

# Tuning in: Reflecting in the Wake of Blackness through a Knitted Flower Antenna

## Felecia Davis

Stuckeman Center for  
Design Computing,  
Pennsylvania State  
University  
USA  
fadav@psu.edu

## Erin Lewis

The Swedish School of  
Textiles, University of  
Borås  
Sweden  
erin.lewis@hb.se

## Farzaneh Oghazian

Stuckeman Center for  
Design Computing,  
Pennsylvania State  
University  
USA  
fxo45@psu.edu

## Berfin Evrim

School of Architecture,  
Planning and Landscape  
University of Calgary  
Canada  
berfin.evrim@ucalgary.ca



Figure 1 The Flower Antenna installation at Museum of Modern Art New York City's (MOMA) *Reconstructions: Architecture and Blackness in America* exhibition during the spring of 2021. ©Berfin Evrim, 2021

## Abstract

The paper presents the context and inspirations for the *Flower Antenna*, a large-scale, hovering, sculptural sound installation that combines sound and transmission art, computational textiles, and architectural design. Computational textiles include microcontrollers and other electronic components as well as use the natural property of the fabric to communicate information to people. The *Flower Antenna* was exhibited at the Museum of Modern Art's (MOMA) *Reconstructions: Architecture and Blackness in America* during the spring of 2021. The authors discuss the use of electromagnetic waves via an electronically active textile construction as a form of non-visual media used to represent the paradox of Blackness and the presence of Black people in architecture in the wake of the history of slavery in the United States. Electromagnetic waves are neither seen

nor recognized by most people, yet they shape the spaces people inhabit and support almost every part of society today with the use of invisible networks cast by the internet and its structures. This artistic project contributes to a discussion and reconstructing an understanding of Black culture in transmission arts, textile design, and in architecture.

## Keywords

Electromagnetic waves, architecture, sound installation, media art, computational textiles, textile design, antenna, Blackness, race, America.

## Introduction

This paper presents the inspirations and context for the *Flower Antenna*, a large-scale, hovering, sculptural sound installation that combines sound and media art, computational textile design, and architectural design. The *Flower Antenna* was exhibited at the Museum of Modern Art's (MOMA) *Reconstructions: Architecture and Blackness in America* in New York City during the spring of 2021. The authors discuss the use of electromagnetic waves via an electromagnetic textile construction as a form of non-visual media to represent the paradox of Blackness and the presence of Black people in architecture in the wake of the history of slavery in the United States.

The *Flower Antenna* is an elliptical-shaped flower, 21 feet (6.4m) long by 15 feet (4.5m) wide. The sculpture operates as a large receiving antenna picks up the frequencies of electromagnetic waves passing through the gallery space, and through a logarithmic amplifier circuit, converts the received frequencies to sound waves to be heard in the installation space. 34 knitted textile cones are suspended around a lightweight elliptical ring that is attached to the gallery ceiling. The cones are hung closer to the ring at one end of the long axis and drop down to the floor at the other end creating a rising section underneath the piece (Figure 1). The project has a pink underbelly made of conductive copper and cotton yarn used to create the conical forms that is electronic and is used to sense electromagnetic waves which is then translated as sound in the gallery space.

## Background

There are two principal metaphors that operate in the *Flower Antenna*, and that have inspired the use of electromagnetic waves as the media to carry the work and connect it to the Black diaspora: the wake, and invisibility.

### The Wake

The first metaphor derives from author Christina Sharpe's concept about 'the wake' as the disturbance that is created behind a ship moving through water. In her book, *In the Wake: On Blackness and Being*, Sharpe discusses a wake created by slavery that remain as ships crossed the Atlantic Ocean with human property. [1] The wakes she describes are the after-effects of slavery on aspects of Black life in the United States and globally by the slave trade. She asks scholars, artists, and other cultural producers to "stay in the wake", which is to work in a way that does not

"seek to explain or resolve the question of this [Black] exclusion in terms of assimilation, inclusion or civil rights, but rather depict aesthetically the impossibility of such resolutions by representing the paradoxes of

blackness within and after the legacies of slavery's denial of Black humanity." (14)

Sharpe names this paradox of the wake and uses it to understand "how slavery's violences emerge within the contemporary conditions of spatial, legal psychic, material and other dimensions of Black non/being as well as in Black modes of resistance" (4) [2] Further, in a descriptive passage, (Anon Author) writes that the *Flower Antenna*

