

Postdigital Rituals in Laptop Orchestras: Human–Computer Interaction and Second-Order Resonance

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Abstract

Purpose: This study examines how rituals operate within laptop orchestras as postdigital performance environments. Although laptop orchestras have commonly been discussed as technological innovations and pedagogical models, their ritual structures and their role in mediating human–computer interaction (HCI) remain underexplored. This article therefore investigates how ritual practices are adapted across different laptop orchestra contexts and how they contribute to second-order resonance in technology-mediated collective performance. **Methodology:** The study employs a qualitative interpretive design that combines comparative performance analysis with autoethnographic observation. It focuses on three performances: *Nonspecific Gamelan Taiko Fusion* (2006) by the Princeton Laptop Orchestra (PLOrk), *Twilight* (2013) by the Stanford Laptop Orchestra (SLOrk), and *Farben* (2024) by the Postdigital Laptop Ensemble at the University of Siegen (PULSE). The data consist of audiovisual recordings, photographs, stage diagrams, program notes, contextual documentation, and autoethnographic fieldnotes produced during rehearsals, technical setup, and performance. **Findings:** The study finds that ritualized spatial arrangements, gestural coordination systems, and symbolically charged technological objects structure collective performance across the three cases. These ritual forms stabilize technology-mediated interaction, organize collective creativity, and transform digital devices into meaningful performance artifacts. Across the cases, rituals function as interactional infrastructures that mediate HCI and support sustained collective engagement. **Implications:** The findings suggest that laptop orchestras should be understood not only as technological or musical innovations, but also as ritual environments that organize distributed agency between performers and technological systems. This has implications for ritual studies in digital society, performance pedagogy, and research on technology-mediated collective creativity. **Originality and Value:** This study contributes to postdigital scholarship by conceptualizing laptop orchestras as postdigital ritual environments and by extending the concept of second-order resonance into technology-mediated artistic practice.

Keywords: Human–computer interaction; Laptop orchestra; Postdigital; Ritual; Second-order resonance

Introduction

In recent decades, laptop orchestras have emerged as a visible form of collective music-making in universities, media art institutions, and experimental performance contexts worldwide (Trueman, 2007; Wang, Trueman, Smallwood, & Cook, 2008; Wilde & White, 2025). These ensembles bring together performers using networked laptops, controllers, and digital instruments in coordinated, spatially organized performance environments (Trueman, Cook, Smallwood, & Wang, 2006). While often discussed in

terms of technological innovation or new musical interfaces, laptop orchestras also function as sites of collective ritual practice, where repeated gestures, spatial arrangements, technological artifacts, and procedural routines shape resonant self-world relations among performers, technologies, and audiences. Drawing on Rosa's (2019) resonance theory and its extension to ritual analysis, this paper argues that these ensembles enact postdigital rituals that not only facilitate collective creativity but also cultivate second-order resonance (Rosa & Rüpke, 2024) reflexive experiences that reference, remember, and anticipate moments of mutual attunement between human agents and digital systems. Understanding these ensembles as postdigital ritual forms is therefore crucial for grasping their broader cultural and social significance. As a contemporary social phenomenon, laptop orchestras matter not only as musical or technological innovations, but as environments in which embodiment, authority, participation, and collective creativity are reorganized under conditions of technological mediation.

From the earliest civilizations to our technology-driven present, rituals permeate human experience, providing powerful mechanisms for meaning-making (Bell, 1992; Boyer & Liénard, 2008, 2020; Brown, 1991; Davis-Floyd & Laughlin, 2022). Their patterned, repetitive, and symbolic nature fosters social cohesion, reinforces fundamental values, and shapes both individual and collective identities (Beattie, 1966; Davis-Floyd & Laughlin, 2022; Kreinath, Snoek, & Stausberg, 2006; Summers-Effler, 2006; Whitehouse & Lanman, 2014). While traditionally viewed through sociocultural and anthropological lenses, recent research has broadened our understanding of rituals to encompass their psychological functions (Anastasi & Newberg, 2008; Berggren & Stutz, 2010). Hobson, Schroeder, Risen, Xygalatas, and Inzlicht (2018) argue that rituals regulate emotions, performance goals, and social connections through both bottom-up (physical actions) and top-down (symbolic meaning) processes. Ritual theory therefore explains how patterned actions organize social cohesion and transformation across religious, social, and theatrical contexts. However, it has paid comparatively little attention to technology-mediated artistic ensembles and the role of digital systems in shaping ritualized collective action.

Rituals take on new significance in the evolving context of the postdigital age. The postdigital challenges the traditional binary between digital and analog, emphasizing instead the fluidity and interconnectedness of our technology-mediated lives (Veletsianos, Jandrić, MacKenzie, & Knox, 2024). The term postdigital is often misunderstood as simply meaning "after the digital." A more nuanced understanding recognizes it as a state where the digital is so pervasive and integrated into our lives that the distinction between digital and analog becomes blurred (Jandrić, 2021; Otrell-Cass, 2023). It is not about abandoning digital technologies, but rather about recognizing their integration with our physical, social, and cultural realities. Jandrić (2021) explains that the "postdigital human is a human being living in the postdigital condition defined by vanishing borders between the digital and the analog in all spheres of life, including their own body." Otrell-Cass (2023) highlights that "in a postdigital view, human embodiment is an entanglement of online and offline performances, that takes place in hyperconnected environments that are inhabited by humans and non-humans." This perspective reflects the performance of rituals, which blur the lines between sacred and secular, individual and collective, and symbolic and functional domains (Livarda, Madgwick, & Mora, 2017). Postdigital scholarship explains the hybridity and distributed agency of technology-mediated experience. However, it rarely addresses collective musical practices as ritual forms or examines how ritual structures organize human-computer interaction (HCI).

