Feminist HCI and narratives of design semantics in DIY music hardware

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Feminist Human-Computer Interaction (HCI) integrates gender, diversity, equity,
and social justice into technology research and design, fostering a more inclusive
and socially aware technology landscape. This article explores the design
semantics of ten Do-it-Yourself (DIY) musical instruments created by women
builders. Design semantics refers to the associations conveyed by designed
objects so as to identity, emotions, performance or the environment and their
sensory qualities such as shape, size, touch or vision. Together these associations
and qualities can establish design narratives that influence the way meaning is
ascribed. We conduct an analysis of these instruments to answer the question
of how fabulations of design semantics, through the lens of feminist HCI
principles, can reshape our understanding of gender bias in object design within
the realm of DIY musical instruments constructed by women builders. Our
investigation uncovers a feminist narrative taking shape as we found out that
DIY instruments design contributes to the fabulation of alternative futures that
challenge prevalent current gender expectations associated with commercial
music hardware. DIY instruments provide a platform for questioning established
gender norms, enabling the development of technologies that embrace diverse
perspectives and maintain a technical identity.

KEYWORDS

Feminist Human-Computer Interaction, music technology, design, fabulations, women,
Do-it-Yourself, instruments

1 Introduction

Gender stereotypes can be promoted through various artifacts (Livingstone, 1992;
van Oost, 2003) and have also been observed in commercial music hardware (Jawad, 2020),
potentially reinforcing gender biases and leading to unequal representation. This problem is
in line with the principles of Feminist Human-Computer Interaction (HCI), which stresses
the importance of considering gender, diversity, equity, and social justice in technology
design (Bardzell, 2010).

In contrast to the commercial music hardware, the Do-it-Yourself (DIY) approaches in
developing new instruments, showcased in events like New Interfaces for Musical Expression
(NIME), the Guthman competition, and the MoogFest, offer alternative ways for exploring
music technology. We analyzed 10 instruments from these venues built by women. Through
this exploration, alternative narratives have been uncovered that challenge the dominant top-
down narratives associated with commercial music hardware. For instance, the promotion
of predominantly male gender roles within the music technology industry while overlooking
women's contributions as technical experts and producers (Mathew et al., 2016). This opens
up space for fabulation.

Fabulations are seen as alternative social relations (Søndergaard et al., 2023, p. 1693) that re-imagine norms, power structures, and relationships in line with feminist approaches. Through this investigation, we sought to address the research question of how fabulations of design semantics (Demirbilek and Sener, 2003), through the lens of feminist HCI principles, can reshape our understanding of gender bias in object design within the realm of DIY musical instruments constructed by women builders.

Feminist HCI counterbalances masculine approaches to and values in technology production, which tend to promote efficiency, individualism, competitiveness, industrial production, and male-dominated sociocultural values. Design semantics refers to the associations conveyed by designed objects so as to identity, emotions, performance or the environment. The objects' materials (Tholander et al., 2012) and sensory qualities such as shape, size, touch or vision can establish design narratives that influence the way of ascribing meaning (Demirbilek and Sener, 2003) to these objects and their agency. By considering the semantics of design, emerging narratives can be examined which can form fabulations. In the search for alternative futures and desirable ways of living, which is also on the agenda of feminist HCI, fabulations can play a crucial role. Cultivating the capacity to envision alternative futures and desirable ways of living is a crucial facet of design (Søndergaard et al., 2023). By engaging in fabulations, existing norms can be reimagined through alternative design semantics, and foster more inclusive and equitable music technology practices.