"links to an invisible urbanism floating above and through the city on electromagnetic waves. These waves are a new global ocean and traversing it in our everyday practices is as perilous as the Atlantic of the Middle Passage. Will all bodies be slaves in these global waters? Who will be seen and who will not? What new but invisible boundaries are being constructed in this electromagnetic city? All bodies lie in its wake. So, there is wake work to be done on this new ocean that is fast shaping our lives." (55) [3]

The *Flower Antenna*'s use of electromagnetic waves as a media is meant to call visitors' attention to this invisible electromagnetic system that connects all of us through the internet, the radio, and other devices that rely upon electromagnetic waves to function. In fact, these waves produce a new electromagnetic ocean that also has been used by dominant culture to *reproduce, again*, systems of service and profit extraction, exclusion and oppression of Black people. This electromagnetic ocean is an invisible wake that we all live in. The *Flower Antenna* calls attention through its explosive form to this wake.

### Invisibility

The second metaphor used in the work regards the invisibility of Black people as an aftereffect of slavery. This paradox of Blackness is described in Ralph Ellison's *Invisible Man*:

I am an invisible man. No, I am not a spook like those who haunted Edgar Allan Poe; nor am I one of your Hollywood-movie ectoplasms. I am a man of substance, of flesh and bone, fiber and liquids - and I might even be said to possess a mind. I am invisible, understand, simply because people refuse to see me. Like the bodiless heads you see sometimes in circus sideshows, it is as though I have been surrounded by mirrors of hard, distorting glass. When they approach me they see only my surroundings, themselves, or figments of their imagination - indeed, everything and anything except me.

Nor is my invisibility exactly a matter of a biochemical accident to my epidermis. That invisibility to which I refer occurs because of a peculiar disposition of the eyes of those with whom I come in contact. A matter of the

construction of their inner eyes, those eyes with which they look through their physical eyes upon reality. I am not complaining, nor am I protesting either. It is sometimes advantageous to be unseen...(3) [4]

Contemporarily and historically, Black people in the United States have been made invisible through systematic oppression and discrimination. Ellison points out to us the possibility of using this unseen place in a broken system for artistic expression. In describing Louis Armstrong's music, Ellison notes that Armstrong is not aware he is invisible; he is someplace else "[that] he's made poetry out of being invisible". Ellison hears the breaks in time in Armstrong's music and "you can slip into the breaks and look around" [5]

The invisibility and yet presence of Black people and Black culture is much like electromagnetic waves, where Black culture has always been present, yet not fully acknowledged. The insistence on being present by persons who are invisible causes a rupturing and ripping of the fabric of life in the United States and in other nations globally where human and civil rights are not deployed in equitable ways. The rise of the Black Lives Matter protests, and historical protests over the killing of George Floyd are social ruptures caused by the invisibility of Floyd and Black people.

Electromagnetic waves are always here, and have always been here. "We are bathed in these waves, TV, broadcasts, probably telepathic messages, from other minds deep in thought." [6] Or, as Richard Feynman writes about the inconceivable nature of the number and types of electromagnetic waves that we are intersected by and live in but do not realize. "IT IS ALL REALLY THERE," [7] It remains to us to craft devices to tune in, in the poetic break of time, if we hope to survive together. The artist Kerry James Marshall uses rich and multilayered colors of black to great effect to elicit this feeling of absent presence he understood after reading Ellison's book [8] (Figure 2).

### Electromagnetic Arts in Black Culture

There are artists working in fields such as interactive and electronic art, sound art and music, furthering the black diasporic mission, or as Sharpe says, looking for the aesthetics of this condition. Among Black, African American, and the African diaspora, there are artists and activists who have taken to working in electromagnetic art (as a type of electronic art), primarily in the form of transmission art and radio for creative and critical purposes and expressions. For example, Mbanna Kantako (also known as Dewayne Readus) pioneered the artistic and political practice of microradio while living in a public housing project in Springfield, Illinois. As a Black activist, he began the station WTRA for political organizing in 1987 among the residents of his housing project. Today

WTRA is known as the Human Rights Radio, and is now an international organization. [9]



Figure 2 Kerry James Marshall, A Portrait of the Artist as a Shadow of his Former Self, 1980 ©LACMA