Ritual has long been understood as a patterned form of social action that organizes meaning, identity, and collective life. One of the most influential definitions comes from Rappaport(1999), who describes ritual as “the performance of more or less invariant sequences of formal acts and utterances not entirely encoded by the performers,” emphasizing its structured yet adaptable character and its role in establishing conventions, moral orders, and shared understandings of reality, though the universal scope of this framework has been debated (Stepanek, 2006). Earlier anthropological approaches similarly viewed ritual as a mechanism for social cohesion and transformation: Durkheim's (1912; 2001) analysis of religious rites framed ritual as a collective representation reinforcing moral order, while Van Gennep's tripartite model of rites of passage separation, liminality, and reintegration highlighted ritual as a process through which individuals and groups move through transformative stages (Van Gennep, Schomburg, & Schomburg-Scherff, 2005). Turner (1996) extended this perspective by emphasizing the liminal and performative dimensions of ritual and introducing the concept of *communitas*, while also distinguishing between traditional liminal rituals and modern liminoid practices associated with artistic and cultural performances. In *From Ritual to Theatre: The Human Seriousness of Play* (1982), Turner further argued that contemporary rituals often emerge in hybrid cultural spaces where boundaries between sacred and secular, tradition and innovation, become fluid. Building on these perspectives, Grimes (1992, 2013) reconceptualized ritual as an evolving and inventive practice rather than a fixed inheritance. In *Reinventing Ritual* (1992) and *The Craft of Ritual Studies* (2013), he emphasized the dynamic creation of new ritual forms in response to changing cultural and technological environments, including those shaped by media and performance. This understanding is particularly relevant in technology-mediated contexts, where digital interfaces, networked environments, and human–computer interaction contribute to the emergence of new ritual configurations and practices (Radde-Antweiler, 2006).

This study draws on resonance theory (Rosa, 2019) and the framework of second-order resonance as developed by Rosa and Rüpke (2024), to understand the transformative potential of postdigital rituals. Rosa and Rüpke (2024) define second-order resonance as the “affective, self-efficacious, and transformative” experiences associated with recurring ritualistic practices. These experiences, characterized by feelings of belonging, affirmation, and aliveness, can occur even in the absence of intense emotional peaks. This framework is particularly relevant for understanding technology-mediated practices, where agency is often distributed among human participants, objects, places, and artefacts that acquire symbolic meaning through repeated interactions (Collins, 2004; Lepisto, 2022; Rosa & Rüpke, 2024). As Rosa and Rüpke (2024) observe, rituals create an “axis of resonance” connecting individuals to larger cultural systems through repeated, meaningful engagements. Resonance theory explains how recurring practices sustain belonging and transformation, yet the concept of second-order resonance has primarily been discussed in religious or social ritual contexts, leaving its application to technology-mediated artistic performance largely unexplored.

In response to these gaps, this study positions laptop orchestras as postdigital ritual environments, investigating how ritual practices mediate HCI and cultivate second-order resonance within technology-mediated ensembles. This article argues that rituals in laptop orchestras are not merely aesthetic or symbolic embellishments, but central mechanisms that regulate creativity and sustain shared experiences of resonance. Through recurring spatial arrangements, gestural languages, technological artifacts, and procedural routines, these ensembles create new ritual forms in which agency is distributed across human

performers and technological systems. By analyzing laptop orchestras through the framework of second-order resonance, this study demonstrates how technology-mediated performance practices cultivate enduring forms of belonging, affirmation, and collective agency. This article asks the following research questions: How do different laptop orchestras adapt and reimagine ritualistic practices in diverse cultural and technological contexts? How do rituals function in mediating HCI within the ensemble? How do these postdigital rituals resonate with performers and audiences, and what transformative experiences do they facilitate? Specifically, how do they contribute to second-order resonance?

Methods

This study adopts a qualitative, interpretive research design to examine how rituals operate within laptop orchestras as postdigital performance practices (Spowage 2020). To address the research questions: (1) how ritual practices are adapted across contexts; (2) how rituals mediate human computer interaction (HCI); and (3) what kinds of resonance and transformation they facilitate the study combines comparative performance analysis with an autoethnographic case study. A comparative approach was utilized because it enables systematic identification of shared patterns and divergences across performances situated in different cultural–technological ecologies (PLOrk, SLOrk, and PULSE). Autoethnography is appropriate for the PULSE case as the study also seeks to account for lived, embodied, and socio-emotional dimensions of ritual practice that are often inaccessible through external observation alone (Adams, Holman Jones, & Ellis, 2015; Chang, 2016; Denzin, 2014; Ellis, Adams, & Bochner, 2011).

The primary unit of analysis is the ritual practice within laptop orchestra performance contexts understood as patterned, repeatable, and symbolically charged actions that organize collective music-making (Grimes, 2013; Rappaport, 1999). Secondary units of analysis include actors performers and conductors/composers and, where relevant, audience positioning and participation. In postdigital contexts, actors are not limited to human participants. Accordingly, the analysis also considers technological artifacts such as laptops, controllers such as GameTrak devices, iPads, software environments, network and audio infrastructures, speakers, and cables; spatial arrangements (seating and staging configurations, performer–audience relations, and scenography); and symbolic actions and objects (gestures, costume or uniformity, "charged" objects such as hemispherical speakers, tether strings, and spray cans, as well as recurring procedural routines such as setup, cueing, and transitions).