2 Materials and methods

In our analysis, we utilized the article "Feminist HCI: Taking Stock and Outlining an Agenda for Design" by Bardzell (2010) as a foundation. Bardzell's work was seminal in explicitly focusing on feminist perspectives in HCI. Later work has also investigated gender and its implications for HCI (Stumpf et al., 2020). The article explores the state of feminism in HCI and suggests ways to incorporate feminist perspectives into design practices. A key aspect of the article is Bardzell's development of feminist interaction design qualities, which serve as a framework for characterizing design artifacts. By applying these feminist interaction design qualities to DIY musical instruments, alternative narratives on music technology practices are expected to be revealed. These qualities, namely pluralism, participation, advocacy, ecology, embodiment, and self-disclosure, align with feminist principles and values. Applying this framework, we examined various instruments to understand their significance in relation to these qualities. Among the qualities, pluralism, ecology, and embodiment emerged as particularly meaningful in terms of their outputs. These qualities highlight the importance of inclusivity, environmental awareness, and the embodiment of diverse experiences in the design of new musical interface hardware. By analyzing the instruments through this lens, we aimed to gain insights into how they may contribute to feminist fabulations and semantic design.

Inspired by Reid et al. (2018)'s research on women who build things, we selected 5 of the featured works and added 5 more instruments from NIME, the Guthman competition and MoogFest. The first criterion was that the instruments should be created

by one woman-identified author. Also, they should be in a DIY status that they can be performed with but are not commercially available. Furthermore, we looked for a balance between recycled, newly manufactured and augmented instruments. Augmented instruments refer to acoustic musical instruments or devices that integrate technological enhancements or modifications, which expand their sonic capabilities or create novel modes of interaction. The chronological range mostly spans from 2012 to 2020 (9 instruments), plus an instrument built in 1996. Here we introduce the 10 instruments in alphabetical order. For the analysis we used existing publications and specific performances (see the Appendix for the list of videos used).

We strive for diversity in selecting instrument makers, in line with intersectional feminism, considering multicultural, geographical, and generational factors. We acknowledge, as Bassett et al. (2019) do, the multifaceted intersections of identity, social circumstances, geopolitics, economics, and the environment. Next, we describe each of the ten instruments (see Figure 1 for a graphical representation).

Bell Controller,[1] developed by Stephanie Cheng Smith in 2015, is an Arduino motor-controlled interface for 15 vibration motors and LEDs attached to muted jingle bells. It can be played in installation and performance modes from a mixing desk.

Electronic_Khipu_ (Cadavid, 2020) is an instrument created by weaving knots with conductive rubber cords to encode sound compositions. It is based on the Andean khipu, an ancient textile computer used for information processing and transmission.

Lori Napoleon's collection called **The Exchange**,[2] created in 2012, consists of analog synths and sequencers made from old telephone switchboards. The analysis focuses on a comb filter/oscillator module of tabletop size.

GramFX,[3] designed by Jassie Rios in 2018, is an augmented gramophone that combines commercial and open-source tools. It utilizes Leap Motion technology for motion capture and Pure Data for effects.

Laser Koto[4] (Masaoka, 2007), developed by Miya Masaoka in 1996, connects a 21-string Japanese koto to a computer through an Arduino interface with laser beams and sensors.

Ni (2021) created **Mermy**[5] in 2020, which is a self-made ceramic pot with embedded contact microphones for sound amplification and processing.

Prism Bell[6] (Mice and McPherson, 2020), created by Lia Mice in 2019, is a standalone system consisting of pipes with embedded Bela Mini units for sound modeling and synthesis.

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1 Stephanie Cheng Smith's Bell Controller webpage: https://music.stephiescastle.com/works/bell-controller.

2 Webpage of Lori Napoleon's Intstruments: http://www.meridian7.net/ME7/instruments.htm.

3 Jassie Rios' GramFX on the Guthman Musical Instrument Competition webpage—2018 Winners: https://guthman.gatech.edu/history.