The Prometheus Radio Project of West Philadelphia broadcasts from a secret location as WPPR, or West Philadelphia Pirate Radio. In an act of defiance against the FCC (Federal Communications Commission based in the United States), they broadcast without license, noting that at the time almost all radio stations in the United States with FCC licenses are owned by only a few corporations. The information distributed through commercial and corporate owned radio has traditionally not benefited Black communities, thus motivating WPPR. WPPR was reborn in 1998 from the take down of Radio Mutiny that served an African American community of West Philadelphia. [10] Most of the sonic works by the artists Mendi and Keith Obadike of Black Sound Art reference the Black experience. This duo have created many sound installations that also cross into live performance that includes original music and dance. Their project *Four Electric Ghosts* (2009) made in Toni Morrison's workshop tells the story of the afterlives of 4 ghosts. [11] The Obadike's also have sound installations in galleries that focus specifically on more abstracted sound including a piece titled *Ring Shout for Octavia Butler* that uses recordings of the Earth's electromagnetic waves and is "underscored by circularly panning audio recordings of the Earth's electromagnetic atmosphere". A third piece, *Blues Speaker for James Baldwin* uses the glass facade of a building as a method to deliver the sound, thus turning the building into a speaker.

[12] The examples of radio and Black diasporic sound archiving, remixing and projecting are crucial to understand the context of this project. The critical concern of the *Flower Antenna* is to sense invisible electromagnetic fields as raw media. This media is a metaphor to carry ideas about the invisibility and presence of the Black diaspora.

### Electromagnetic Fields as Artistic Material

Electromagnetic fields are composed of electric and magnetic fields that oscillate in perpendicular planes, that are interdependent and locked in co-existence. These fields draw analogies to “ether” and “atmosphere” as an omnipresent force or an “abstract everywhere” [13] that form the environment in which we exist. Electromagnetic fields are “invisible, intangible, and inaudible” [14] passing through the objects and spaces that make up our built environment. Most electromagnetic fields are artificially produced by telecommunications that compose the modern world, while the Earth itself produces its own electromagnetic field that resonates at a very low frequency (3 – 30kHz). [15] Through demodulation and amplification, these fields can be detected and translated into sound.

Artists have been working with electromagnetic fields as a form of artistic material over the past century, for example John Cage [16], Alvin Lucier [17], Takis [18], Robert Barry [19], Christina Kubisch [20], Joyce Hinterding [21], Scanner [22], Akin O. Fernandez [23], Pe Lang [24], to name a few. Artists’ engagement with EMF suggests that they present as malleable, formable material that can be used for artistic purposes.

### Sonic Aesthetics of Electromagnetic Fields

The indeterminate and irregular sonic expressions of EMF picked up by the *Flower Antenna* present at times as “noises, bleeps, blips, and pulses” [25], as well as static and screeching sounds. These sounds have no beginning and no end; they are persistent layers of multiple transmissions that intermingle with one another as they pass from background to foreground in our sonic awareness. Sound artist Valerie Dubois has described specific signals found within the high frequency spectrum. To Dubois, Bluetooth signals present as high, steady-pitched sounds that, when mixing with other signals, start to create a sonic texture where “medium to fine grain particles intertwine in the foreground, while a more fat and gross granular texture lies in the background”. [26] She describes WLAN as expressing a dry, persistent ‘pa.pa.pa.pa.pa’ sound, and the sound of GSM as a “morse code that displays an aggressive character” and that does not evolve over time [27, *ibid.*] These sounds are site-specific, yet they transcend the architecture of the gallery

space, and draw our attention to the immediate invisible through an act of affective listening.

### Fibre Arts and Black Feminist Cultures and Networks

Within the United States, Sharbreon Plummer writes in *Haptic Memory: Resituating Black Women’s Lived Experiences in Fiber Art*

“The erasure of Black women’s presence and voices has been a significant problem throughout the course of history—including artistic discourse. Although progress has been made in terms of visibility, there is still an enormous amount of work required to rectify the effects of white supremacist hegemony on Black women’s artistic progress” [30]

[Plummer] argues that not only do Black women artists exist in a space of double-subjugation due to the intersections of race and gender; those who choose to work in the medium of fiber are also faced with the historical baggage and discrimination that accompanies craft-based mediums) [31]

Furthermore, [Plummer argues] that

“Traditional Eurocentric methods of interpreting fiber-based work are limited in their ability to effectively account for the specialized relationship that Black women have to materiality. While literature surrounding women’s work may account for the gendered history of fiber and textile-based practices, Black women’s contributions and distinct relationships to labor and creativity are in need of continued exploration. Plummer proposes looking at the intersectionality of Black women’s experience” to account for Black women’s lived experiences and creative outputs.” (13) [32]