The study examines three laptop orchestra contexts with one focal performance in each: PLOrk (Princeton University) Nonspecific Gamelan Taiko Fusion (2006), SLOrk (Stanford University) Twilight (2014), and PULSE (University of Siegen) Farben (2024) (autoethnographic case). The three cases were selected through purposive sampling to provide analytically meaningful variation across laptop orchestra practices while remaining comparable within a shared technological performance paradigm. PLOrk and SLOrk were chosen due to their historical significance in the development of laptop orchestras and their influential role in establishing ensemble-based approaches to networked digital music performance. The Princeton Laptop Orchestra (PLOrk), founded in 2005, represents one of the earliest pioneering laptop orchestras and has played a central role in shaping the field's technical and pedagogical foundations (Rossing, 2014). The Stanford Laptop Orchestra (SLOrk), founded shortly thereafter by Ge Wang, was selected as a closely related yet distinct institutional lineage that explores different

compositional and performative approaches to human–computer interaction within laptop ensemble contexts. The PULSE ensemble (Postdigital Laptop Ensemble, University of Siegen) was included as a contemporary case that extends this tradition within a postdigital educational setting and allows for autoethnographic insight through direct participation in rehearsals and performance. Together, these cases provide a historically grounded and conceptually diverse sample that captures different ritual–technological configurations and cultural references, including intercultural musical traditions (e.g., Gamelan and Taiko in PLOrk), performative human–technology dramaturgy (SLOrk), and urban cultural practices such as graffiti-based sound and gesture interaction (PULSE). This combination enables a comparative examination of how postdigital rituals emerge across distinct cultural, technological, and institutional contexts.

Across these cases, the analysis draws on the following data sources: audiovisual performance documentation (e.g., publicly available recordings); photographs, stage diagrams, and schematics (including ensemble setup diagrams and spatial layouts); program notes and contextual documentation (e.g., descriptions accompanying recordings and post-performance talk material where available); and autoethnographic materials for the PULSE case, including fieldnotes and reflexive journaling produced during rehearsals, technical setup, and performance, as well as observations from participation in ensemble support (co-teaching, audio networking, rehearsal support, and documentation).

Data collection followed a structured process designed to support transparency and cross-case comparability. First, cases were selected and delimited, focusing on three laptop orchestra contexts representing distinct cultural technological performance ecologies, including a participatory case (Mills, Durepos, & Wiebe, 2010). Next, documentary materials were compiled, including available recordings, images, diagrams, and written contextual materials for each performance. This was followed by systematic performance observation through repeated viewing and inspection of documentation, with attention to ritualized actions, staging, objects, and performer technology interactions. Relevant visual materials were then identified and cataloged, including images, frames, and diagrams that most clearly represented ritual actions, spatial arrangements, technological mediation, and symbolic artifacts. Finally, in the PULSE case, autoethnographic documentation was produced through fieldnotes and reflective journaling recorded during rehearsals, technical setup (e.g., routing and networking), and the performance event. Particular attention was given to ensemble dynamics, moments of technical breakdown and repair, and recurring procedural routines interpreted as potential ritual forms.

Analysis proceeded in four stages, combining thematic coding with cross-case comparison and theory-driven interpretation: Ritual-element coding (within-case): each case was coded using Grimes' (2013) ritual attributes actions, actors, places, times, objects, languages, and groups to produce a structured description of ritual practice in each performance context. Technological mediation and HCI analysis: within each case, coded ritual elements were further interpreted in terms of how technology mediates action and agency, including interface constraints/affordances, networked synchronization, gesture capture, and distributed control across human and non-human agents. Cross-case comparative synthesis: the three cases were compared to identify shared patterns (e.g., ritual leadership via conductors, standardized setup routines, symbolic objects) and meaningful divergences (e.g., remediation of cultural traditions in PLOrk, theatrical narrative and surrender in SLOrk, commemorative totems and embodied camera-based interaction in PULSE). Interpretive integration with postdigital theory and second-order

resonance: empirical patterns were linked to the postdigital condition (hybridity, remediation, materiality, fluid boundaries) and interpreted through second-order resonance as recurring, sustaining, and self-efficacious ritual experience (Rosa & Rüpke, 2024). Autoethnographic insights from PULSE were integrated as contextual and experiential evidence that deepens interpretation of observed ritual forms, particularly where emotional regulation, group cohesion, and "charged" objects/places emerged through repeated participation.

This study adhered to standard ethical principles for qualitative research. The analysis of PLOrk and SLOrk performances relied exclusively on publicly available audiovisual documentation and related materials that are accessible through open online platforms. No private or restricted data were used. For the PULSE case, the autoethnographic component was conducted through the author's participation in teaching, rehearsals, technical preparation, and performance-related activities within the ensemble context. Observations and fieldnotes focused on collective practices, technological arrangements, and performance processes rather than on personal or sensitive information about individual participants.

