darkness of *Reflective*'s inner space and the diagram that users see before they enter. Her ongoing efforts to find more effective ways of shaping those elements reflect the profound challenge of staking a piece's success on the state of the audience's attention. In her emphasis on reflection and acceptance in characterizing this state, Yamada suggests that the openness in open mediational music extends as a pursued quality of the listener; *Reflective*, in its continuation of her effort to achieve that state, demonstrates that openness and mediational listening hinge on one another.

## Thicket

Musician Morgan Packard and visualist Joshue Ott were already in the practice of collaborating in "audiovisual jam sessions"[36] before they codeveloped an interactive work called *Thicket* for Apple's iOS platform. According to one informational web page on the project, "Thicket is an audiovisual world of texture, movement, line and tone."[37] More concretely, *Thicket* is an application that users may download to their iPad or iPhone from the iOS Application Store. When first opened, the application scatters its logo into a cluster of thin white lines on a black background. A pulsing, uptempo rhythm plays with mellow electronic percussion sounds. A tap on the screen propels this pattern into motion, adding accented notes to a cycling pattern and generating new lines which rotate, stretch, change color and fade. Other touch gestures, like tapping or dragging with different numbers of fingers, throw different events and effects into the audiovisual piece. While the general structure of gestural interaction remains constant, the resultant sounds and visual patterns transition back and forth in phases, in a way that feels much like a song progressing between verses and choruses. Tapping a small dot in the corner of the screen reveals a menu of "modes." These modes present substantially different systems of interaction among gesture, sound and graphics; each mode is essentially a separate piece within the container of the application.

[36] Morgan Packard, interview by author, July 21, 2014.

[37] Joshue Ott and Morgan Packard, "Thicket:Classic," accessed April 1, 2016, http://apps.intervalstudios.com/thicketclassic/.



*3:* Thicket. Patterns of line and color emerge in *Thicket*'s "SineMorph" mode in response to the same touch gestures that influence its musical progression.

*Thicket*'s information page continues on to say, "Thicket is part art piece, part toy, part wind chime, part spiderweb." This framing is at least as much invested in a playful defiance of categories as it is in establishing an actionable set of expectations for the potential user. Besides fostering curiosity, the page mainly emphasizes—without using the term itself—immersion: "world" precedes "piece," and user testimony of getting "lost" in the application bolsters the notion of *Thicket* as more of a setting than a durational experience. While "control" and "interaction" make appearances, they do so to point out the coupling between sonic and visual elements rather than to highlight interactivity as a defining feature of *Thicket*; another testimonial praises the "seamless interaction of audio and visuals." *Thicket*'s creators do not privilege user

interaction first and foremost, but rather the immersive effect of thoughtfully interlinking user control, auditory elements and visual elements. After a nod to Packard's and Ott's artistic backgrounds, the information page concludes, "Thicket is an intimate, highly personalized realization of the artistic styles they have each developed over years of dedicated work in venues throughout the world." The rendering of particular aesthetic choices, rather than the affordance of new ones, is central to the application's framing; interaction, for its part, lends individuated potency to this particular meeting of auditory and visual styles.

For Packard, *Thicket* branched from a musical trajectory into which the writing code had long been intertwined. Having participated as a musician and DJ in the drum and bass scene in Boston for some time, Packard saw that movement becoming "calcified" and more conservative in its sonic development. Shortly after moving from Boston to New York and deciding to seek out new musical scenes, he "heard somebody playing club music with homemade software, and that was a real 'aha' moment," he recalls in an interview. He felt that "there was something about what he was doing that made it clear he had a handle on a larger aspect of the sound in real time than anything I'd ever heard before." The performance drew Packard, whose artistic interest already lay in process-centric notions of repetition and change, toward custom software as a new focus in his musical practice.

A software library that Packard today maintains along with another developer shares the name of the club where he saw that performance: Tonic. That performer, whom Packard approached after the set, used a musical programming language called SuperCollider. Packard began using SuperCollider to implement musical processes he had conceived during his time in the drum and bass scene, and he continues to rely on it in his performances and recordings. Tonic's source code and example projects show a clear influence from SuperCollider. For

example, in SuperCollider, a set of one or more signal generators and modifiers are bundled together as a "synth," which then sends its audio to an output destination. Tonic projects, though written in the C++ language rather than SuperCollider, use the same term and structure: a C++ class type called "Synth" is extended, following the class hierarchy protocol of object-oriented programming, into a subclass type defined by the user with the line `class ExampleSynth : public Synth`. An instance of ExampleSynth can then be added to the signal chain with the command `TONIC_REGISTER_SYNTH(ExampleSynth);`. This instruction corresponds to the "send" method in SuperCollider that routes a synth to an audio server. While SuperCollider has many uses, its server-centric architecture makes it "ideal for realtime networked music"[38] most often presented through live performance. As a software tool that synthesizes sounds from the ground up, SuperCollider codifies a large set of decisions on how to represent auditory elements in software and data structures. Just as his use of SuperCollider influenced Packard's live performance, his development of Tonic carried many of these decisions from SuperCollider into the a new context of listener activation by reproducing them in a library for other software applications.

In co-developing *Thicket* for the iOS platform, Packard and Ott were able to retrace in software their own process of collaboration. Packard recounts that he and Ott "developed a really close symbiotic relationship where we were working on our own set ups and then coming together and having audiovisual jam sessions, where we'd have the new versions of what we had made. We'd be geeking out technically, but also aesthetically a bit." Their process was structured by separate, parallel development in each artist's own technical materials—Packard's SuperCollider patch for sound and Ott's superDraw program for visual expression—that coalesced in regular cross-sensory encounters. The architecture of an iOS application allowed for

[38] James McCartney, "SuperCollider," accessed April 1, 2016, https://supercollider.github.io.

a similar separation and coalescence: user inputs like finger taps and pinches could be sent to separate processes for generative music and generative graphics, which would then recombine into a singular audiovisual experience through the user's physical interaction with the iOS device. While audiovisual objects can certainly be presented in other platforms, the affordances of and expectations associated with iOS in particular made *Thicket*'s a particularly compelling coalescence of sound and vision. In contrast to audiovisual encounters in desktop operating systems, where sonic and graphical elements could be expected to originate in separate processes with separate windows just as often as they originate in the same. An iOS application occupies the entire space of the device's screen and, in keeping with a platform-wide tendency toward gestural and multi-sensory interface design, user actions trigger sound effects more often than they would in corresponding applications for a window-based environment. By granting it ownership of the entire interactive space defined by gestural input and sonic and graphical output, *Thicket*'s platform thus enables it to combine separate technical processes in that space and thereby to transport the user into the collaborative site of Packard's and Ott's jam sessions.

According to Packard, *Thicket*'s platform provided not just a compelling fit for the application but an impetus for the project in the first place. Packard recounts that he and Ott "saw the phone as a really interesting platform and had both been wanting to get into developing for it," and that they "took some little steps toward learning how to do it." Upon Apple's announcement of their iPad tablet, "Josh said, 'I want to make something on this that's like what we do.' So it was in anticipation of the iPad's release that we made a push to get something done so it could be in the store as soon as the iPad was released." Packard and Ott saw a platform that provided an opportunity for their work not just in terms of a device and its interface affordances, but also a means of distribution and a moment of excitement around its release on which their

work could capitalize. They were correct in identifying that opportunity: *Thicket* earned recognition from iOS users as well as from Apple's curators for App Store featured lists. The platform's economic structures additionally proved a good fit for *Thicket*, as Packard and Ott later integrated the in-app purchases model in order to provide *Thicket* as a free app with one mode included and the option to purchase additional modes for a small payment. When Packard says that the iPad presented "an obvious and naturally perfect platform for distributing what we did together," his choice of "distributing"—rather than "conveying" or "reproducing"—emphasizes that in *Thicket*'s case and for interactive musical works more generally, platforms are not simply containers for a musical work. The hardware and software elements that determine the forms available to a musical work are enmeshed with other elements that help establish its audience, the social context of its reception and in many cases the financial viability of maintaining and refining the work.