The intersectionality Plummer refers to is Kimberly Crenshaw’s concept of intersectionality that looks at gender, race, class as interconnected systems, that exist in an environment structured by supremacist hegemony. [33, *ibid.*] For Plummer Black Feminist Thought, work done by Black women working on the margins of an emergent larger women’s movement, and theorized by the sociologist Patricia Hill Collins provide methods to understand and resist dominant values placed onto Black women. [34, *ibid.*] In addition the writings of Collins and others provide critique against a dominant system.

Rose Sinclair, a British based textile designer and professor writes speaks about the notion of Caribbean all-women textile networks in the UK in the ‘50s and ‘60s that generated social and economic change. These clubs used “life and oral stories to tell the untold”, while the women’s textiles “embody both material culture and diasporic tales”.

These clubs and the women in them have provided new ways to think about textile networks and their impact in textile design. [35] As a designer she discusses the invisibility of the Black woman in the crafting space, not appearing in mainstream magazines and literature. These are places that provide a maker a liminal space that “allows for the reader a construction of creative methods through which they understand portrayal of self and by extension representation.” (112) [36] Without self-representation, the envisioning of a (possible) future or its creation can be limited.

### Women Working with Large Textile Structures

According to Oghazian and Vazquez, there are at least three scales of consideration working with textiles for large architectural structures. First, there is a micro or stitch scale that demands close attention to stitches and the structure of the textile emerging. Second, there is a mesoscale that the structure of the emergent fabric. Finally, there is a macro scale that demands consideration of textile behaviour for making large parts of the structure that shelters people. A designer working with textiles for architecture must move between multiple scales between small micro-scale and the macro scale of a shelter. [37] The *Flower Antenna* is a large-scale installation work that uses the textile as architecture: that is, it takes up and produces space. There are a few artists whose work takes up space working in bespoke knitting or textiles that use interlooping (I.e., knitted or knotted textiles) and that produce space as architecture. Janet Echelman is an artist who works with netted structures that attach between buildings over large plazas or in large indoor spaces. An example of Echelman’s work may be seen in her piece *Earthtime 1.78* in Vienna, installed in 2021. [38] Echelman’s vibrant coloured structures are suspended in the air, seemingly floating freely above viewers’ heads. Another artist using knotting to make works that produce spaces for children to play such as *Woods of Net* in Japan is Toshiko Horiuchi MacAdam. Her work *Fiber Columns/Romanesque Church* reconstructs a church arched passage. [39] *Soft Civic* built in Columbus Ohio in 2019 by architect Bryony Roberts, is a knotted play space for children. [40] The work of Mette Ramsgard Thompson at the Center for Information Technology and Architecture at the Royal Danish Academy uses industrial knitting for architectural-scale structures such as the *Hybrid Structure* in the central square of Guimarães, Portugal: Largo do Toural constructed in 2016 or *Isoropia* built for the Danish pavilion at the 16th Venice Biennale. [41, 42] Other designers that work with knitting for large structures are Jenny Sabin a designer in New York in the project *Lumen*, a structure that changes colors based on the amount of light was installed in the courtyard of the Museum of Modern Art’s PS1 in 2017. [43] Heat responsiveness is used in the

works of knitted tension structures *Patterning by Heat* by Felecia Davis and Delia Dumitrescu. [44] The work of Jane Scott with MUDD Architects, in the *Bioknit Pavilion* in Cubbitt Park, Kings Cross, London in 2019 uses inflatable technology combined with 3D knitting. [45] While there are men working with knitted textiles in large-scale architectures, for example, Sean Alquist and his *Social Equilibria – Orchids Playscape* [46], this area of large-scale architectural knitting currently seems to be populated mostly by women.

### Electromagnetic and Transmission Arts in Textile Art and Design

Textile antennas are generally designed for applications such as receiving and transmitting from wearable electronic systems. [47] However, alongside their functional properties textile antennas can also be carriers of metaphor and meaning, and therefore present in various forms across art and design. In Ebru Kurbak and Irene Posch’s work *Drapery FM* [48], a large, knitted textile is suspended from the ceiling in a gallery setting. Knitted copper rows and wales of the textile are separated by dielectric wool yarn stitches to form textile-based resistors and capacitors that make up the tuning circuit. The signal antenna is knitted within the same textile structure as the soft tuning components, resulting in a fully soft FM transmitter. Nearby radios in the gallery space are tuned to the FM frequency of the textile and can listen to an audio recording of the hand-knitting machine working as the textile antenna was knitted. The work presents as soft electronic art, merging textile materials and techniques with the intangible and invisible medium of radio waves.