Results

1. Adaptation and Reimagination of Ritual Practices

Across PLOrk's *Nonspecific Gamelan Taiko Fusion* (2006), SLOrk's *Twilight* (2014), and PULSE's *Farben* (2024), ritual practice is adapted and reimagined through recurring patterns of spatial organization, bodily posture and movement, gesture systems and conducting, and symbolic objects and performance artifacts (PULSE, 2024; SLOrk, 2014; Trueman et al., 2006). Rather than appearing as staging choices, these patterned actions and material arrangements operate as ritualized forms that structure collective music-making and reframe technological performance as a culturally meaningful event.

Ritual space is reconfigured through seating arrangements and spatial organization that evoke communal order while adapting to digital performance infrastructure. In PLOrk (2006), the performers sit on stage in a symmetrical arrangement, with everyone positioned cross-legged on cushions or mats, each operating a laptop placed directly in front (see Figure. 1a).



Figure 1. Comparative ensemble spatial organization: (a) aerial view of PLOrk during *Nonspecific Gamelan Taiko Fusion* (2006); (b) historical Gamelan orchestra of Kanjeng Pangeran Ario Yudo Negoro, Yogyakarta, Java, 1911. Figure 1a is a frame capture from Princeton Laptop Orchestra

(PLOrk), “Nonspecific Gamelan Taiko Fusion,” YouTube, accessed 10 February 2026, CC BY. Figure 1b source: Universiteitsbibliotheek Leiden (Leiden University Libraries), photograph by Jean Demmeni, public domain

This configuration resembles those seen in traditional Gamelan ensembles (see Figure. 1b), and the visual symmetry emphasizes a shared, communal performance frame even as cables, audio interfaces, and hemispherical speakers make the technological infrastructure visible. In SLOrk (2014), the performers are arranged in a half nested circle on the stage, surrounded by laptops, cables, and other electronic equipment, and the warm, orange lighting evokes a sunset, creating a bounded ritual space within a modern concert hall (Figure. 2).



Figure 2. Aerial stage view of SLOrk during *Twilight* (2013), showing the semi-circular ensemble arrangement and bounded ritual space. Frame capture from Stanford Laptop Orchestra (SLOrk), “Twilight,” YouTube, accessed 10 February 2026, CC BY

In PULSE, the ensemble is likewise staged as a collective formation: the students, dressed entirely in black, are seated in a semi-circular formation on the floor, with each performer operating a laptop, controller, or an iPad interface (Figure. 3).



Figure 3. Tim Bolinht conducting PULSE during *Farben* (2024), showing floor seating, collective formation, and the projected graffiti backdrop. Frame capture from Post-digital Laptop Ensemble University of Siegen (PULSE), “Farben – Tim Bolinht,” YouTube, accessed 10 February 2026, CC BY

The semi-circle and floor seating in PULSE reflect the communal ethos of the laptop orchestra, while the projected graffiti image serves as a visual anchor that frames the performance space as commemorative and symbolically charged.

In PLOrk, the cross-legged seated posture and evenly spaced performers align with a disciplined ensemble body, recalling the tightly knit configurations of Gamelan performance practice and the repeatable, patterned coordination typical of interlocking percussion traditions (Lindsay, 1979). The performance's ritualization is reinforced by the gradual progression from tuned bell timbres to drum sounds, with texture and density gradually increasing, which echoes the cumulative intensification associated with ensemble percussion and ceremonial build-up. In SLOrk, ritual is made explicit through staged bodily transformations: performers begin in a seated position on floor mats, and slowly rise to control sound through GameTrak tether controllers, and later lie motionless on the floor next to their laptops (Figure 4), producing a sequence of kneeling, rising, a "tethered" connection to the digital, and prone stillness that functions as a ritualized enactment of decline, separation, and surrender.



Figure 4. SLOrk performers lying on the floor during *Twilight* (2013), illustrating ritualized bodily stillness and staged disengagement. Frame capture from Stanford Laptop Orchestra (SLOrk), "Twilight," YouTube, accessed 10 February 2026, CC BY

In PULSE, bodily gesture is reimagined through the translation of graffiti writing or drawing actions into performance: performers use camera-based and motion-sensor interactions to simulate the gestures of spray painting. Here, physical movement is not ornamental but becomes a repeatable ritual technique that binds embodied action to symbolic meaning (graffiti as tribute) within a postdigital setting.

Gesture systems and conducting practices operate as ritual languages, producing leadership roles and shared attention structures that differ across ensembles yet consistently ritualize authority and coordination. In PLOrk, the performance is structured through machine-synchronized coordination. Trueman et al. (2006) describe it as "an experiment in human-controlled, but machine-synchronized percussion ensemble performance," and the networked step sequencer (the "Non-Specific Audicle Face") provides a shared temporal grid that performers collectively enact. This supports a ritualized form of coordination in which shared timing is externalized and stabilized, producing a sense of collective discipline that parallels traditional percussion ensembles while translating it into a digital interface. In SLOrk, the conductor assumes a visibly ritualized role: Ge Wang kneels to the ground and interacts closely with the GameTrak

device, while his deliberate and symbolically charged gestures are amplified through the performers' coordinated physical and sonic responses (Figure. 5).



Figure 5. Ge Wang conducting SLOrk during *Twilight* (2013), illustrating the conductor's ritualized leadership role. Frame capture from Stanford Laptop Orchestra (SLOrk), “*Twilight*,” YouTube, accessed 10 February 2026, CC BY

The conductor's role shifts beyond musical direction toward ritual leadership, guiding the ensemble through repeated gestural acts that frame the performance as a ceremonial narrative. In PULSE, conducting is explicitly reinvented as ritual language. Bolin's cues index fingers pointed outward, a single raised finger, a palm facing downward, and both hands raised with palms outward function as a gestural lexicon that performers collaboratively interpret and internalize (Figure. 6).