Though *Thicket*'s relationship to its platform hinges on collaboration and an interchange between sound and image, isolating its status as a musical work and Packard's role as the musical contributor portrays a convergence of cultural values through and within multiple layers of infrastructure. Packard's musical practice is one layer, where individual values like the significance of repetition wield their influence and where sounds and rhythmic elements transmitted through musical traditions from Jamaica via London via Boston are reproduced in new compositions. This practical layer takes shape not just in the techniques and interests Packard holds in his memory but also in the software and hardware components that make up his studio. Packard discusses his development in electronic music partly as a process of "building and expanding the studio," and states that "with an electronic musician, [one's] sound *is* the studio in a lot of respects." Having recentered his studio on a single, evolving code document—

his SuperCollider patch—Packard came to feel that his process was *in* that piece of software. Asked about the terms he uses for various compositional techniques, Packard says one can "look at some code and then you'd see my terms." The SuperCollider patch presents a seam where the layer of Packard's musical practice meets that of the SuperCollider language itself, putting the decisions about representation and musical utility made over the course of a long-running audio software project into an operational exchange with Packard's values and techniques. The Tonic library, in whose development Packard ported much of SuperCollider's functionality into a new computational context, retraces and reifies that seam.

Each individual technique or decision embedded in these pieces of software couples an idea about music to a method of rendering sound in software, a building block of what will ultimately be instantiated as a sensory event in a musical piece. As a category, we might consider these couplings musical *phantasms*. Fox Harrell puts forth the term "phantasm" to denote "a combination of imagery (mental or sensory) and ideas."[39] In the same way that phantasms, in Harrell's examples, provide cognitive shorthands for people making sense of their surroundings by invoking the imaginary, sonic elements that elicit the desired associations to instruments and traditions are deployed as musical phantasms by an artist in the creation of a piece that succeeds in its intended exchange of meaning and affect with the listener. Collectively, these sonic units constitute *cultural systems*—"production-oriented cultural phantasms that are distributed over many components, some of which may be material such as media." The merging infrastructural layers which transpose these systems of musical utility and meaning into new formal contexts become *integrative cultural systems*: "cultural systems that are transmitted through, and enacted

[39] D. Fox Harrell, *Phantasmal Media: An Approach to Imagination, Computation, and Expression* (Cambridge, Mass.: The MIT Press, 2013), 4.

with, media."[40] Framing Tonic as an integrative cultural system presents the software library as a point where musical traditions—the club-centered drum and bass tradition and the academic computer music setting in which SuperCollider was developed—undergo a merger through Packard's negotiation and in the specific context of a computational medium. *Thicket*, in turn, brings this bundle of cultural systems into contact with those enmeshed in the iOS platform, which both serves as the software component of the medium by which *Thicket* meets its listeners and bears its own history of development as a culturally and politically negotiated piece of infrastructure.

Harrell emphasizes that "making the cultural foundations of phantasmal media explicit" is a necessary step toward "diversifying the range of expressive computing practices."[41] The wide intention toward openness in open mediational music and its infrastructures, this call suggests, cannot be fully realized only by publishing source code. When software developers open-source their tools, as Packard has done with Tonic, their work takes on expectations of legibility and accountability for maintaining and documenting them; this step certainly advances their agenda of openness. Yet software libraries are attended by more expectations of functional clarity than cultural elucidation. Artist-technologists could further advance that agenda by shaping their code to more directly communicate the cultural negotiation they already perform in its development. Part of the mediational responsibility of listeners in works like *Thicket* is to complete the integration of different cultural systems—those in the piece and those in the platform—by activating their computational interplay and completing the transposition of musical ideas from their original contexts into dynamic configurations in a new media platform. Making explicit the cultural roots of these works, therefore, stands to serve not only the future developers of similar

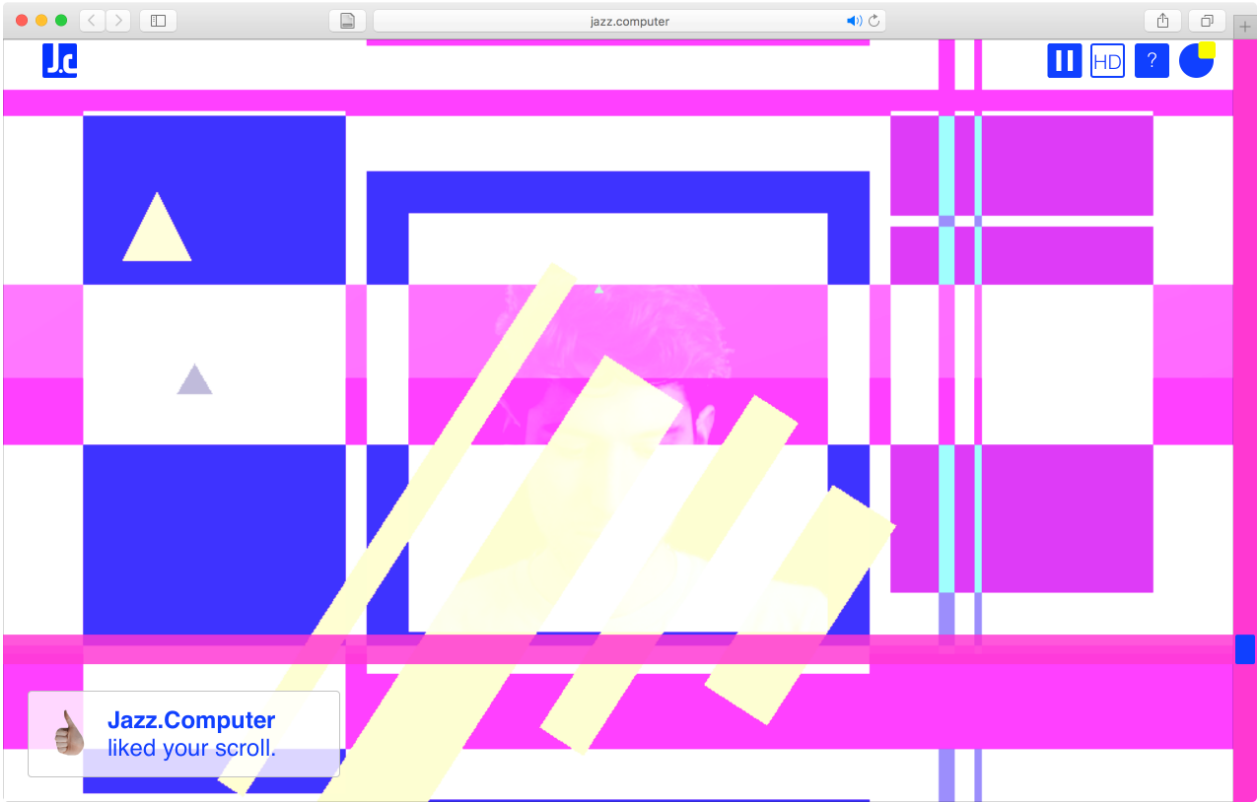
[40] Harrell, 208.
[41] Harrell, 249.

projects but also the listeners. If cultural foundations and embedded phantasms are revealed in a work itself as well in its infrastructure, the possibility for diversified production extends directly to listening practices; this opportunity strengthens a potential integration between the openness of the work and its conception of mediational listening.