4 Miya Masaoka's webpage: http://miyamasaoka.com.

5 Video demo of Ni Shan's Mermy: https://youtu.be/RgSbQdjMoRo.

6 Lia Mice's webpage on Prism Bell: https://www.liamice.com/prismbell.

FIGURE 1
This is a graphical representation of the 10 selected instruments. Illustrations by Isla Sharpe (@sharpearts).
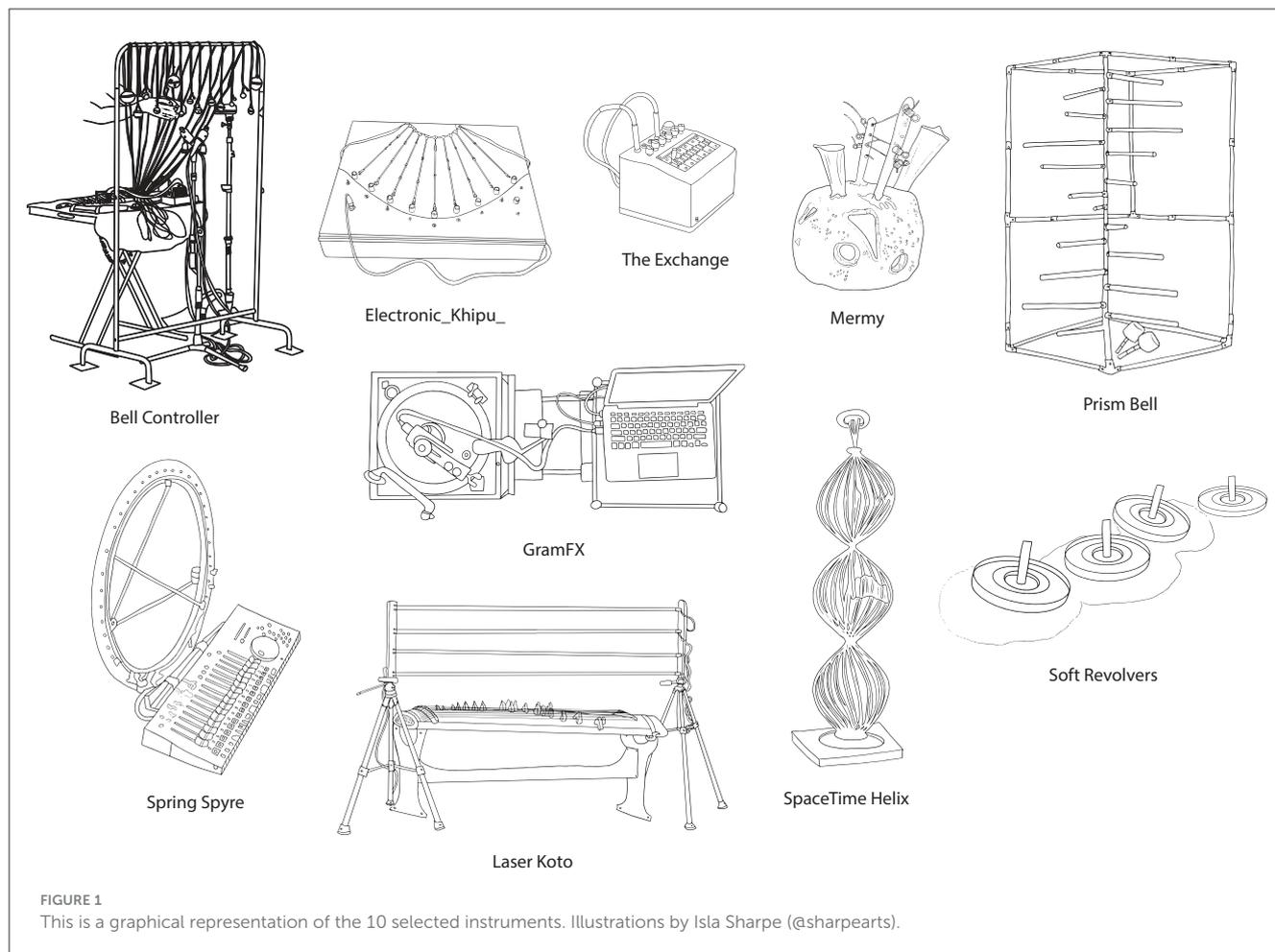
Soft Revolvers,[7] created by Myriam Bleau in 2014, are spinning tops with embedded sensors that trigger sound samples.

SpaceTime Helix[8], a kinetic light sculpture by Michela Pelusio created in 2012, features a rotating string attached to a motorized plate, producing sound and controlling additional textile surfaces with MaxMSP.