Figure 6. Conducting gestures used as a “gestural lexicon” in PULSE's *Farben* (2024). Frame capture from Post-digital Laptop Ensemble University of Siegen (PULSE), “*Farben – Tim Bolin*,” YouTube, accessed 10 February 2026, CC BY

Unlike traditional orchestras, laptop ensemble performances are organized through composition-specific gestural systems that form unique syntax of bodily cues. Repeated throughout the performance, these gestures function as ritualized coordination practices,

demonstrating that ritual in this context is not inherited unchanged but actively constructed in relation to the composition's structure and intent, while also drawing on experimental lineages such as Morris's (2017) conduction method.

Symbolic objects and performance artifacts become charged ritual materials, mediating meaning through visible technological and cultural references. In PLOrk, technological artifacts are staged as quasi-instrumental objects: "custom-built hemispherical speaker systems" placed around performers project sound outward "in a manner similar to acoustic instruments" (Trueman et al., 2006), and their prominent presence contributes to the ritual framing of each performer as an individual sound source within a communal formation. The performance explicitly draws on cultural traditions Gamelan and Taiko where repetition, coordination, and ceremonial embodiment are central; the structured, seated position resonates with Gamelan organization, and repetitive, interlocking patterns find a digital counterpart in synchronized sequences. In SLOrk, the GameTrak tether string becomes a central ritual object: the performer's focused manipulation of a thin tether string evokes a delicate and supernatural interaction with the technology, and the tether's visibility symbolizes the connection between performer and technology, later transforming into a sign of severance and loss. In PULSE, the performance activates both digital and analog artifacts as ritual totems: sampled spray-can sounds, physical spray cans shaken on stage, and the graffiti projection establish a symbolic ecology in which objects are not props but carriers of commemorative meaning (Figure. 7).



Figure 7. Symbolic use of spray cans as ritual objects in PULSE's *Farben* (2024). Frame capture from Post-digital Laptop Ensemble University of Siegen (PULSE), "Farben – Tim Bolinht," YouTube, accessed 10 February 2026, CC BY

The spray cans take on a dual existence present and distant, material and immaterial, and the spatial placement of sound (including speakers behind the audience) intensifies the ceremonial framing of remembrance and transformation.

The three cases show that laptop orchestras adapt and reimagine ritual practices not by abandoning tradition, but by remediating ritual forms through postdigital performance. PLOrk foregrounds communal and cultural continuity through seated arrangements and percussion-derived ensemble discipline; SLOrk intensifies ritual as theatrical narrative through staged bodily transitions and a conductor-centered ceremonial

dramaturgy; and PULSE extends ritual into a commemorative and participatory practice, where invented gestural languages and symbolic artifacts (graffiti imagery and spray cans) shape collective identity and shared purpose. Across all cases, ritual emerges as a patterned framework that organizes collective music-making while translating cultural, technological, and symbolic materials into repeatable postdigital performance forms.

2. Rituals as Mediators of Human–Computer Interaction (HCI)

Across the three cases, ritual practices function as interactional infrastructure: they stabilize complex human–machine relationships by organizing timing, distributing control, and making technology-mediated coordination intelligible to performers. Rather than treating interfaces, networks, and devices as neutral tools, the performances show how repeated procedures and standardized configurations convert technical systems into reliable, collectively readable modes of action.

In PLOrk, ritualized coordination is achieved through machine-synchronized timing and a shared interface grammar. *Nonspecific Gamelan Taiko Fusion* is described as "an experiment in human controlled, but machine-synchronized percussion ensemble performance" (Trueman et al., 2006). PLOrk members use laptops to trigger "various percussive sounds" that "are temporally positioned" (Trueman et al., 2006), and timing is stabilized through a networked, collaborative step sequencer, the "Non-Specific Audicle Face" (Trueman et al., 2006). This interface, consisting of a grid of squares and a color palette, enables each performer to select and position sounds while a central server controls timing (Audicle Face, 2006). The ensemble's interaction is mediated through a repeatable system of selection, placement, and synchronization: performers enact individual choices within a shared temporal structure maintained by the network and server, reducing uncertainty and making collective precision achievable at scale.

In SLOrk, HCI is mediated through tethered gesture capture, where bodily movement becomes an operational interface and constraint. In *Twilight*, performers control sound through GameTrak tether controllers: the position and movement of the controller in 3D space are translated into musical output by the software running on their laptops (Figure. 8).



Figure 8. SLOrk performers using GameTrak tether controllers in *Twilight* (2013), illustrating gesture-based sound control. Frame capture from Stanford Laptop Orchestra (SLOrk), "Twilight," YouTube, accessed 10 February 2026, CC BY

The tether limits the range of motion but allows for precise control of the sound, turning control into a disciplined, repeatable mapping between movement and output. The performance repeatedly foregrounds this mapping through detailed interaction moments: performers manipulate the tether in various ways, bend the string with one hand to manipulate the sound, and maintain focused, precise motion that directly shapes sonic response. Later, the performance makes the technological substrate explicit when a laptop displays lines of code, pulling attention toward the computational layer that underwrites the interaction (Figure. 9).