## Jazz.Computer

Yotam Mann is a musician whose work frequently takes the form of web-based interactive experiences. His project *Jazz.Computer*, developed along with visual artist Sarah Rothberg, is one such experience: the piece's information page describes it as "an interactive song that responds to the position and direction of your scrolling that is generated live in the browser."[42] Upon loading, a set of blank shapes populate the browser window in an arrangement that suggests a social media platform; a box at the center frames a brightly colored "play" icon that invites the user to click and enter the piece. On clicking, a pulsating chord suggests a kind of anticipatory stasis, and an animated popup element with a thumbs-up image instructs the visitor, "Scroll to advance the song." A first emphatic scroll throws new instruments into the song, which enters a chord progression. Similar popups continue to slide onto the screen, reminding the listener to scroll more and infusing the piece with a parodic strain through their perky tone. A vocal part enters the mix, and a repeating structure of alternating progressions and arrangements becomes apparent. Every scroll effects a clearly discernible change in the piece's visual and musical elements, but not through a simple coupling of a scroll action's metric quantities to audiovisual parameters; rather, the piece creates a sensation that scrolling adds energy and momentum to the piece, increasing its liveliness and bringing about its transitions more quickly.

[42] Yotam Mann and Sarah Rothberg, "Jazz.Computer Info," accessed March 14, 2016, http://jazz.computer/info/.




*4:* Jazz.Computer. A notification element gives the listener positive feedback upon scrolling to the advance the piece, while generated shapes obscure an image of Mann singing.

Like many of Mann's recent projects, *Jazz.Computer* relies on a software library he maintains called Tone. In the "Technology" section of the information page, Mann writes that

> "Everything in Jazz.Computer is synthesized and effected live. The only sample is the voice, which is pre-recorded but triggered and effected in real-time. This is made possible with a recent browser technology called the Web Audio API and a library built with this API called Tone.js. I developed Tone.js in order to realize ambitious interactive songs like Jazz.Computer. Tone allows a developer to produce and arrange music entirely in the browser."[43]

The mediating chain of software units behind a song like *Jazz.Computer* thus includes four major players: the web browser, which presents the piece's sounds and images to the listener and the

[43] Mann and Rothberg, "Jazz.Computer Info."

listener's actions to the piece; the Web Audio API (application programming interface), a standardized set of audio-specific instructions that the web browser can execute; Tone, which abstracts functionality from the Web Audio API into forms more convenient to the developer of the piece; and, finally, the software object specific to the piece, which defines the particular musical, visual (with another corresponding chain of libraries and browser functionality) and interactive elements. As the developer of Tone and the producer of the songs that rely on it, Mann occupies two positions in this chain that are demarcated more by their separate software objects than by distinctions in the work they require.

Mann says that his work on Tone "came out of working with Web Audio from, I think, nearly the beginning…. I always needed to convert note names to frequencies, and I always needed to convert quarter notes to their time in seconds, and all of this kind of stuff. It started as just a bunch of these little modules that did that."[44] The repetition of tasks involved in early pieces Mann built with the Web Audio API led him to concretize them as reusable software objects, or modules. Both examples demonstrate the nature of those tasks: translating musical representations into mathematical quantities. As this line of development continued, "those modules then started to become a little more rigorous and a little more encapsulated. And then it kind of quickly ballooned, as soon as I thought, 'Oh, well if these three things combine, I can make this third thing and I can make this fourth thing, and I can abstract that away and I can keep building upward and upward.'" Mann's development of Tone, while continuing its emphasis on translation, took on an additional process of abstraction. Once he encapsulated these translator units as discrete objects, he could construct a system of interoperation among them, allowing for translations of greater complexity to be performed between a more abstract musical concept and a corresponding set of numerical operations. This organization follows principles of

[44] Yotam Mann, interview by author, February 18, 2016.

object-oriented programming, a modern paradigm of software languages under which tasks are managed by instances of virtual objects communicating with one another. In the current version of Tone, an artist can create an eighth note at middle C by creating an Instrument object and giving it the instruction `instrument.triggerAttackRelease("C4", "8n");`.[45] The object's "triggerAttackRelease" function initiates a chain of processes that includes both translations Mann mentions above, passing through intermediary objects such as "Note" and "Transport" along the way from musical event to machine-readable instruction.

Mann's work of combining all these processes in Tone is motivated not by convenience alone, but by the interaction of his creative process with the platform where his pieces are received: the web browser. In his first experiments with making web-based pieces, Mann says in an interview, "a lot of the early songs were [generated from materials I prepared in] Ableton Live and a lot of Max for Live…. but then I built this system so that I could totally do away with that part, so I would build it entirely in the browser." Mann implies a barrier in the production of a song's sound structure as well as in the nature of its underlying materials: the point where the pre-processed samples are handed over to the program that, running in the listener's browser, dynamically alters their sound or sequence in response to listener input. In developing Tone, in other words, Mann wanted to move this barrier to what he felt was its ideal position. The work of "building" the song moved gradually out of the domain of pre-production (in applications on Mann's personal computer) into that of the interactive song's colocated production-reception in the browser.

Mann emphasizes that the principal target of this transition was not the range of sonic manipulations available to his pieces on the browser side, but rather his own creative process. A

[45] Yotam Mann, "Tonejs/Tone.js," accessed March 14, 2016, https://github.com/Tonejs/Tone.js.

mostly hidden feature of *Jazz.Computer* testifies to this priority: the site visitor can access, through the piece's info page, the same graphical user interface (GUI) that Mann used in the course of composing the song. Mann added this interface layer, which contains a large array of sliders controlling various sonic parameters, as a solution to the time-consuming nature of composing in code: "The problem with producing music in code, or a difficult part, is the [cycle of] 'change one thing, go back, reload the page, listen to it, change one thing, reload the page'—it's very time consuming compared to normal production tools." Mann uses the GUI feature to map aspects of an in-progress piece onto a virtual control surface made familiar to the world of computer music by software applications like Max and Ableton Live. These parameters, which he must first make available to the GUI in code, allow him to sculpt the abstracted musical qualities of the piece more fluidly, both in terms of efficiency and in terms of openness to revision and experimentation.

Mann's development of Tone thus realized a movement of piece and process alike into the web browser, placing the web as a platform at the center of his artistic practice. "There was this really cool thing that I like about that," he says of using the GUI to complete his pieces, "which is the means of production and distribution as one thing: so I produce in the browser, the music is produced/reproduced in the browser, and it's also the method of distribution over the internet and through the browser." In formulating this collapse of production and reception through the internet, Mann harnesses his work to the participatory ideal of much web-based media. He also valorizes pieces like *Jazz.Computer* as musical works that listeners encounter through a fundamentally different mode of playback than the reproduction by which recorded songs are heard. This mode resembles paradigms of re-performance in pre-digital media—as Nick Seaver writes of player pianos, "Re-performance opens up the ambiguous spaces between production

and reproduction, allowing a priori for the proliferation of hybrid recording-performances."[46] Player pianos made re-performance compelling in large part by co-locating performance and reception at the mutual interface of the piano; Mann treats the web browser as such an interface and thereby derives an equally compelling effect both for himself and for listeners.