In *Listening Space* [49], Afroditi Psarra uses software-defined radio (SDR) to record satellite passes in proximity to her listening station. These transmissions are translated to audio waveforms that are assigned as yarn and colour changes on a hand-knitting machine to produce pattern changes. The pulses that make up the transmission signals are represented with black and white yarns, as signals and void. Psarra’s use of knitted textile on which to transpose the satellite transmissions was for the purpose of archiving the transmission that would otherwise be lost to the ether due to their temporal nature.

Erin Lewis’ *Ambient Energy Harvesters* [50] is a series of textile antennas that use various yarns and textile structures to yield different frequency ranges. These large, reconfigurable textile antenna structures are suspended from trees in the dense Swedish forest where they pick up electromagnetic waves from free space and, through a half-wave rectifying circuit, convert the waves to a usable power source. The power can be used for practical and artistic applications, and functions in remote places. Lewis



states that “positioning them in the forest reveals a contrast between expectation and reality -- where EMF surrounds us not only in urban environments, but in nature environments as well.” (142) [51]

### Description of the work

The *Flower Antenna* is a 21' (6.4 m) by 15' (4.5m) knitted textile receiving antenna sculpture. The sculpture is suspended from the ceiling from a light 20lb (9kg) fiberglass ring that holds 34 parametrically sized cones that hang from this ring. The cones are attached to the fiberglass ring by rope. The knitted cones are made of industrially knitted cotton and copper and cotton yarns, tensioned with aluminum hoops at each end. Fine fiberglass rods provide intermediate ring support and straight fiberglass members the weight of the entire work is 200lbs (90kg).

The cones for the *Flower Antenna* were knitted on a Shima Seiki Whole Garment knitting machine that permitted seamless tubes as well as integrated pockets that held the compression system of lightweight fiberglass rods (Figure 4). The project was installed at the Museum of Modern Art in New York, as part of the *Reconstruction: Architecture and Blackness* exhibition in America the spring of 2021. Authors David and Lewis worked to develop a functioning receiving antenna (Figure 3). The project uses invisible electromagnetic waves to build upon the metaphorical relationship of invisibility of Black culture and as an artistic expression in textiles using a medium that is invisible.

The project translated invisible electromagnetic waves in the gallery to sound through its industrially knitted material. During the exhibition at MoMA during Covid-19 restrictions there was not an opportunity to record and understand how people interact with this antenna. There was no opportunity to tune or play with the potentials of the materials or aesthetics of the sound. This work is planned for a future installation of the project.

### EMF-Sensing Electronics

The *Flower Antenna* uses a logarithmic amplifier circuit (Figure 5) that detects high frequencies in the range of 2.4GHz and 5GHz, which spans Bluetooth, WiFi, GSM, and GPS, and other intermittent spectrum noise. The circuit has been adapted from the open-source design of Howse and Mizayaki's *Detektors* circuit used for sonically expressing EMF [52] [53], though has been modified to allow for the knitted petals of the *Flower Antenna* to affect the frequency of the signal based on the textile antenna properties. The circuit interprets the radiant qualities of the textile material over an area, and the scale of the radiant surface to set the gain of the signal. Further, the position and scale of the *Flower Antenna* in the gallery space is directionally

sensitive to the reception of electromagnetic waves within the frequency range. The final presentation carries a quality of indeterminacy due to the auxetic qualities of knit materials when stretched in a frame, in addition to the qualities of the MOMA gallery which includes interference and reflection from building components and the dense electromagnetic environment in which the MOMA gallery is situated.



Figure 3 Underside view of *Flower Antenna* installation at MoMA gallery © Berfin Evrim, 2021

### Exhibition

The *Flower Antenna* was displayed for three months in the MOMA Gallery. A speaker was set up at the entry into the part of the gallery that the antenna sat in, separated from the knitted piece by a threshold (Figure 6). When visitors walked into the space, they heard the high-pitched squeal of the antenna. Some participants reading the gallery description of where the sound was coming from sent a partner or friend over to the antenna to see if they could change the sound of the piece by going very close to the piece but were stopped by gallery minders as well as a tape guard marking the ground. People were not able to get close enough in this gallery. A second installation of the piece is

planned so that the authors can play with the antenna and hear how it changes as bodies get very close to it.