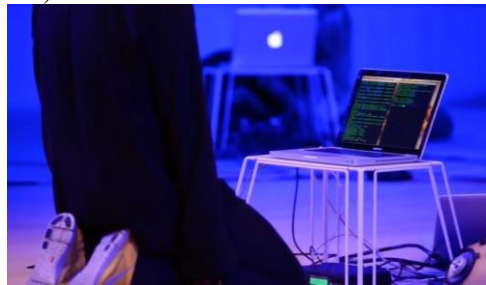


Figure 9. Ge Wang kneeling before the computer during *Twilight* (2013), foregrounding the computational interface within performance. Frame capture from Stanford Laptop Orchestra (SLOrk), “Twilight,” YouTube, accessed 10 February 2026, CC BY

The conclusion of *Twilight* intensifies the HCI framing through interface disengagement: the conductor removes the glove tethering the performers to the digital realm, emphasizing a clear procedural boundary between being connected to the system and being disconnected from it. Across these sequences, interaction is not merely performed; it is ritualized through repeated coupling and decoupling actions, consistent mappings, and visible constraints that make a complex system workable in real time.

In PULSE, ritual mediation of HCI emerges through a modular performance architecture that routinizes set-up procedures, network routing, and distributed control across multiple devices. The performance system in *Farben* integrates laptops, iPads, and controllers into a structured technical ecology. The iPads are central to interaction design: performers use an experimental MIDI controller, which utilizes touch, camera tracking (of hands, face, body, and color), and motion sensors, enabling performers to control sound with gesture (Figure. 10).

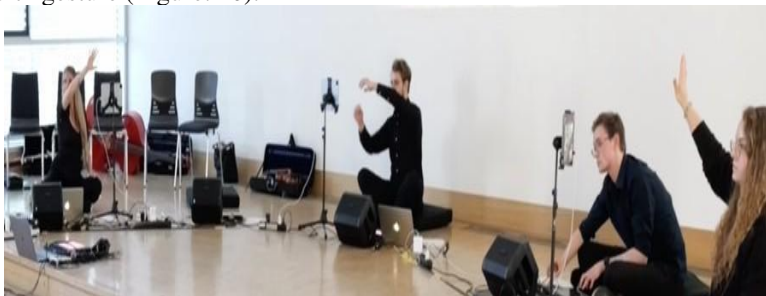


Figure 10. PULSE performers employing hand-gesture control to modulate sound in real time during *Farben* (2024). Frame capture from Post-digital Laptop Ensemble University of Siegen (PULSE), “Farben – Tim Bolin,” YouTube, accessed 10 February 2026, CC BY

Three iPads trigger synthesized sounds, while two are dedicated to recreating the visual and sonic textures of digital spray paint. This creates an interaction environment in which sensing, gesture recognition, and parameter control are distributed across multiple devices rather than concentrated in a single instrument.

Together, these cases show that rituals mediate HCI by converting technologically complex performance environments into repeatable, collectively coordinated interaction systems. PLOrk routinizes interaction through a shared grid-based sequencer and server-controlled timing; SLOrk ritualizes gesture-to-sound mappings through tethered controllers with visible constraints and procedural coupling/decoupling; and PULSE routinizes distributed control through modular station design, standardized networking/routing, and sensor-based gesture interfaces. Across all three, ritual practice does not merely accompany interaction it is a primary mechanism through which ensemble HCI becomes stable, interpretable, and collectively actionable.

3. Resonance, Transformative Experience, and Second-Order Resonance

Across the three cases, postdigital rituals generate different forms of resonance, linking technological performance practices with 1) cultural memory; 2) existential reflection, and 3) commemorative experience. While each ensemble operates in a distinct cultural–technological ecology, all three demonstrate how repeated, symbolically structured interactions with technological artifacts foster affective connection, collective identity, and what Rosa and R pke (2024) describe as second-order resonance.

In PLOrk’s *Nonspecific Gamelan Taiko Fusion*, resonance emerges through the remediation of traditional ensemble practices into a digital context. The work draws inspiration from Gamelan and Taiko traditions, with the progression from bell-like tones to drum patterns mirroring the increasing intensity and interactivity typical of these forms. The repetitive, interlocking structures characteristic of Gamelan find their digital counterpart in synchronized laptop sequences, creating continuity between analog ritual traditions and networked performance. Through these recurring sonic and spatial patterns, the performance evokes communal traditions while reconfiguring them through digital instruments, fostering a shared musical experience that bridges past and present.

In SLOrk’s *Twilight*, resonance is shaped by an existential narrative enacted through symbolic gestures and staging. The performance constructs a ritualized journey through humanity’s relationship with technology, moving from active engagement to detachment, submission, and reflection. The gradual progression of lighting, posture, and gesture stages a meditation on technological dominance and human fragility. Moments such as the performers lying motionless beside their laptops and the conductor’s final bowing gestures toward the computers produce a powerful emotional arc, transforming the performance into a ritualized reflection on human agency in a technologically saturated world. Rather than referencing external cultural traditions, *Twilight* creates its own symbolic framework, using staging, movement, and technological interaction to provoke reflection on the conditions of contemporary digital life.