*Jazz.Computer*'s basis in software is hardly secondary to its interactivity; the web browser, a software platform, is simultaneously central to the conception, execution and experience of the work. The trajectory of Mann's work rebuts a straightforward narrative where an impetus toward interactivity in music necessitates work in software. Trained as a concert pianist into his career as an undergraduate music student, Mann first drew software into his compositional process by making generative systems in Max/MSP. His turn from these projects in algorithmic composition toward interactive pieces was coupled to an interest in the technology of the Web Audio Application Programming Interface (API): "I saw that the Web Audio API and what you could do in the browser were a different paradigm, where the distribution is instantaneous and it's not just about the software but about the interaction with the software; not just hitting play on this generative system… but touching and interacting with the songs." Intertwined from the beginning, Mann's desire to produce work for the web and his impulse toward interactivity were even more closely fused by choosing his pieces' objects of critique from within the web ecosystem. *Jazz.Computer*'s isolation of the scrolling content feed as an interface element, as well as its playful over-saturation with urges to scroll faster, advances a satirical consideration of social media platforms and the role of scrolling in prolonging a user's encounter with these platforms as the thoughtless consumption of content. In this way, *Jazz.Computer* exemplifies the possibilities of interactive musical works to deliberately and critically locate themselves in a

[46] Nicholas Patrick Seaver, "A Brief History of Re-Performance" (Thesis, Massachusetts Institute of Technology, 2010), http://dspace.mit.edu/handle/1721.1/59573, 91.

particular technological container, making explicit the socially constructed conventions of that platform at the same time that they rely on them for structure and distribution.

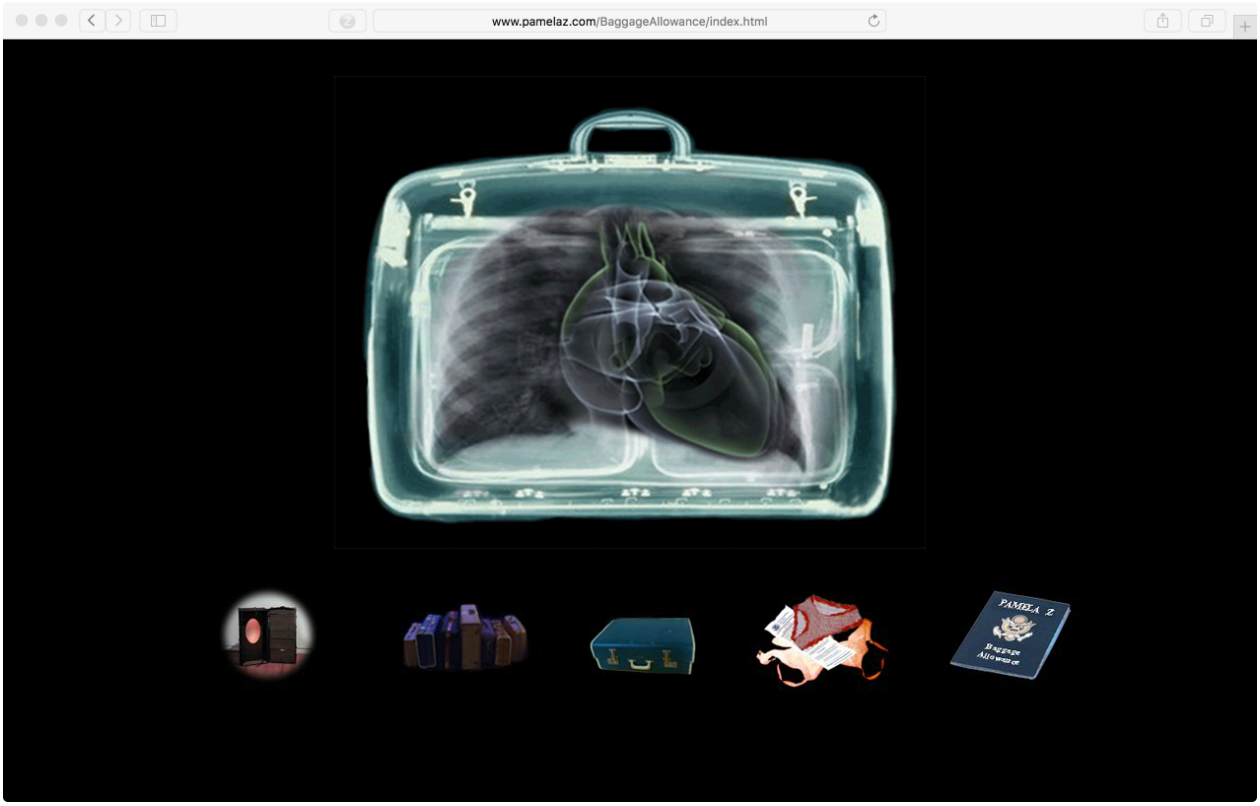
Aside from this critical centering of his work on and in the web platform, Mann works to advance the possibilities of interactive musical works by creating specific affordances for other artists. He finds one avenue for this pursuit in maintaining Tone as an open source library, carefully documented and updated with links to projects that rely on it. Another avenue is in education; Mann teaches a class called Interactive Music in New York University's Interactive Telecommunications Program. These two arenas, one framed by software development practices and the other by an institutional setting, may seem disparate, yet Mann links them closely together: "I always wanted [Tone] to be open source, and the reason was—I teach a class, and there are other people doing this stuff, and Tone has a number of users—… I want it to be in conversation with other things in the world…. Interactive music should be a thing that isn't just me making these web experiences." By portraying these axes of outreach as self-motivated, Mann demonstrates the close linkages for musical practice between impetus, interactivity, and openness. At the same time that pieces like *Jazz.Computer* rely on their platform for both infrastructure and contextual meaning, they also draw on and contribute to the ecosystem of software-based artworks in which their authors participate.

## Baggage Allowance

Pamela Z's *Baggage Allowance* takes a number of forms. Audiences can experience the piece as a live performance, as a gallery installation, and as an interactive piece in their web browsers. An attached information section announces this online piece as the "web portal," elaborating that "This site is the Web-based version of the intermedia work Baggage Allowance. The Baggage Allowance web portal went live in early 2011 and will remain active indefinitely."[47] The term "web portal," Z explains in an interview, entered her conception of the project through collaboration with the director of the Bay Area Video Coalition, the organization that sponsored her proposal. While Z "assumed there was probably some more technical definition… that [the director] was using," the term resonated with her intent to make the web-based component a full "entryway" to the piece; "Most of the time, on the web, people just have documentation of the original piece, or just flat, single-channel [recordings], or images. But I wanted this to really be an iteration of the piece, such that when somebody goes there, they're actually entering the piece."[48] Much as a performance and a score and a recording can all instantiate the same musical work, Z constructed the web portal as one node of *Baggage Allowance*, a work whose constant traversals among media seem to preclude the possibility of instantiation in just one format.

[47] Pamela Z, "About Baggage Allowance," accessed April 14, 2016, http://www.pamelaz.com/BaggageAllowance/aboutWebPortal.html.

[48] Pamela Z, interview by author, March 24, 2016.




*5:* Baggage Allowance *web portal*. The top-level view of the web portal displays an array of objects that respond sonically and visually when hovered over or clicked with the cursor.