Figure 4 Knitted pink copper and polyester yarn with black cotton yarn, textile antenna material with compression frame rings and compressive fiberglass rods. © Felecia Davis, 2021

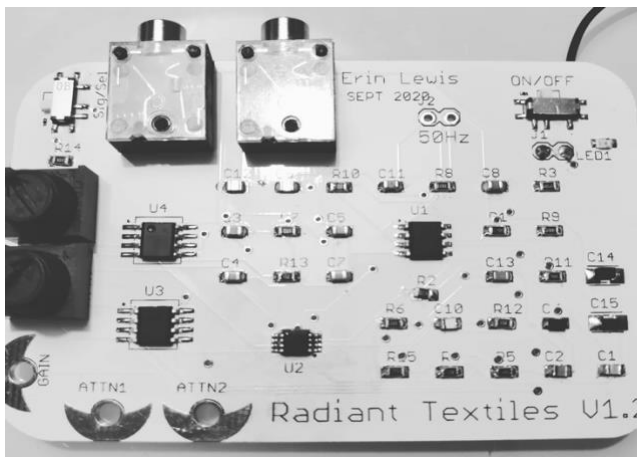


Figure 5 EMF sensing circuit used in Flower Antenna installation © Erin Lewis, 2020

## References

- [1] Sharpe, Christina, *In the Wake: On Blackness and Being* (Durham: Duke University Press, 2016), 14.
- [2] Ibid, 14.
- [3] Anon., Author, "Fabricating Networks: Transmissions and Reception from Pittsburgh's Hill District" in *Reconstructions: Architecture and Blackness in America*, Eds. Sean Anderson and Mabel O. Wilson (New York, New York: Museum of Modern Art Press, 2020), 55.
- [4] Ellison, Ralph, *Invisible Man* (New York, New York: Vintage Press, 1980), 3.

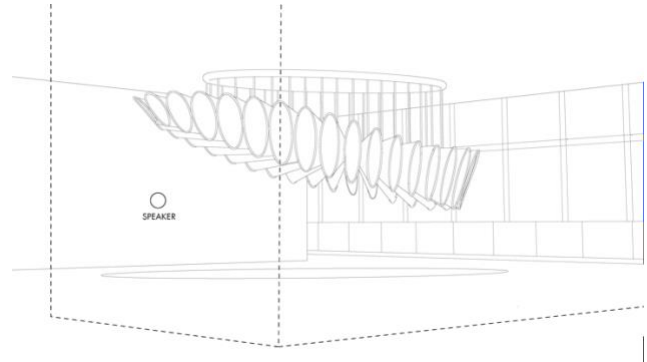


Figure 6 Sketch of installation setup in gallery space © Berfin Evrim, 2021

## Contributions and Future Work

This work makes a contribution to artistic practice related to Black culture, in particular in the United States. Contributions include the design of a large scale, space producing or architectural structure made of textile that has the added functionality of performing as a wide band antenna. The authors have used this networked textile as a way to tune into the disruptions and turmoil that roiled the United States initiated by the murder of George Floyd. This event resonated globally and is a historic and transformative moment. By tuning in to this broken system, as artists, cultural producers, designers, we can, in that paradoxical system, remake another vision for a world [54] In spite of the persistence of a historic system that pushes out and de-values Blackness, we can invent a place of creativity, freedom and life affirming values.

## Acknowledgements

This project was funded by The H. Campbell and Eleanor Stuckeman Fund for Collaborative Research grant 2017-18; Agnes Scollins Carey Early Career Professor in the Arts grant 2018-2021; and the Stuckeman Center for Design Computing Interdisciplinary Project Support grant 2020-2021

- [5] Ibid. 8.
- [6] Harger, Honor, Perelló, Josep, Honor and Luis de Vicente, José, *Invisible Fields: Geographies of Radio Waves*, (Barcelona: Actar – D Press, 2011), 19 & 27.
- [7] Ibid. 28.
- [8] Tomkins, Calvin "The Epic Style of Kerry James Marshall," *The New Yorker Magazine*, August 9 Issue, 2021, accessed 10-10-21, <https://www.newyorker.com/magazine/2021/08/09/the-epic-style-of-kerry-james-marshall>
- [9] Joseph-Hunter, Galen, Duff, Penny and Papadomanolaki, Maria, *Transmission Arts: Artists and the Airwaves*, (New York, New York: PAJ Publications, 2011), xvii.