In PULSE’s *Farben*, resonance is rooted in a commemorative and emotionally charged cultural reference. The work was dedicated to a graffiti artist who had passed away shortly before the performance, and the sonic materials spray-paint recordings, urban ambiances, and metro announcements evoke the artist’s world. The projected graffiti imagery and the use of both digital and physical spray cans create a ritual framework centered on memory, loss, and transformation. The spatialized audio environment and the embodied gestures of the performers transform the performance into

a ceremony of connection, where the spray cans function as symbolic artifacts linking the present performance to the artist's legacy. This integration of sonic, visual, and gestural elements produces a collective, commemorative atmosphere that anchors the ensemble's actions in a shared emotional context.

Across the three cases, second-order resonance manifests through recurring interactions with charged technological objects and performance structures. As Rosa and Rüpke (2024) note, second-order resonance grows from repeated ritual participation, establishing an "axis of resonance" through familiarity, continuity, and shared practice. In laptop orchestras, this process is evident in the repeated use of everyday technological devices laptops, controllers, iPads, cables, and speakers within collective performance settings. These objects acquire symbolic meaning through repetition, becoming associated with past performances, shared experiences, and collective identities.

In PLOrk, hemispherical speakers and synchronized sequencing evoke the communal resonance of traditional ensemble rituals. In SLOrk, tethered controllers and staged gestures become symbolic of the fragile bond between humans and machines. In PULSE, spray cans, iPads, and spatial audio systems function as commemorative artifacts that connect performers and audience to the memory of the artist. In each case, technological objects are not neutral tools but ritual elements that accumulate meaning through repeated use.

These performances also illustrate how second-order resonance emerges through distributed agency between human performers and technological systems. As Rosa and Rüpke (2024) suggest, agency in ritual contexts is often attributed not only to participants but also to objects, places, and activities. In laptop orchestras, performers shape sonic outcomes through gestures and interactions, while software, networks, and devices simultaneously constrain and enable those actions. This interplay produces a feedback loop of shared creative control, reinforcing feelings of collective efficacy and belonging.

Furthermore, the immersive sonic environments, synchronized movements, and symbolic staging observed across the cases suggest conditions conducive to trance-like or transformative experiences. As Becker (2004) observes, "deep listening is a kind of secular trancing," often associated with feelings of transcendence or communion. The layered textures, repetitive structures, and spatial soundscapes of laptop orchestras can foster heightened states of awareness and collective absorption, even outside explicitly religious contexts. This reading is offered as an interpretive extension grounded in observed immersive conditions (layered textures, repetition, spatialization), rather than as a claim about measured listener states. In this sense, the performances generate transformative experiences not only through peak emotional moments, but through repeated, structured engagement with shared technological rituals.

Together the cases demonstrate that postdigital rituals in laptop orchestras can foster resonance in multiple forms: cultural continuity in PLOrk, existential reflection in SLOrk, and commemorative connection in PULSE. Through repeated interaction with symbolic technologies, spatial arrangements, and collective procedures, these ensembles cultivate second-order resonance sustained experiences of belonging, affirmation, and shared agency within technology-mediated performance environments.

Discussion

This study set out to examine how rituals operate within laptop orchestras as postdigital performance environments. Across the three cases, several key findings emerge. First, laptop orchestras consistently adapt and reimagine ritual structures drawn

from diverse cultural, theatrical, and technological traditions. Despite differences in context, each ensemble organizes performance through recurring spatial arrangements, symbolic gestures, and structured procedures that function as ritual frameworks. Second, rituals play a central role in mediating HCI. Rather than operating as purely technical processes, interactions with laptops, controllers, and digital interfaces are embedded in patterned gestures, collective synchronized choreography, and symbolic staging. In this sense, ritual structures regulate the relationship between human performers and technological systems. Third, these ritualized interactions produce forms of resonance that extend beyond individual emotional peaks. Through repeated engagement with shared procedures, spatial arrangements, and symbolic technological objects, laptop orchestras cultivate second-order resonance ongoing experiences of belonging, affirmation, and collective agency. The findings suggest that rituals are not peripheral or decorative elements of laptop orchestra practice. Instead, they function as core mechanisms through which collective creativity, technological mediation, and social meaning are organized.

These findings extend and connect three strands of existing research: ritual theory, postdigital theory, and resonance theory. From the perspective of ritual studies, the results support Grimes' (1992, 2013) argument that rituals are not static inheritances but are continuously reinvented in response to changing cultural and technological conditions. The laptop orchestras examined here demonstrate how ritual forms migrate into technology-mediated environments, where seating arrangements, gestures, objects, and procedural routines take on symbolic and organizational roles similar to those in traditional ritual contexts. In this sense, the ensembles resemble Turner's (1982) notion of liminoid performance spaces, where artistic practices function as hybrid ritual forms in secular, experimental settings.

The findings also contribute to postdigital scholarship. Postdigital theory emphasizes hybridity, fluidity, and the entanglement of human and technological agency. The cases examined here illustrate how these characteristics become materially and symbolically organized through ritual practices. Laptop orchestras embody postdigital hybridity by blending traditional musical references with digital interfaces, while the boundaries between performer, instrument, and environment become fluid. Agency is distributed across performers, software, networks, and objects, reinforcing the idea that postdigital experience is shaped by interactions between human and non-human actors.

In this context, ritual provides a framework for organizing this distributed agency. Rather than viewing technological mediation as purely technical, the results show how ritualized actions structure and stabilize interactions between humans and machines. The repeated setup procedures, spatial arrangements, gestural languages, and symbolic artifacts observed across the ensembles demonstrate how the materiality of the digital becomes central to the performance experience.