The first view of the *Baggage Allowance* web portal presents the visitor with a large image suggesting an an x-ray of a human chest superimposed on that of a suitcase. Moving the cursor over this image makes a beating heart appear in the center of the hybrid cavity shaped by the ribs and the suitcase shell. The site thus attaches to the action of hovering (holding the cursor over an element without clicking) a notion of activating and infusing life into an object. Below the large image are five smaller objects set against the page's black background. The rightmost, a passport bearing Z's name and the piece's title, brings the visitor to the information section. The other four, each recognizable as contents of or containers for luggage, enlarge when hovered over and

also trigger short recordings of Z's voice. These recordings overlap with one another and are panned to different points on the stereo spectrum, so that when the cursor moves quickly among them, a layered pattern of vocal samples emerges; the resulting sound resembles that of Z's live music, in which she often uses a sampler bank filled with snippets of her voice that she has recorded beforehand or captured as the song builds. When clicked, these images each open onto an individual media object. Two are videos, and two are themselves interactive objects that again respond visually and sonically as the cursor moves over their various parts. These also follow the mechanism of the sampler, each object functioning as a trigger for a set of sound clips carefully arranged to enmesh with one another into a gestalt musical sensation.

The sampler, a central component of Z's live performance setup, makes a passage through the conventions of browser-based interactivity and of the Adobe Flash programming language into the web portal, suggesting that these media objects result from a translation of ideas rooted in live performance. Z has, in fact, constructed all four pieces pieces in the web portal through a process of translation: "Working in Flash, I had to say, 'Well what's the computer screen version of this physical object that has drawers that I can open and close and slide?' It was like working in a whole different medium; I was translating the content and the ideas but not the techniques or the methods." The drawers to which she refers belong to the weeping steamer trunk, a piece included in the gallery installation of *Baggage Allowance* as well as in the web portal. While the physical object first anchored the content and ideas of the weeping steamer trunk, it in fact affords less of a resemblance to Z's performance work than does its virtual iteration; listeners may experience a similar flitting deftness as they open virtual drawers and trigger sounds as that which Z achieves with the help of custom gestural devices for triggering samples in her concerts. In this way, the web piece, while translated from the sculptural form, enacts an important role in

triangulating the underlying concept across all three modes of *Baggage Allowance*'s presentation.

Translating a piece from a physical mechanism into a software representation, of course, is no simple task. One piece in the gallery installation asked users to place any bags they had brought onto a conveyor belt for security screening, eliciting an emotional response of indignation and protection—only to reveal itself as an artwork by superimposing unlikely objects into their bags on a false x-ray scanner screen. Z determined that "the real life interactivity of that particular section of the piece maybe just doesn't translate to a digital" because the setup and the emotional hook of the work depend so closely on a narrowly familiar type of physical encounter involving one's personal property. Among a set of installation pieces that Z says originated largely from visual ideas rather than sonic, the bag x-ray is the only to feature no deliberate sonic element; its untranslatability suggests sound and music as elements which can perhaps carry artistic ideas across the physical-to-digital barrier more readily than other kinds of elements.

Other musical works have involved interactive versions co-developed with and translated from their instantiations in more conventional formats. A notable example is Björk's *Biophilia*, which the musician released as both a recorded album and as a set of interactive pieces, each corresponding to a song on the album and incorporating its materials and together contained in an iOS application. In Z's conception of the web portal for *Baggage Allowance*, she gives a valuable glimpse into the reasons artists include interactive formats in the set of modes for these distributed works, as well as the nature of the labor that goes into representing a set of musical ideas and concepts in a distributed manner. By framing the translation of her work for the web as a component of the work's primary conception, not as a secondary product of its first run in

offline settings, Z prompts an interrogation of all three modes together as *platforms*. Points that seem intuitive about web-based works, such as their public visibility and their persistence without substantial cost or material footprint, seem more unusual when turned as questions to their corresponding works on the stage or in the gallery. Such questions stand to identify tensions between works' intent and the material conditions of their reception: the expectations of a performance in a concert hall might impose a time window that does not fit the work's ideal duration, or the location and setting of a gallery might discourage certain members of the public from becoming participants. Iterations of musical works in software platforms not only address some of these potential barriers; they also provide a lens through which to address problems in more standardized contexts by casting them, too, as platforms.

Constructing the web portal using Flash was a smooth process for Z, who has herself developed custom software in Max/MSP and other languages since the 1990s and who also cites her geographic proximity to specialists in these tools in the San Francisco Bay Area as helping her realize complex custom technological components in her various processes. Yet Z sees technical problems arising for the *Baggage Allowance* web portal not in construction but in maintenance: as web browsing transitions toward mobile platforms that do not support Flash, Z finds herself having to qualify introductions of the piece with a note on compatibility. Z mentions Apple's iOS, specifically, both as a notably Flash-unfriendly environment and as a platform she would target for the piece if she were to retool its technical components today. "I never spent a lot of time keeping up with the code that you have to know to do modern web stuff," she explains, raising the issue that working as a full-time artist rarely affords time to maintain an up-to-date knowledge of a full range of software technologies as they move through industry-centered cycles of updating and obsolescence. Technologically adept artists like Z may

execute ambitious and successful works in software, but, if those works are to "remain active indefinitely," even these artists must acquire additional time and resources to reinvest in the continued maintenance of past projects. Otherwise, a critical facet of the appeal for a web component—its public permanence beyond the gallery or performance versions—can be jeopardized by the unpredictable turns of industry hype and platform standards. Artists with parallel careers in software development may be able to find those resources in the overlap between their two areas of work, aligning them toward mutual development. This kind of hybrid arrangement, however, cannot only accommodate a subset of artistic undertakings.

*Baggage Allowance* demonstrates what can be gained from instantiating a musical or multimedia work as an interactive piece on a software platform in parallel with its other versions. It also, as a work currently affected by an external process of technical change, demonstrates the clash within such instantiations as offering effective means for a work's persistence and, at the same time, as requiring maintenance labor outside the scope of the artistic practice that goes into their construction. These two findings resolve in a prescription for artists and technologists to attend carefully to the *platform ecosystems* in which artworks take shape and encounter their audiences. The formal differences among platforms as sites for interaction and reception should not be thought of as separate from the infrastructural dependencies on elements beyond the artist's control that influence the life cycles of platform-specific artworks.

# Chapter Three: A Musical Orientation toward Computational Media

## Platforms

The approach of platform ecology that intermedia works like *Baggage Allowance* suggest calls for an open conception of what kind of setting might constitute a platform and how, in particular, that setting's attachments to computational infrastructure fit into its political situation. Tarleton Gillespie summarizes a computational definition of "platform" as "an infrastructure that supports the design and use of particular applications."[49] The involvement of iOS and the web browser in interactive works fits this computational meaning, since the pieces take shape as programs executed within these structures. Yet, as Gillespie establishes, "In the discourse of the digital industries, the term 'platform' has already been loosened from its strict computational meaning…. It now makes rhetorical sense to use the term to describe a computational service, but detach it from the idea of further software programming."[50] Indeed, while iOS and web browsers support software applications through the iOS Software Development Kit and through scripting provisions in the HyperText Markup Language standard, both also deliver static content: a web browser may be used to access media files directly, and all iOS installations contain an access point to Apple's store for media content. Both of these platforms additionally provide infrastructure for a whole host of further platforms, which latter category includes the platforms Gillespie examines in depth, namely YouTube. These platforms do not typically play host in turn to other software; under the emergent usage, Gillespie writes, "'Platforms' are 'platforms' not necessarily because they allow code to be written or run, but because they afford

[49] Gillespie, 349.
[50] Gillespie, 351.

an opportunity to communicate, interact or sell."[51] Gillespie suggests a contribution of meaning from architectural, figurative and political understandings of 'platform' into this new conception in media industries. The figuration carries with it not just a grounding in computational infrastructure, but also a sense of equitably bolstered opportunity and, at the same time, a suggestion of political valence.

