# Touchable Animation: Touching the Sound in Expanded Animation

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**Abstract.** Motion, visuals, and sound constitute the primary attractions in the realms of film and animation. Experimental artists leverage abstract imagery and sound in their animations to convey their emotions. However, the motion depicted on a two-dimensional screen limits the full embodiment of the viewer's experience. As a result, expanded animation and kinetic elements have emerged as alternative avenues for experimental artists aiming to extend the auditory and visual dimensions beyond the confines of the 2D screen. This article delves into the concept of corporeal experience as it relates to sound within the context of expanded animation, employing a kinetic and haptic approach. The research's primary objective is to explore the intricate relationship between sound, touch, and visuals in kinetic-based expanded animation. This exploration is informed by a review of existing literature, artistic analyses, and the author's own studio practice. This paper represents a significant step in an ongoing investigation into the development of methodologies for incorporating tactile elements into expanded animation projects.

**Keywords:** Expanded Animation, Sound, Touch, Kinetic.

## 1.1 Introduction

Experimental animation has been practiced by artists seeking to express their feelings. The ability to manipulate time and space is a unique characteristic not found in other visual media. Time has become an essential element in conveying an artist's inner emotions, relating to various natural rhythmic phenomena in the human body, such as breath, pulse, heartbeat, footstep, and more.

In addition to the temporal element, the role of human touch in the creation process of experimental animation is crucial. Many experimental animation works were, in fact, created by painters like Robert Breer and Oskar Fischinger. During the animation creation process, these artists rely on their hands to manipulate objects in space over time. This handcrafted aspect is believed to facilitate the "fluid, primary expression of thought and feeling" [1]. Moreover, incorporating the artist’s bodily traces is a key objective in most abstract and non-narrative works [2]. Several animation techniques,


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such as stop-motion and claymation, are considered highly effective in conveying materiality and the artist's imprints to the audience.

However, these bodily and handcrafted traces are only visible and can be experienced through viewing visuals on a two-dimensional (2D) screen, which restricts the delivery of corporeal experiences to the audience. The limitation of movement in a 2D space has driven several contemporary independent artists to express their emotions and experiences through expanded animation practice. This medium allows for the inclusion of elements from reality, such as physical objects and real movement. Some artists also incorporate mechanical and kinetic elements in their expanded animation to explore motion beyond the traditional 2D screen. One challenge faced by artists during their experimental audio-visual projects is achieving coherence between two primary elements (audio and visual) to create a unified perceptual experience [3]. Introducing the sense of touch as a new element presents another challenge in creating a unified whole piece. Therefore, this article will delve into how to incorporate touch coherently into expanded animation to create a unified experience for the audience. The purpose of this research is to investigate the relationship between touch, sound, and visual elements in expanded animation.

## 2 Methodology

This essay delves into the potential of expanded animation as a medium for conveying an artist's inner emotions. It explores how abstract visuals, tactile elements, and kinetic components can respond to sound, creating a holistic sensory experience. To begin this investigation, a review of existing literature and an analysis of strategies employed by experimental artists in integrating touch, sound, and kinetics in expanded animation were conducted.

Subsequently, the essay focuses on my own project, which centers on the exploration of touch and sound in expanded animation through the incorporation of kinetic elements. The primary emphasis is on understanding the interplay between touch, sound, and visuals in expanded animation. This discussion is informed by insights from the literature review and artistic analysis and is based on my studio practice, which involves developing prototypes of tactile devices using Arduino, 2D animation, and kinetic movements.

Within the framework of this research, three key elements are examined:

**Audio/haptic response**: This aspect explores how the tactile response corresponds to the audio elements within the piece.

**Visual/haptic response**: Here, we delve into how the tactile response connects with the visual and motion components of the piece.

**Dominance**: This element investigates how different approaches impact the equilibrium between visual, audio, and tactile elements.

## 2.1 Inner Feeling and Abstract Imagery

The advent of sound-track recording technology in film marked the end of the silent movie era while also inspiring artists to create abstract animations synchronized to music. This practice, known as visual music, has been actively explored by independent artists such as Oskar Fischinger and Norman McLaren. Both Fischinger and McLaren, as experimental animators, have exhibited a deep understanding of the psychological and emotional connection between music and abstract imagery.