- [10] Rosenblum, April, "Exclusive: Radio Pirates Speak Out After One Year Operation (1998)" accessed 10-12-21, [https://www.prometheusradio.org/mutiny\\_speaks\\_out](https://www.prometheusradio.org/mutiny_speaks_out)
- [11] Joseph-Hunter, Galen, Duff, Penny and Papadomanolaki, Maria, *Transmission Arts: Artists and the Airwaves*, (New York, New York: PAJ Publications, 2011), 34.
- [12] Obadike, Keith and Mindy, "Mindy and Keith Obadike" Website, accessed 10-21-21, <http://blacksoundart.com/#/gallery/>
- [13] Milutis, Joe. *Ether: The Nothing That Connects Everything*. Minneapolis: University of Minnesota Press, 2002. Accessed October 18, 2021. ProQuest Ebook Central.
- [14] Miyazaki, Shintaro. "Urban sounds unheard-of: a media archaeology of ubiquitous infospheres." *Continuum* 27, no. 4 (2013): 514-522.
- [15] Barr, R., D. Llanwyn Jones, and C. J. Rodger. "ELF and VLF radio waves." *Journal of Atmospheric and Solar-Terrestrial Physics* 62, no. 17-18 (2000): 1689-1718.
- [16] "John Cage: Official Website." Accessed October 18, 2021. <https://www.johncage.org/>.
- [17] "Intermedia Art: Alvin Lucier | Tate". 2021. *Tate.Org.Uk*. [https://www.tate.org.uk/intermediaart/alvin\\_lucier\\_biography.shtm](https://www.tate.org.uk/intermediaart/alvin_lucier_biography.shtm).
- [18] Tate. "Takis 1925 – 2019." Tate. Accessed October 18, 2021. <https://www.tate.org.uk/art/artists/takis-2019>.
- [19] The Museum of Modern Art. "Robert Barry | MoMA." Accessed October 18, 2021. <https://www.moma.org/artists/352>.
- [20] Kubisch, Christina. 2021. "Christina Kubisch". *Christinakubisch.De*. <http://www.christinakubisch.de/>.
- [21] "Joyce Hinterding — Haines & Hinterding." Accessed October 18, 2021. <http://www.haineshinterding.net/2013/05/21/joyce-hinterding/>.
- [22] "Scanner". 2021. *Scanner*. <http://scannerdot.com/>.
- [23] Joseph-Hunter, Galen, Duff, Penny and Papadomanolaki, Maria, *Transmission Arts: Artists and the Airwaves*, (New York, New York: PAJ Publications, 2011), 15.
- [24] Lang, Pe. 2021. "Pe Lang". *Pelang.Ch*. <http://www.pelang.ch/>.
- [25] Mizayaki, 2013
- [26] Dubois, V. I. R. G. I. N. I. E. "Electromagnetic Field as Medium to Listen to the Texture of the World." *Invisible Places. [online] Azores* (2017): 660-665.
- [27] Ibid.
- [30] Plummer, Sharbreon, "Haptic Memory: Resituating Black Women's Lived Experiences in Fiber Art", (PhD.diss., Graduate Program in Arts Administration, Education and Policy, Ohio State University, 2020), 13.
- [31] Ibid., 13.
- [32] Ibid., 13.
- [33] Ibid., 13.
- [34] Ibid., 16.
- [35] Sinclair, Rose, Faculty Profile, Goldsmith's University of London, accessed 10-12-21 <https://www.gold.ac.uk/design/staff/sinclair/>
- [36] Sinclair, Rose, "Tracing back to trace forwards: What does it mean/take to be a Black textile designer." *Textile Design Theory in the Making*. Ed. Elaine Iggoe, (London: Bloomsbury Visual Arts, Bloomsbury Collections 2021), 112.
- [37] Oghazian, Farzaneh and Vazquez, Elena, "A Multi-Scale Workflow for Designing with New Materials in Architecture: Case Studies across Materials and Scales", A. Globa, J. van Ameijde, A. Fringut, N. Kim, T.T.S. Lo (eds.), *PROJECTIONS - Proceedings of the 26th CAADRIA Conference - Volume 1*, The Chinese University of Hong Kong and Online, Hong Kong, 29 March - 1 April 2021, pp. 533-542