Laetitia Sonami's **Spring Spyre**[9] (Fiebrink and Sonami, 2020), developed in 2013, incorporates a metal wheel, three strings, and audio pickups controlled by a Roland PC1600 MIDI controller, with feature extraction and machine learning done using MaxMSP and Wekinator software.

3 Results

In this section, we present the results of our analysis of the instruments across three selected feminist HCI qualities, providing

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7   Myriam Bleau's webpage on Soft Revolvers: https://www.myriambleau.com/softrevolvers.

8   Michela Pelusio's webpage on SpaceTime Helix: https://michelapelusio.org/SpaceTimeHelix.

9   Laetitia Sonami's webpage on Spring Spyre: https://sonami.net/portfolio/items/spring-spyre.

a detailed account of our findings and highlighting the three patterns that emerged.

3.1 Pluralism

We interpreted the quality of pluralism as emphasizing and recognizing diverse perspectives, experiences, and voices. It encourages the design of instruments that represent the multiplicity of identities, cultures, and backgrounds. Each instrument has a unique approach.

Bell Controller creates a soundscape that evokes the imagery of visual fireflies and the sound of crickets in both performance and installation mode, capturing the essence of a Biosphere. **Electronic_Khipu_** incorporates elements from different cultural traditions, referring to the practices of the former Inca Empire and Andean societies. There is a hybridity that brings together both worlds, western electronic music and ancient traditions. **The Exchange** is the repurposing and upgrading of old telephone switchboards that have enabled the utilization of a popular object for a new function. **GramFX** is an augmented gramophone, a reproduction of a sound device with gestures that produce sound which manipulate tangible objects (e.g., cranking the gramophone) and intangible objects (e.g., activating the effects by moving the

hands in the air). The instrument has been repurposed so that the device has different ages and musical variations through different types of vinyl play. **Laser Koto** has a hybridity and different ages, as it incorporates elements from different cultural traditions, such as the koto and its cultural heritage in Japan, where it has been played for centuries. This is also found at a technological level, in terms of the invocation of digital play. **Mermy** is an instrument that incorporates elements inspired by mythology, specifically drawing on the form of a female sea creature, and combines them with advanced technology to create a performer's avatar. **Prism Bell** is a digital instrument with physical qualities, designed so that the timbre of the instrument changes with each piece. The instrument's chromatic scale provides pluralism. **Soft Revolvers** embraces the integration of playfulness in its design, transforming a simple toy into an instrument through the concept of hybridity, merging the act of play with the process of shaping and manipulating sound. **SpaceTime Helix** is an opto-acoustic instrument that constantly changes shape, combining artistic and scientific elements into one experience, as plural time and space are considered. **Spring Spyre** harnesses the power of machine learning to analyse Sonami's performance data, dynamically altering the synthesis process for transition between predictable and unpredictable outputs. The essence of pluralism emerges from the ongoing dialogue between the artist and the algorithm, fostering a rich interaction with the AI system.

3.2 Ecology

We read this quality as emphasizing the interconnectedness of technology and the environment. Especially, what material solution has been chosen for the physical components and hardware of the instrument.

Bell Controller features various surface textures, with the exception of small round sheet metal bells. These bells, equipped with vibration motors and LEDs, emit buzzing sounds. The technology is partly visible and hidden behind the instrument. **Electronic_Khipu_** consists of conductive rubber strings on a wooden plate, arranged like the original khipu's wool strings. The technology serves a technological purpose and allows for knotting interaction, being partly visible and partly hidden. **The Exchange** is an assembly of upcycled telephone switchboard modules, interconnected like guitar pedals, designed for modular synthesis. Its visible buttons and cables integrate into its aesthetic and functionality. **GramFX** is an upcycled gramophone that blends visible and concealed components that can evoke a sense of nostalgia. The addition of motion sensors and cameras introduces a modern twist. **Laser Koto** enhances the traditional koto with laser beams and infrared sensors, creating an augmented interface. The beams form a distinct pattern above the wooden instrument, enhancing visual, and sonic capabilities. **Mermy** is a minimalist clay pot whose shape exudes warmth and protection. Its concealed technology allows for easy user interaction. **Prism Bell** is constructed from upcycled PVC pipes arranged in an accessible winding configuration. The technology remains concealed, while emphasis is placed on the bells. **Soft Revolvers** has a circular acrylic structure for smooth play, with integrated sensors, some of which are visible. **SpaceTime Helix** features physical and abstract optical