In Fischinger's "An Optical Poem" (1938), he employs manipulative movements to convey his emotional response while listening to Franz Liszt's "Second Hungarian Rhapsody" symphony. The absence of representational images in this animation shifts the viewer's focus toward rhythm. The use of abstract objects enables viewers to discern how these objects' movements, positions, repetitions, and scales relate to the abstract feelings elicited by the symphony's sonic elements. As articulated by Wells, Fischinger's use of non-objective, non-figurative elements demonstrates animation's potential to accommodate the "fluid, primary expression of thought and feeling" [1].

This fluid, primary expression is also evident in the work of Norman McLaren, particularly in "Begone Dull Care" (1949). Here, McLaren explores the psychological and emotional relationship through handcrafted abstract images. Known for pioneering camera-less animation, McLaren directly drew frame-by-frame images on the film celluloid. "Begone Dull Care" not only showcases handcrafted components but also seamlessly aligns music and imagery. In her article "Seeing Music Move: Norman McLaren's Direct Animation and Jazz" (2014), animation theorist Lilly Husband noted experiencing a rhythmic dance performance while watching the film. This connection between abstract animation and dance makes sense, as dance is often seen as the most expressive way to unify sound and movement, harmonizing with the fluid, primal expression of thought and feeling. Husband attributes this sensation to the concept of isomorphism, defined by Arnheim as "the structural kinship between the stimulus pattern and the expression it conveys" [4]. Additionally, Chion [5] discusses isomorphism in relation to mickeymousing, a term in cinema referring to the pairing of music and images. This practice bridges the "eye's relative inertia and laziness" with the "ear's agility in identifying moving figures," helping viewers register rapid visual sensations in their memory. The structural relation mentioned by Husband, Arnheim, and Chion might refer to the spontaneous feeling evoked from McLaren's abstract imagery, which shares a similar structure to a dancer's action moving their body. This spontaneous physical response during the expressive drawing process resonates with Curtis' concept of "Body Energy" [6] emitted from the movement of lines, colors, and shapes connecting music and images [1].

Beyond visual music, the interplay between body energy and abstract imagery also emerges in other avant-garde animations that do not rely on music. Experimental artist Vicky Smith, in her exploration of incorporating artists' bodies into animation, conducted an experiment aimed at integrating unnoticed, habitual physical actions into animation. In "33 Frames Per Foot" (2014), Smith, with her foot coated in ink, repetitively performed actions like walking, tiptoeing, and hopping atop a 16mm film strip. When this film is projected onto a screen, viewers can discern an abstract animation imbued with the traces of Smith's body. Notably, an audible gasp emanated from the audience as Smith struggled to maintain her slippery foot on top of the 16mm film, Smith, 2015. Smith's performance appears closely related to Curtis' notion of "Body Energy," whereby, instead of being reflected through the movement of lines, colors, and shapes, it emanates from the abstracted patterns of Smith’s footprints.

# 3 Result

## 3.1 Touching sound in Film and Animation

In both traditional and avant-garde cinema, the role of sound has become as significant as that of visuals. The apparent movement we observe on the screen is an illusion. This visual motion, often the focal point of two-dimensional screens, is merely a trick registered in our brains, a result of the phenomenon known as the persistence of vision or the generated illusion of movement within a digital or computerized space. In contrast, the vibrations emanating from the speakers in audio-visual playback devices are palpably real. They reach our ears in the form of sound waves, but the impact of these sound waves extends beyond our auditory perception to touch various parts of our bodies.

The experience of hearing sound through vibrations is intricately linked to the concept of sonic tactility, as elucidated by Cranny-Francis in her article "Touching Film: The Embodied Practice and Politics of Film Viewing and Filmmaking" (2009). She posits that sound possesses the capacity to physically touch viewers in cinema spaces. The correlation between hearing and touch has also been explored by Schafer [7] in his book "The Soundscape: Our Sonic Environment and the Tuning of the World". Schafer points out that "hearing and touch intersect when the lower frequencies of available sound transition into tactile vibrations (around 20 hertz). Hearing, in essence, becomes a way of remote touch" [7]. He further explains that at higher audio intensities, approaching the maximum level, sound sensations can even transform into discomfort or pain. Cranny-Francis argues that the concept of sonic tactility in cinema has a historical precedence dating back to the silent film era when studios and distributors collectively determined the accompanying audio for films. During this silent film era, viewers became "sutured" to the film, their bodies resonating as the sound was presented as a live performance [8].