Conceiving of a concert stage as a platform hardly stretches this meaning; the stage already meets the architectural definition of "platform" quite soundly, after all. Less distinctly elevated settings like the galleries where Reiko Yamada installs *Reflective*, though, still meet the criteria of Gillespie's definition in that they afford a space in which artists can communicate their works and, through the works themselves or in formalized events like opening and closing receptions, interact with their audiences. The infrastructural elements available to artists in the gallery for communicating their works include the architectural space, the social and institutional apparatuses that grant artists access to the space, the people who work as curators and attendants to facilitate access to the space and its resources, and the non-architectural material goods like computers and loudspeakers needed to set up the artwork in that space. As with software programs, these roles and materials are often defined by protocols; the literacy to understand these protocols requires, in place of computer science training, immersion in the expectations and etiquette of the broadly defined cultural milieu where concerts and gallery showings are arranged.

The reasons for attending to sites like galleries and concert stages as platforms are the same as the elements which the media industry application of "platform" works discursively to conceal: the "edges" of the platforms, or the situations that reveal the type of socially determined conditions that the term "platform" elides. "To the degree that information intermediaries like

[51] Gillespie, 351.

YouTube claim to be open, flat and neutral spaces open to all comers, the kinds of interventions and choices these providers actually do make can be harder to see," Gillespie writes. "But these 'platforms' do have edges." The conditions under which contributors' works enter and disappear from the platform "are practical, technical, economic and legal, and they stray far from the hands-off neutrality suggested by the 'platform' rhetoric."[52] These kinds of interventions and choices are by no means confined to services located in the web. Curatorial and economic roles determine what artworks make it onto the stage or gallery floor, and though the fact of these roles and their understood subjectivity are in no way denied to the same extent as in the context of a platform like YouTube, the complete ladder of stakeholders and influences behind those determinations is rarely made transparent. At the same time online services adopt the "platform" label in order to advance a notion of neutrality, applying that same label to offline settings can supply a framework for critiquing the often taken-for-granted opacity of the choices made in their structuring and operation.

Popular awareness of algorithms as agents in everyday exchange of cultural materials has increasingly included a demand for more transparency in the metrics by which algorithms determine what items to promote and what to leave out. The metaphor "black box" again emerges as a negative figuration of this demand. That term and the dissatisfaction it bears toward inscrutability have spread far from their algorithmic context, however, with everything from libraries to gender attracting "black box" as a critical appellation. "Breaking out" of the black box means exposing its concealed mechanics, making them open to inspection and modification; inversely, for any domain where critics call for that type of revelation and agency, black boxes can be usefully coalesced as the figurative husks in need of breaking open. By placing a material status on often abstract obstacles to transparency, and by accompanying that object with the

[52] Gillespie, 358.

potent action of breaking, the "black box" metaphor helps to direct focus and prescribe action in fights for more just conditions. Critique of algorithmic systems thus contributes methods to the critique of other systems often far removed from and long predating the computational realm. By invoking these methods and by demanding many of the same parameters—representative curation, accountability, and transparency, for example—from digital platforms as from cultural institutions, contemporary critics perform the same linkage suggested by multi-platform works like *Baggage Allowance*.

New media deployments of interactivity cannot, on their own, break the black boxes of platforms; simply making a form interactive does not throw open its container, a limitation that "black box" asserts in emphasizing that operational secrecy persists in spite of accessible inputs and outputs. Thoughtful designs for interaction, however, let audiences enter a dialog with the algorithms helping to produce their experience. Such a dialog asks people to decide their relationship to the algorithm: in *Reflective*, Yamada sees visitors either confront her software as a set of rules challenging them to a contest for control or, more often on second visits, accept the limitations of what they can know about the algorithm and reflect on the actual experience formed by the meeting of their decisions with the aestheticized, algorithmically determined consequences of those choices. In this way, *Reflective* declines to claim that it can singularly rupture the barriers that conceal mechanisms of curation and access in the gallery platform, instead pushing visitors who enter the architectural black box of its private space to make that entrance—and thereby an entrance into negotiation with the algorithm—deliberately, conscientiously and reflectively. The valorization of the listener's role as a musical activator thus becomes also, in the greater context of daily cultural exchange with algorithms, a politically

charged valorization of the choice not to activate an artwork and of the responsibility audiences incur when they do choose to activate it.

Interactivity offers one tool for artists to conscript in bringing audiences into critical engagement with the platforms that host their work. Musicians who continue to work in the apparatus of record production also pursue that goal and devise ways of doing so that are no less meaningful or effective for the absence of software-driven interactivity. Artists like Holly Herndon employ the term "platform" in conceiving how their own recorded work enters the public sphere and incorporate that contention into every level of their process. In a profile of Herndon, Liz Pelly writes,

> Together, Herndon and [her partner Mat] Dryhurst make work that interrogates the concept of the platform, which is also the title of Herndon's album, *Platform*, released in May by RVNG and 4AD. More broadly, their collaborations explore the intimate ways that internet culture embeds itself into our everyday lives - the emotional effects of the surveillance state, the disorientation and confusion it causes. Herndon's music incorporates "browsing sounds", where using software made by Dryhurst, she sample the bleeps and bloops of clicking through Skype, Youtube, Facebook. In a different time, the sensory experience of navigating such commercial space might be likened to the sounds of strolling around a mini-mall. But this is 2015: the corporations are in our laptops, and our laptops are in our bedrooms. *Platform* channels that frightening intimacy. [53]

Herndon's songs on Platform interrogate the web browser and the ecosystem of proprietary services it supports that position themselves as platforms. Her critical orientation in *Platform* aligns closely with Yotam Mann's in *Jazz.Computer*. While Mann critiques from the upper level of that platform hierarchy, having built custom infrastructure to retain as much control over his pieces' form as possible within the bounds of the web browser, Herndon deliberately operates within the next level down: web-based platforms like Spotify and YouTube where she knows her recordings will meet their listeners. Where *Jazz.Computer* sharpens its critique with Facebook-evoking visual elements designed by Sarah Rothberg, Herndon weaves elements borrowed from

[53] Liz Pelly, "Holly Herndon and Her Expanding Platform," *The Media*, December 15, 2015, 65 edition, http://www.fvckthemedia.com/issue65/holly-herndon.

web platforms directly into the musical content of her recordings. Each approach succeeds in its critique through a carefully defined engagement with the platform: Mann, isolating scrolling as the sole mode of interaction with his piece, prompts users to reflect on that action and its trappings in exchanges with other web platforms; and Herndon extends the notion of her platform to include both its containers, like the web, and its actuating events like the record release. "We were interested in seeing the release of an album as a platform with certain mechanisms that may be experimented within. So much of this is dictated by industry," she writes. "We tried to subvert this with the interviews and press surrounding *Platform*, asking how we can keep enough name recognition so that the work is sharable and infectious, but use the platform to highlight other people's research."[54] Herndon catches the "platform" concept in its computationally centered but loosened status, the same one self-applied by web services, and pushes it back into its figurative meaning as an opportunity to be heard; she thereby further aligns the presentation of her works with their political intent. In a symmetrical move, by relying on custom and open software, artists like Mann hold their platforms to a stricter computational meaning, opening a distance from which to critique other occupants of those meta-platforms like the web browser that still play host to software in addition to static content.