interfaces, evolving from a bright, transparent arcing helicoid. The technology is operated by a sometimes concealed controller. **Spring Spyre** is a vertically aligned metal disk with taut, pliant springs and a compromised console. Its technology is partially visible in its performance, showcasing a minimalistic use of components.

3.3 Embodiment

The approach undertaken considers quality in the ways in which the instruments can support and enhance embodied experiences, taking into account diverse abilities, gender expressions, and cultural practices.

The **Bell Controller**'s expressivity lies in the micro-movements of acoustic objects. A mediated interaction occurs between the objects and the hidden performer behind the instrument. Through the controller and Arduino switchboard, the performer creates a passive and independent environment. The Bell Controller produces high frequencies and rhythmic pauses, utilizing contact microphones to equalize a rich assortment of high and low frequencies. **Electronic_Khipu_** retains the traditional form and interaction in a new electronic interface, allowing for real-time knotting of strings. This technology brings back ancient traditions of calculating and decrypting. Sample-based music is heard, featuring textural and synthetic algorithmic note-based sounds, with low frequencies and slow rhythmic beats. **The Exchange** filter/oscillator modules are hand-sized and emphasize control, merging layers of low to mid frequencies shaped with digital effects. **GramFX** involves manual cranking of the vinyl while engaging with sensors above it, creating immersive experiences with sound effects and a multifaceted range of musical frequencies. **Laser Koto** combines acoustic and laser instruments, allowing the simultaneous playing of both with the two hands. Laser beams trigger various samples, creating a note-based and polyphonic music range. **Mermy** is played by stroking, plucking, and blowing into it, producing soft and subtle sounds. **Prism Bell** is played with large gestures, that trigger synthesized percussive tones resembling distorted electric guitar strings and bells. In **Soft Revolver**, spinning tops, spun with both hands, invite playful exploration and are linked to synthetic sounds. **SpaceTime Helix** allows the performer to control light frequencies, colors, speed, and sounds manually. The shape of the light sculpture can be manipulated by hand, creating rhythmic textures that integrate harmoniously with the sonificated acoustic sounds. **Spring Spyre** consists of intersecting wire coils that can be gently plucked with the fingers, generating a noisy texture combined with a low, steady drone. This instrument facilitates active listening and contemplation.

3.4 Patterns

We understand patterns as recurring challenges to traditional norms of instrument design and musical interaction. Norms can manifest themselves through marketing, physical design or aesthetic preferences. Regarding the physical design for example, some electronic musical instruments have larger, bulkier designs that may exclude individuals who do not conform to stereotypical body types (Spiel, 2021). By understanding these patterns and

their significance, we can explore the transformative potential they hold in reshaping the relationship between performers and their instruments.

1. **Reimagining familiar gestures for new musical interfaces**: By repurposing expected interactions and gestures, creations like the Electronic_Khipu_ GramFX, Soft Revolvers, and Prism Bell emerge, forming a significant pattern of reinvention. By reinventing gestures, designers can challenge and reimagine the relationship between the performer and the instrument. This approach promotes inclusivity and empowers the performer to explore new modes of expression, ultimately reshaping the narrative of musical interaction.

2. **Repurposing traditional technologies for new musical interfaces**: By converting outdated technologies or acoustic instruments into electronic interfaces and enhancing them with a digital layer, innovations such as the GramFX, The Exchange, Electronic_Khipu_, and Laser Koto show how digital augmentation has the capabilities of merging old and new technology. By repurposing traditional technologies, the dominant narrative of technological progress can be challenged and alternative futures explored. This approach promotes sustainable practices and encourages a reevaluation of our relationship with technology, emphasizing values such as cultural preservation and the coexistence of old and new.