## 3.2 Liberating motion from two-dimensional space

The concept of motion in film and animation, a central visual element, has traditionally been confined to two-dimensional screens. However, throughout the past century, artists and scientists have striven to extend the boundaries of visual and motion experiences beyond these flat surfaces, even venturing into painting canvases. In the early 20th century, avant-garde artists like Duchamp pioneered what was termed 'kinetic art.' In his book "Kinetic Art", Brett [9] emphasized that kinetic art isn't exclusively tied to mechanical systems, electric motors, or vibratory patterns. According to Brett [9], kinetic art is about liberating movement through space.

Independent filmmakers have sought ways to introduce the physical objects inclusion alongside projected moving images, a technique associated with expanded cinema practices. As Uroskie [10] points out, this expanded cinema model is more than merely introducing the gallery as an additional element alongside the darkroom, a component of traditional filmmaking. This model aims to blend traditional cinematic elements like the temporality and immateriality of projected moving images with the stillness and materiality of sculptures or paintings.

In her article "Expanded Cinema as Expanded Reality" Export highlights that the film practice element remains a vital aspect of expanded cinema, encompassing various facets like filmmaking, production editing, and projection, which are fundamental components of film phenomena. Export [11] explains that incorporating reality into expanded film practice is crucial. She also notes that "expanded cinema also refers to any attempts that activate, in addition to sight and hearing, the senses of smell, taste, and touch" [11].

Husbands [12] references Robert Breer as an example of an experimental animator who brought physical objects to the gallery. As a former abstract painter, Robert Breer sought to merge animation's temporal aspect with abstract painting's materiality by presenting animated optical toys such as flipbooks, folioscopes, and mutoscopes in gallery settings [10]. According to Husbands, interacting with these optical toys allows viewers to "examine the skilled execution of a portion of an animated work, and they also have the potential to reveal the incredible amount of labor that goes into the animation process" [12].

In a similar quest to liberate motion from flat screens, scientists from MIT Media Lab designed a pin-based shaped display that permits users to physically engage with the device's shape-changing interfaces. The device's shape can transform in response to digital input triggered by user touch [13]. The planar surface still resembles a conventional 2D screen for audiovisual media, which aligns with the kinetic artists' objective of extending motion beyond the two-dimensional realm. Examining most experiments involving this shape-changing device reveals that rectangular-shaped pins are employed to incorporate visual elements projected onto the planar surface. This feature demonstrates the interplay between visual, tactile, and motion elements.

In her article titled "Composing Visual Music: Visual Music Practice at the Intersection of Technology, Audio-visual Rhythms, and Human Traces," Watkins [2] delves into how rhythm, texture, and material impact our visual and auditory experiences. While texture and material are directly linked to the sense of touch, rhythm, although primarily auditory, is also perceptible through physical vibrations, extending our understanding of the connection between sound, visuals, and tactile sensations in expanded animation.

# 4 Discussion

## 4.1 My Studio Practice

The following section explores a series of experiments conducted with the goal of creating a novel tactile experience that combines elements of visuals, sound, and touch. This discussion encompasses four key aspects: The Tactile Device, Recording the Rhythm of My Body, the 2D Animation, and Converting Sound to Motion while integrating Visual, Sound, and Tactile elements.

1. **Tactile Device**

To begin, I drew inspiration from the pin-based shape display developed by the MIT Media Lab. With the expert guidance of Rangga Winantyo, an optoelectronics specialist, I embarked on creating a tactile device. This device utilized servo motors and the Arduino microcontroller to generate a tactile sensation that could be controlled by uploading a code input.