Interactivity and basis in software are neither assured nor exclusive means of critical engagement between a musical work and its platform, but, in reinforcing a computational capacity of "platform" as an infrastructure for custom software, they help to amplify an insistence that the platforms where listeners experience music should be more supportive and less proprietary; more like the open web and less like YouTube. By offering an explicitly and uniquely bounded space to the listener, interactive musical works advance a notion that a musical experience can include testing the bounds of the listening environment and mindfully entering—

[54] Williams, Herndon and Dryhurst.

or choosing not to enter—a relationship with the container they form. The proximity of interactive musical works to recorded works within software platforms spotlights the absence of those possibilities from many of the interfaces through which recordings are delivered, indicating that the disparity between interactive and fixed musical pieces grows more, rather than less, dramatic as the two become closer neighbors. The figure of the platform reveals that the political project of interactive musical works is not to impose interactivity on other musical works, but rather to hold all services and infrastructures that distribute music to their task of providing the conditions for consensual and conscientious listening.

## Listening

The claim that interactive musical works valorize the listener's role in instantiating musical works asks what conditions have put that role in need of valorization: what has been done, and by whom, to downplay the act of listening? Once again, platforms prove useful in this search. The platforms that play host to the four works studied here each provide a strictly defined type of support for these music pieces that exist as software applications and a separate type of support for recorded songs. In doing so, they take on the prerogative of rhetorically framing disparities between the two. That framing can be understood in relation to how other settings frame different musical presentations. For example, a live performance of a musical piece in a concert hall is often bracketed by prerecorded music played through the same loudspeakers as the live program; by convention, the venue staff will usually raise the house lights (those over the audience rather than the stage) before the prerecorded music begins playing, marking it as separate from the performance and cueing the audience that they may talk over the music. Software platforms make analogous distinctions in the different ways that their user interfaces represent the data objects for content files and for applications. In iOS, for example, the iTunes Store application is used for retrieving recordings, and the App Store application is used to retrieve more applications. Interactive musical works like *Thicket* can only be accessed through the App Store, but, once downloaded, they occupy spaces at the top level of the operating system's interface. Recordings, on the other hand, can be transferred onto an iOS device by other means but occupy a secondary status, appearing as menu items in application interfaces but not as denizens of that top level. The act of playing a recorded song in iOS therefore involves both an entrance into a sub-interface and the selection of a song title as an instruction to that interface, while playing a software-based piece, regardless of the degree to which it actually employs interactivity, is framed as itself an entrance to an interface.

Software platforms do not introduce participation to music, which as a mode of expression has always laid a special claim to systems of exchange both in the moment and mediated. Listening already entails in many cases, as much as the reception another's work, a step toward remixing, composing, and distributing one's own music. Various media have provided opportunities for cultural movements to couple the act of listening to those creative acts. In the cassette culture that blossomed in the early days of that format, for example, tapes were frequently distributed in individual trades among fellow amateur musicians—this social routine of reciprocity, along with the technological convention that most cassette players included a recording function, put the moment of listening in close contact with the drive toward composition and the method of distribution. Morgan Packard gives another example, explaining the "dub-plate system" that formed an important part of the infrastructure for drum and bass scenes. "When you're a hot producer, in 1995 London, you pass out DAT tapes to special DJs, and those DJs would take those tapes down to the vinyl cutting house and cut a dub plate," Packard recalls. "So within a week of a producer finishing a track in the studio, you would be on pirate radio and in the clubs in London."[55] This system, with specific reliances on different recording formats and codified socio-technical roles for producers, DJs, record cutters and radio operators, provided a hierarchical structure of competitive exchange centered on the moment of animated listening and on its site, the dance floor. Yet the demarcation of active and passive listening also precedes digital media. A contemporary music streaming platform might emphasize listening as passive by requiring just one act of selection and then employ algorithms to make further selections when the end of the song or album is reached. At the same time, a concert series might offer subscribers so little sense of input into the curation process that they feel distanced from any works beyond those that attracted their initial interest.

[55] Packard, interview.

Software platforms, however, differentiate themselves from platforms like the concert hall not just through the fact of their technological construction but also through their rhetorical invocations of new and participatory media paradigms. Participatory media promise to do away with uninspiring encounters, ushering in heightened modes of engagement between artists and audiences. In many cases they have indeed fostered such modes, yet the persistence of non-participatory media within new media platforms highlights friction between that promise and the politics attending same voices that invoke it. Apple, for example, takes up simultaneous economic interests in fostering a sphere of application development for their platform and also in maintaining that platform as an appealing conduit to older corporate stakeholders in the music industry, namely major record labels. These dual interests manifest in the properties of the separate tunnels interactive and recorded musical works must take into the iOS platform: Apple provides through its Developer Program a process by which technologists can publish their work to the App Store, but musicians seeking to add their recordings to the iTunes Store must do so through an intermediary—either a record label or an independent aggregator service. Apple reinforces this separation with the further rhetorical element of the App Store's categories, including "Entertainment" and "Instrument" in the taxonomy but not "Song" or "Artwork." A group of artists started an online petition in 2015 asking Apple to add an "Art" category to the App Store out of frustration that artistic applications were relegated to what they saw as ill-fitting or overly utilitarian categories;[56] as of this writing, the corporation has not acted upon their request. Despite affording a close proximity between recorded and interactive media, the platform proactively maintains a separation between the two that casts the former as passively received and constrains the latter's presentation.

[56] Seth Indigo Carnes, Serkan Ozkaya, and Paulina Bebecka, "+ArtApp | Petition Apple to Add Art to the App Store," accessed April 11, 2016, http://www.artapp.org/about.

Jonathan Sterne pushes the concern of participatory media's commercial constraint into an argument that consumerism may co-opt the rhetoric of participation so fully that opting out of interactivity and into passivity could be a necessary mode of resistance. Sterne argues that, in contrast to twentieth-century forecasts that musical meaning would be heightened through new modes of participation, "Active participation is now a privileged mode of consumerism" and that applications of interactivity are at risk of subsumption under the consumerist purpose. "If you want democratic participation, you also need a reflective populace," he writes. "If you're going to break the fourth wall in your theater production or installation piece, the participants have to be able to take on some kind of critical perspective on the work in order for it to have any avant-garde potential."[57] Without that consideration, and in unison with a commercially driven push toward participatory media artifacts, interactive works can become complicit in coercing subjects into dialogs to which they have not consented and in whose terms they have had no say. That the interactive musical works studied here propose a different tack than Sterne's call to re-embrace passivity is clear in the mere fact of their interactivity. The question of whether they succeed in offering a critical perspective and resisting complicity in the commercial forces transmitted through their platforms hinges on the works' claims about *listening*.