3. **Promoting round and soft elements**: Pattern 3 displays, in the context of new musical interface hardware, a preference for circular and round shapes. It is evident in various creations, including the Spring Spyre, Mermy, Bell Controller, SpaceTime Helix, Soft Revolvers, and GramFX. The preference for round and soft elements can contribute to the envisioning of alternative design aesthetics and narratives. By breaking away from rigid and angular forms, a harmonious association between humans and musical interfaces can be fostered.

4 Discussion

We examined the implications of the feminist HCI qualities, in terms of their design semantics, for potential new narratives that foster fabulations on DIY music hardware made by women builders. We have identified three main patterns that subsequently have revealed a series of observations when reflecting within the scholarship of design semantics and feminist fabulations.

The first pattern was the reimagining of familiar gestures. Amidst fabulations, as "one way of imagining alternative futures that helps foreground critical feminist technoscience" (Søndergaard et al., 2023, p. 3), this approach reshapes the narrative of musical interaction by challenging traditional notions of control and authority. It promotes inclusivity by opening up opportunities for diverse performers with varying backgrounds and abilities to engage with music in their own unique ways. Traditionally, musical instruments have often been designed with a predefined set of gestures and interactions, which can limit the creative expression and agency of the performer.

The second pattern, the repurposing of traditional technologies for new musical interfaces, provides an alternative narrative to the dominant portrayal of technological progress as a linear path. It challenges the assumption that innovation can only be achieved through the constant development of new technologies.

An unquestioned logic of novelty and innovation would often under-scrutinize the impact on environmental sustainability (Masu et al., 2023). Many of these practices shift from the production of new artifacts to the reuse of existing resources.

In the third pattern, overall, rounded and soft lines are more common than sharp lines in seven of the ten selected objects. The use of the circle as the most prominent shape suggests the use of a universal symbol with multiple meanings, including wholeness, infinity, timelessness and cyclical movement, as well as warmth and protection (Dondis, 1974), which has traditionally been connoted as a feminine symbol. In commercial products, although there is a general tendency to favor curved artifacts over angular ones (Westerman et al., 2012), in musical interfaces we find mainly angular shapes (Jensenius and Voldsund, 2012). The preference for round and soft elements can contribute to the envisioning of alternative design aesthetics and narratives that echo circular, sustainable principles.

DIY design constantly challenges binary expectations and disrupts traditional gender narratives (Stewart et al., 2018; Kori and Novak, 2020). According to Rode, in the concept of technology as a male-dominated culture, with its historical bias toward men in design and technological development, "there is a need for technologies that allow for the demonstration of Technical Femininity" (Rode, 2011, p. 379). The design space created by these female builders can maintain a technical identity, as well as their status as technical devices (Rode, 2011). Their practice intersects with computer science, hardware design and instrument making, and thus DIY instrument makers challenge and reshape traditional gender narratives within these fields. It is likely that DIY design faces less pressure to conform to standards and norms. It leaves room for intersecting identities (D'Ignazio and Klein, 2023), like marginalized individuals and communities, to reclaim their voices, access resources and take ownership of their creative processes, challenging traditional hierarchies by empowering their own musical expressions. Hence, the places where music technology is made, whether in companies, cultural institutions or universities, can be challenged (Jawad and Xambó, 2020; Pardue and Bin, 2022).

Applying Bardzell's (2010) HCI framework to our research on DIY instrument making has revealed a feminist narrative emerging. DIY practices bring fabulation to life, as instrument makers challenge dominant gendered expectations associated with commercial music hardware. This approach offers avenues for re-imagining norms, power structures, and relationships. Moreover, it provides a forum to question gendered assumptions, allowing for the creation of technologies that incorporate varied viewpoints and defy conventional gender preconceptions via alternative design semantics.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

KJ: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. AX: Conceptualization,

Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm. 2023.1345124/full#supplementary-material

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