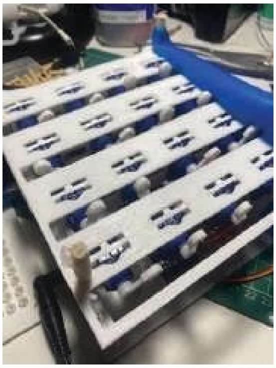

**Fig. 1.** Configuration of 16 Arduino-servo motors (Source: Personal research documentation)

The device consisted of 16 servo motors interconnected with an Arduino and 16-channel servo motor microcontrollers. Each motor was equipped with a modified plastic horn, enabling rotational movements spanning from 0 to 90 degrees. These rotating plastic horns, in turn, exerted pressure on an elastic silicone rubber sheet, causing the pins on top to move up and down in response. This mechanism created a gradual transition effect between individual pins, producing a gradient-like sensation.

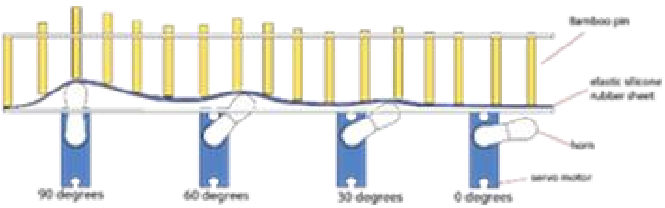


**Fig. 2.** Motorised tactile screen diagram (Source: Personal research documentation)

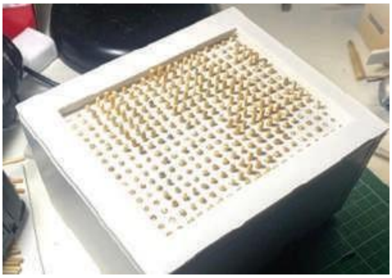

**Fig. 3.** Motorised tactile screen diagram (Source: Personal research documentation)

Once fully assembled into a working prototype, I could finally touch the animated pins with my fingers. The seamless gradation effect between pins resembled the oscillating waves seen on an audio monitor's oscilloscope. I had anticipated a uniform rhythmic sensation when I touched the tactile screen. However, the rhythmic pattern of the pin movements as perceived by my eyes did not align with the haptic sensations my fingers experienced. While my eyes perceived the pins' movements as a unified motion, my fingertips and palm skin detected varying timings and rhythms depending on the specific area they touched.

Nonetheless, touching the pins physically allowed me to sense materiality in a way that a conventional audio-visual medium couldn't convey. As I observed the pins emerging from a flat surface, I could feel my fingers being guided by their movements. Simultaneously, I could sense the imperfect texture of each pin, created through manual cutting and sanding with a cutter and sandpaper.

At this stage, the only sound emanating from the device was the mechanical noise produced by the motors. The distinctive sound of multiple motors rotating offered a pronounced rhythmic sensation that synchronized with the pin movements. This may evoke the viewer's curiosity, prompting them to imagine what's transpiring within the device and ponder what brings the pins to life. This scenario bears a resemblance to the concept of sonic materiality in film, defined as any unintended sound generated during the recording process [14]. While such materiality can disrupt narrative film's representational quality, in my device, it effectively bridges the haptic sensations experienced in my hands with the servo motors' movements. As the motors rotate continuously, I can feel the vibrations, their intensity fluctuating in response to the number of active motors in motion. This fluctuation creates a visceral sensation in the fingers.

## 2. Recording Process

Inspired by Vicky Smith's experiment "33 Frames Per Foot" (2014), where she investigated unnoticed habitual physical actions, I recorded the sounds of my daily activities to discover the rhythm of my own habitual physical actions. I decided to use the sound of slicing a red apple as the starting point for an experiment aimed at translating sound into animated pins. This exploration was centered around three main elements: sound, visuals, and animated pins. The goal of this experimentation wasn't merely to interpret sound into visuals and transform them into animated pins. At this stage, the relationship between touch, visuals, and the recorded sound had not yet been established.

**Fig. 4.** Recording the sound of my activity slicing an apple (Source: Personal research documentation)

The primary objective was to create an entirely new experience by uniting three internal sensory elements: recorded sound, animations created based on the sound, and the haptic sensations derived from the animations. When discussing Disney's endeavor to combine sound and images in "Fantasia" (1940), film critic Daphne Leong emphasized the essentiality of this union of media. In her article, "Fantasia's Rite of Spring" as Multimedia: A Critique of Nicholas Cook's Analysis, Leong noted that "in addition to the need to create the impression of internal unity within both the images and the soundtracks separately, the two tracks must also cohere so as to invite perception as a unified whole" [3].