The findings also extend resonance theory, particularly Rosa and R pke's (2024) concept of second-order resonance. Previous work on second-order resonance has focused primarily on religious or social rituals. This study demonstrates that similar processes occur in technology-mediated artistic contexts. Laptop orchestras can foster resonance not only through intense moments of musical or emotional engagement, but through repeated, structured interactions with technological objects and collective performance routines.

Across the cases, laptops, controllers, speakers, and cables function as "charged" ritual objects that accumulate meaning through repeated use. These objects become associated with past performances and shared experiences, reinforcing group identity and

continuity. The structured progression of concert rituals such as stage arrangements, cueing gestures, and coordinated entrances creates an atmosphere where performers and audiences experience a sense of connection and shared presence. In this way, laptop orchestras demonstrate how second-order resonance can emerge in secular, technology-mediated artistic practices.

One of the main strengths of this study lies in its comparative, cross-case design. By examining three ensembles from different institutional and cultural contexts, the study identifies recurring ritual structures while also highlighting meaningful variations. This comparative approach makes it possible to distinguish between case-specific features and broader patterns of postdigital ritual practice. A second strength is the integration of autoethnographic insight in the PULSE case. Autoethnography provides access to the embodied, affective, and procedural dimensions of ritual practice that are often inaccessible through external observation alone. This perspective deepens the analysis of second-order resonance, particularly in relation to emotional regulation, group cohesion, and the symbolic charge of technological objects.

However, the study also has several limitations. First, the number of cases is relatively small and focused primarily on university-based ensembles. As a result, the findings cannot be generalized to all laptop orchestras or technology-mediated musical practices. Second, the analysis relies primarily on performance documentation and autoethnographic observation rather than interviews, audience studies, or longitudinal data. This limits the ability to assess how resonance is experienced by participants over extended periods or across different performance contexts. Finally, the interpretive nature of the analysis means that some conclusions particularly those related to symbolic meaning and resonance are necessarily inferential. While grounded in theoretical frameworks and observational evidence, these interpretations should be understood as analytical propositions rather than definitive claims about performer or audience experience.

The findings carry several implications for future research, pedagogical and artistic practice, and the broader understanding of technology-mediated performance practices. First, the study suggests that laptop orchestras should be understood not only as technological or musical innovations, but as cultural ritual environments that structure collective action and meaning. Recognizing the ritual dimensions of these ensembles may inform pedagogical and compositional approaches, encouraging practitioners to consider spatial arrangements, gestures, and technological objects as symbolic and organizational elements rather than purely functional tools. Second, the results indicate that ritual practices play a central role in mediating HCI. This has implications for the design of digital musical interfaces and performance systems. Practitioners may benefit from considering how repeated gestures, spatial routines, and symbolic artifacts contribute to performer experience, group cohesion, and audience perception. Third, the study extends resonance theory into postdigital artistic contexts, suggesting that second-order resonance can emerge in secular, technology-mediated performance environments. Future research could examine how such resonance develops over time, how it is experienced by performers and audiences, and how it varies across different cultural and technological settings.

Several questions remain open. Longitudinal studies could explore how repeated participation in laptop orchestras shapes performers' sense of identity and belonging. Audience-centered research could investigate how postdigital rituals are perceived and interpreted by listeners. Comparative studies across different types of technology-mediated ensembles such as networked improvisation groups, live coding communities,

or virtual performance environments could further clarify the role of ritual in shaping postdigital artistic practice. Overall, this study demonstrates that rituals are central to the functioning of laptop orchestras as postdigital ensembles. By organizing HCI, structuring collective creativity, and generating sustained forms of resonance, postdigital rituals provide a crucial framework for understanding how technology, culture, and social experience intersect in contemporary performance contexts.

Conclusion

This study has examined laptop orchestras through the lens of postdigital rituals, demonstrating how recurring spatial arrangements, gestural repertoires, procedural routines, and technological artifacts operate as ritual infrastructures within collective performance. Across the cases of PLOrk, SLOrk, and PULSE, these ritualized practices organize collective creativity, stabilize human computer interaction (HCI), and sustain shared experiences of second-order resonance. Rather than treating technology as a neutral tool, the analysis shows how agency emerges through distributed relations among performers, devices, software, spaces, and symbolic objects.

By bringing ritual theory into dialogue with postdigital and resonance-oriented perspectives, the article extends the concept of second-order resonance into technology-mediated artistic practice. In these ensembles, resonance is not confined to moments of intensity, but is cultivated through repeated, materially situated participation in hybrid performance ecologies. This complements emerging discussions of postdigital resonance by showing how resonance can be grounded in concrete ensemble procedures, symbolic artifacts, and routinized interactions that structure collective experience over time.

More broadly, the study contributes to postdigital scholarship by positioning laptop orchestras as sites where the entanglement of human and technological agency becomes materially and symbolically organized through ritual practice. In this sense, laptop orchestras offer a useful lens for examining how postdigital conditions are enacted in embodied, collective, and performative contexts. They demonstrate how cultural memory, technological systems, and social interaction are co-constituted through repeatable practices that sustain belonging, coordination, and meaning.

By framing laptop orchestras as postdigital ritual environments, the article charts new directions for research on technologically mediated collective practices across music, education, and related disciplines, where ritual, resonance, and distributed agency intersect. These settings afford fertile ground for examining how postdigital relationality is ritually mediated, reflexively stabilized, and socially experienced.

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