- [38] Echelman, Janet, "Earthtime Vienna 1.78, 2021" Website, accessed 10-21-21, <https://www.echelman.com/#/178-vienna/>
- [39] Quirk, Vanessa, "Meet the Artist Behind those Amazing Hand Knitted Playgrounds" *ArchDaily Magazine*, November 28, 2021, accessed 10-12-21, <https://www.archdaily.com/297941/meet-the-artist-behind-those-amazing-hand-knitted-playgrounds>
- [40] Roberts, Bryony, "Soft Civic" Website, accessed 10-21-21 <https://www.bryonyroberts.com/#/soft-civic/>
- [41] "Hybrid Tower / CITA - The Royal Danish Academy of Fine Arts" 12 Mar 2017. *ArchDaily*. Accessed 12 Oct 2021. <<https://www.archdaily.com/805969/hybrid-tower-cita-the-royal-danish-academy-of-fine-arts>> ISSN 0719-8884
- [42] La Magna, Riccardo & Fragkia, Vasiliki & Noël, Rune & Sinke Baranovskaya, Yuliya & Tamke, Martin & Längst, Philipp & Lienhard, Julian & Thomsen, Mett. "Isoropia: An Encompassing Approach for the Design, Analysis and Form-Finding of Bending-Active Textile Hybrids" *Proceedings, of the IASS Symposium 2018 Creativity in Structural Design*, July 16-20, 2018, MIT, Boston, USA.
- [43] Lynch, Patrick, "Jenny Sabin Studios Light Capturing Lumen Installation Debuts at MoMA PS1", *ArchDaily*, 30 June, 2017, <https://www.archdaily.com/874661/jenny-sabin-studios-light-capturing-lumen-installation-debuts-at-moma-ps1>
- [44] Davis, Felecia and Dumitrescu, Delia. "What and When is the Textile? Extending the Reach of Computation Through Textile Expression." *Real Time - Proceedings of the 33rd eCAADe Conference Vienna University of Technology, Vienna, Volume 2, September 2015*, 417-426.
- [45] Scott, Jane, "Bioknit Pavilion (2019)", accessed 10-12-21 <https://responsiveknit.com/2019/09/20/bioknit-pavilion/>
- [46] Alquist, Sean, Website, University of Michigan accessed 10-12-21 <https://taubmancollege.umich.edu/news/2021/05/28/ahlquist-invited-17th-international-architecture-exhibition-%E2%80%93-la-biennale-di-venezia>
- [47] Mehman, Andreas, *Textile Antennas*, in Schneegass, Stefan, and Oliver Amft. *Smart textiles*. Cham, Switzerland: Springer, 2017, 148.
- [48] Ebru Kurbak |. "Drapery FM (2012) | Ebru Kurbak," January 3, 2013. <https://ebrukurbak.net/draperyfm/>.
- [49] Psarra, Afroditi, and Audrey Briot. "Listening Space: Satellite Ikats." In *Proceedings of the 23rd International Symposium on Wearable Computers*, 318–21. ISWC '19. New York, NY, USA: Association for Computing Machinery, 2019. <https://doi.org/10.1145/3341163.3346932>.
- [50] Erin Lewis, *Ambient Energy Harvesters* in "Radiant Textiles: A Framework for Designing with Electromagnetic Phenomena" 2021. [http://urn.kb.se/resolve?urn=urn:nbn:se:hb:diva-26256\\_142](http://urn.kb.se/resolve?urn=urn:nbn:se:hb:diva-26256_142).
- [51] Lewis, Erin. "Radiant Textiles: A Framework for Designing with Electromagnetic Phenomena" 2021.
- [52] Miyazaki, Shintaro, Martin Howse, Judith Funke, Stefan Rieckes, Andreas Broeckmann, and Hartware Medien Kunst Verein. "Detektors. Rhythms of Electromagnetic Emissions, their Psychogeophysics and Micrological Auscultation." In *Proceedings of the 16th International Symposium on Electronic Art ISEA*, pp. 136-138. 2010.
- [53] Mizayaki, 2013.
- [54] Harney, Stefano and Moten, Fred, *The Undercommons: Fugitive Planning & Black Study* (New York: Minor Compositions, 2013)