I used the animation "Kinetic Sandwich" (2002) as my primary reference for this experiment. Besides the thematic similarity of kitchen sounds, I observed an impression of internal unity in this animation. Eric created a repetitive stop-motion animation using images of sandwich ingredients. What intrigued me in this animation was how Eric juxtaposed sound and visual elements that weren't inherently related but remained coherent with each other, successfully offering a fresh perspective on the process of making a sandwich.

This is consistent with the isomorphism theory that Arnheim [4] and Chion [5] have mentioned. For instance, in a sequence displaying sliced meatloaf with a flowing marbling texture, Eric correlated the texture with the sound of water running from the tap, creating the impression that he was washing sandwich ingredients. In my exploration, I sought to discover a way to establish a relationship between the distinct elements of sound, visuals, and tangible pins, allowing them to cohesively combine into a novel, expanded animation experience.

## 3. Converting Sound to Motion

Utilizing Adobe After Effects software and the audio spectrum, I transformed the sound into a sine wave animation graphic. This sound spectrum animation served as my guide when creating a 2D animation in Adobe Photoshop. The concept of animating based on the audio spectrum drew inspiration from one of the scenes in Disney's "Fantasia" (1940). In this scene, the conductor introduces a non-human abstract character known as 'the soundtrack,' capable of producing the sound of various musical instruments. The character generates an abstract animation resembling a sine wave in response to the sounds produced. The abstract animation in this scene appears to be manually crafted by accentuating and applying various colors to the character's movements, aligning them with a sine wave graphic. I envision the animator using the musical instrument's sine wave as a reference while also relying on their intuition, shaped by their experience of hearing the musical instrument.

Before embarking on my animation in Adobe Photoshop, I prepared a wide working canvas, positioning color references and the audio spectrum alongside the animation area. Instead of opting for the widescreen aspect ratio, I chose a square aspect ratio for the animation because it better aligned with the device's dimensions, measuring 14 cm in length and 12 cm in width. To the left, I placed images of apples, while the audio spectrum resided on the right. I established a grid dividing the animation area into 16 segments corresponding to the servo motor positions in the tactile device. The idea behind this grid was to craft an animation from the blocky images within these segments, ultimately providing a color guide for controlling the servo motors.

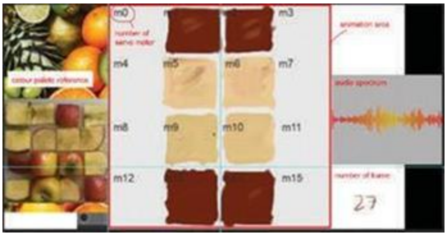


**Fig. 5.** Working canvas area in Adobe Photoshop (Source: Personal research documentation)

The intensity of the audio spectrum graphic on the right side assists me in determining how many segments I should fill with colors extracted from the images on the left. I combine these guides with my intuition, which is shaped by my experience in apple cutting. This intuition arises as I listen to the sound recording, encompassing the sensation of knife control and the visceral feeling when cutting the apple. To enhance the viewer's connection to the sound, I also incorporate some of the stop-motion animations I have created during the actual apple slicing in the recording process.

Upon completing the animation, I faced the laborious of converting all the frames into 16 series of numbers, which would be employed to control the motors in the Arduino software. First, I converted the animation into desaturated images. Next, I transformed the saturated version of each frame into a color-coded diagram using Microsoft Excel. In this software, I created tables with formulas to convert the color code diagram into a series of rotation angle numbers. Subsequently, I copied all these series of numbers and edited them to ensure compatibility with the Arduino software. Finally, I generated 16 lines of command code for each frame in my animation. Up to this point, I've produced 150 frames for a five-second animation, which means I must generate a minimum of 2400 lines of command code within the Arduino software.

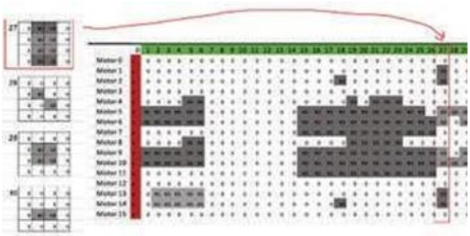

**Fig. 6.** Converting each frame of animation into a number code (Source: Personal research documentation)

There are methods to make the motors operate directly based on sound input by using sensors that can be connected to the Arduino. However, my approach to sound interpretation and its conversion through a painstaking process categorizes my work as experimental animation. Simultaneously, it pushes beyond the traditional confines of animation.