The term "active listening" joins the narrowed notion of participation that alarms Sterne, in that it suggests an imperative to intercede in a sonic work rather than an opportunity to do so. Interactive musical works in part resist inclusion in other categories of software-based sound projects—namely instruments or games—by way of their attitudes toward instruction. Three of the four pieces in this study open with an element of verbal instruction: the diagram outside *Reflective* begins with "Enter into this darkness," notification panes in *Jazz.Computer* urge the

[57] Jonathan Sterne, "What If Interactivity Is the New Passivity?," *Flow*, April 2012, http://www.flowjournal.org/2012/04/the-new-passivity/.

visitor to scroll, and a recording at the virtual entrance of the *Baggage Allowance* web portal insists that one "thoroughly inspect every bag" and "be nosy." One can easily group these instructions with those that a game or instrument presents upon first encounter, when the user is learning the language of interaction that structures the interface. The expectations under which those instructions are made, however, differ fundamentally. User interfaces broadcast their instructions as a granting of control, whether of a player character in a game or of an instrument's output. These three interactive musical works, in contrast, offer instructions with no promise as to the extent of control, but rather as invitations to instantiate a work and thereby to meet the artist in a dialog pre-laden with their agenda. The instructions, as much as they specify the mode of interaction, also lay this agenda out in full view. The *Reflective* diagram goes on to tell the visitor, "you must decide; take a step or stay still," and "these traces are your own, imperfect as they may be," imbuing the interactive mechanism with a strongly inflected and outward-facing type of responsibility toward which non-participation is explicitly figured as a valid approach. *Jazz.Computer*'s reminders to keep scrolling, in their over-the-top tone as well as by their visual reference, carry out an important satirical linkage between the piece and the social media platforms in the focus of its critique. The *Baggage Allowance* introduction performs a similar function, announcing in its vocabulary the juxtaposition between personal affects and invasive security measures that shapes the piece's meaning. These works invite a listening that is not merely active but activating, that is framed as a service toward the work, and that is politicized in its initiation.

Sander Van Maas, commenting on a recent historical shift in conceptions of listening, finds a political valence in this turn. "Listening, by emancipating from an essentially implied, passive-receiving, and subjected position, has become an explicit factor in culture and the object of

proactive collective and individual politics,"[58] he writes. The reinforcement of passive listening in some software platforms notwithstanding, Van Maas's claim makes evident the extent to which the possibilities alone of new listening situations lend momentum to re-conceived productive notions of aurality. Jason Freeman exhibits this development in the context of computational media, building pieces that "invite or sometimes even require listeners to explore a space as they listen and to push listening toward a creative and potentially public and collaborative activity through their use of space."[59] Beyond the literal application of "space" in Freeman's projects, which often experiment with sound objects in three-dimensional virtual environments, the binding of listenership to a particular space through exploration can frame the role of interaction and non-auditory elements in other musical works. The methods available to a listener of influencing a piece, as well as the cues toward these methods from within and from without the auditory content of the piece, define a space in which the listener may wonder, discover, discern and reflect. In open mediational music, listening becomes not just a reception but a rehearsal of the artist's critique.

Pieces like *Thicket* hone this sense of space, transposing the formal characteristics of a musical composition onto an abstract terrain whose nature shifts and cycles. Here the critique is elaborated not through verbiage but in the successful reorientation by a musical experience of a tightly constraining platform. Taking over the input and output surfaces of an iOS device with the user's activation, *Thicket* supplants the utilitarian expectations of the platform by the same turn with which it promotes the status of sound from a selected material or an attention-grabbing effect to a formative layer of the environment. In achieving this separation out from within their

[58] Sander van Maas, "Introduction," in *Thresholds of Listening: Sound, Technics, Space*, ed. Sander van Maas (New York: Fordham University Press, 2015), 1.

[59] Jason Freeman, "Movement at the Boundaries of Listening, Composition, and Performance," in *Thresholds of Listening: Sound, Technics, Space*, ed. Sander van Maas (New York: Fordham University Press, 2015), 122.

platforms, these four pieces each evidence the special role of sound that Frances Dyson identifies in producing the new media hallmark of immersion;[60] and by doing so, they offer listeners a distance from which to assess the algorithmic conditions of their platforms while still enmeshed in them. In rehearsing this process, listeners work toward a production of knowledge about the algorithmic elements in other parts of their lives. Nick Seaver argues that "knowing algorithms" whose internal mechanisms are concealed is not a matter of revealing them. Instead, he offers, "Constructivist accounts of knowledge production emphasize the processes through which knowledge is achieved, not as the overcoming of barriers or pulling back of veils to reveal what is really going on, but as interactional work that produces local and contingent truths."[61] Open mediational music offers encounters where listening can constitute that interactional work. It asks listeners to accept the limitations of their access to the secret innards of the algorithms that touch their lives and, at the same time, to attend critically to those algorithms through the platforms that anchor them.

That listening forms the basis of this broadly applicable mode of attention is true to the nature of sound and hearing: we listen with our bodies, our bodies are located in space, and whatever sound enters that space informs our ability to make sense of it, even if we must make due with those sounds coming from behind veils we cannot yet pull aside. The addition of interactivity to music does not in one assured stroke liberate attention, or even musical ideas, from the passivity that consumerist powers impose. Yet in advancing a mode of critical attention that contains within it a means of its own rehearsal, interactive musical works can valorize not

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[60] Frances Dyson, *Sounding New Media Immersion and Embodiment in the Arts and Culture* (Berkeley: University of California Press, 2009).

[61] Nick Seaver, "Knowing Algorithms," *Media in Transition*, vol. 8 (Cambridge, Mass., 2013), 4.

just the act of listening but also the vital role listening stands to play in the climate of computationally mediated life.

## Conclusion

In assembling *Reflective*, *Thicket*, *Jazz.Computer* and *Baggage Allowance* under the umbrella of *open mediational music*, I have attempted to take stock of the current impetus behind musicians' uses of software and interactivity in conceiving their works. These interactive musical works are most strongly characterized by their valorization of the listening act as a mediational responsibility and by their reinforcement of openness as a guiding principle for new media. More than just arriving at these characteristics as textual properties of their work, the artists behind such pieces pursue openness and mediation as qualities their listeners will enact. *Open mediational music* points to a productive desire, amid the enforcement of passivity on the reception of recorded music and the inscrutability of the platforms through which listeners encounter it, to conscript new forms and technologies in the service of more mindful musical encounters.

Open mediational music thus stands out as an ideal and phenomenon, located in a particular techno-cultural moment, rather than a genre or medium unto itself. Each of the artists studied here derives his or her own motivation and direction for producing interactive work. The variety of platforms and tools they choose in pursuing this line of sonic creation speaks to the decentralized nature of that phenomenon; and their development of new infrastructures, tailored to different platforms and embedding distinct traditions of musical representation in software, demonstrates the multiplicity of approaches to any common aims of interactive music. These undertakings also emphasize the role of novelty in open mediational music's conception: rather than building upon experiments in musical interactivity from prior technological situations, for example those of the CD-ROM era, these projects tend to capitalize on a particular platform or tool in navigating a break from the closed systems confronting their authors, each of whom do so on their own terms and toward their own unique agenda.

In their marked departures from conventions of musical reproduction in the pursuit of mediational agency and openness in their listeners, these works resonate perhaps most strongly with precedents like event scores by Pauline Oliveros. By breaking the musical score out of its conventional positioning among composers, performers and listeners, Oliveros and other artists strive for a similar movement away from passive aural reception and toward a deeply mindful mode of listening. That Oliveros has invoked "software" in this line of work suggests software as significant to musical creativity in more than in its availability as a construction material alone. If we consider instructions, the base units of computer programs, to be also the potential base units of musical composition, we can imagine new possibilities for musical experiences co-constituted by technological systems and conscientious listeners.

This relationship between sound and software channels the problems of either domain into the other—in the theoretical approaches of sound studies and software studies, but also in the risks and opportunities artists face when working at the juncture of sound and software. Musicians working in code must confront the uniquely potent capacity of software systems to embed and reproduce cultural values, which in many cases run counter to those an artist might wish to advance and even in other cases must be made more explicit in order to advance artistic conditions. They and conservators also adopt new burdens of maintenance in keeping their work accessible, especially in the face of closed infrastructures threatened by obsolescence. In facilitating critical awareness of platforms and in offering a rehearsal of that critique, open mediational music takes on these challenges and extends outward, through the model of listening, the possibilities for critically attuned participation in new media.

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