## 4. Combining Visual, Sound and Tactile

Inspired by the rectangular pins used in the shape-changing device developed by the MIT Media Lab group, I replaced the bamboo pins with rectangular shapes in my second prototype. By doing so, I aimed to bring the haptic and visual sensations closer together when projecting the 2D animation directly onto the tactile device. The movement and visual elements of the abstract animation projected onto the device were determined by the intensity of the previously recorded sound.

During the initial trial, I observed that the 2D animation and the movement of the device's pins were occurring at different speeds. For a brief period, the constant servo motor noise created the illusion that the animated pin was moving more rapidly than the 2D animation. When I attempted to synchronize these two motions, I discovered that the speed of the 2D animation I created exceeded the movement of the pins. It was in this moment that I realized how significantly the sounds produced by the servo motors could influence the viewer's perception.

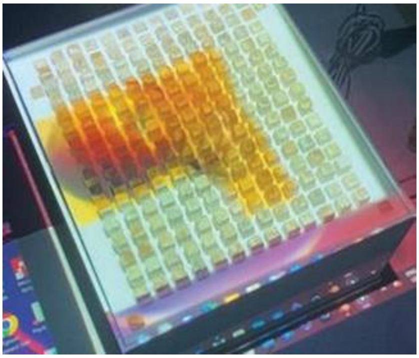

**Fig. 7.** Projecting the 2D animation straight on the device (Source: Personal research documentation)

When the animation displays blank frames without sound effects for several milliseconds, the impression of the pins moving faster than the animation intensifies. This auditory impression harkens back to the silent movie era when filmmakers used music to mask the mechanical noise of projectors. Contrasting with this practice, some avant-garde films accentuate the noises produced by the cinema apparatus, highlighting that silence in cinema is never truly silent [15]. In my expanded animation, I aimed for the servo motor sounds to be audible, keeping the audience aware of the forces propelling the pin movements. Simultaneously, I wanted the audience to perceive the rhythm of the 2D animation. Therefore, synchronization between the servo motor and the animation remained essential.

It appear that the projected 2D animation diminishes the animated pin's ability to evoke the viewer's haptic senses. Without the projected 2D animation, the tactile device's haptic qualities, such as the handcrafted appearance of the pins and the three-dimensional surface, stood out prominently. However, when saturated colors and high-resolution images from the projected 2D animation dominated the visual aspect, the tactile surface appeared quite flat. I then explored methods to reduce the dominance of visual elements. My initial idea was to adjust the projector's focus to create an out-of-focus image, which proved effective. I found that projecting blurred images of the 2D animation onto the device could maintain the visibility of the haptic qualities, encouraging viewers to interact with the animated pins.

Continuing the exploration, I introduced a translucent layer on top of the tactile device. This idea emerged after observing one of the students at the Glasgow School of Art who used translucent fabric as a projector screen in her work. This technique produced slightly blurred images on the fabric while simultaneously casting a vague image on the wall.

**Fig. 8.** Placing translucent object on the top of device. (Source: Personal research documentation)

## 5 Conclusion

In conclusion, the integration of haptic sensations into audio-visual media offers a new unifying experience within the realm of expanded animation. It is evident that our perception of rhythm through touch, as opposed to the traditional auditory or visual channels, introduces a unique dimension to the multisensory experience. The incorporation of haptic elements not only enriches the viewer's understanding but also enables them to discern the substantial materiality of physical motion in the expanded animation context. Furthermore, my experiment underscores that the pursuit of unity among disparate elements does not necessitate an equal distribution of each component. The distinct visual element inherent to real movement in contrast to 2D animation emphasizes the potential for distraction from the presence of other sensory components, particularly touch. Finally, the utilization of kinetic methods holds endless potential to create new haptic experiences for inclusion in expanded animation. Therefore, in future projects, additional haptic elements will serve as a focal point for further exploration.

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