xCoAx 2024
12th Conference on Computation, Communication, Aesthetics & X
Fabrica, Treviso, Italy
2024.xCoAx.org

Mother Bear Mother Hen & Rattlin' Bog: Activating Critical Making, Art Hack Practice & Ludic Modalities in Developing Interactive & Virtual Reality Artworks

Victoria Bradbury
vbradbur@unca.edu
University of North Carolina Asheville, Asheville, North Carolina, USA

Mother Bear Mother Hen and Rattlin' Bog are two interactive artworks that integrate physical computing with screen-based content compiled and coded in the Unreal game engine. Both were produced between 2020-23 through Epic MegaGrant funding and with undergraduate research assistants. The *Rattlin' Bog* installation sends signals to code through conductive materials embedded in a detailed laser-engraved sculptural interface. Animal characters onscreen interact with one another and with their bog environment. *Mother Bear Mother Hen* connects wearable bear and chicken jackets to a virtual reality game through serial communication. Real-world stomping is transmitted to the game and results in player movement. Light and sound are output through the jackets as reactions to the gameplay. Both artworks activate 3D modelled and animated animal characters to construct narratives about social and environmental systems. This paper discusses ways in which the artist and her team utilised critical making, art hack practice, and ludic modalities in producing these projects.

1. Introduction: Critical Making, Art Hack Practices and Ludic Modalities

Creating a 3D experience with a game engine requires multiple skillsets including character design, modelling, rigging, animation, storytelling, sound design, and games programming. To add a layer of bespoke physical interactivity, a practitioner must design and construct an interactive device and integrate it into the screen-based content using microcontrollers, sensors, and serial communication. The projects presented in this paper employ these and other modalities that combine screen-based and 3D making and troubleshooting skills.

The author-artist created two projects that combine Unreal Engine software with physical computing over a three-year period funded by an Epic MegaGrant titled, "Interfacing Unreal with Physical Computing and New Media VR Pedagogy"[1]. *Mother Bear Mother Hen* integrates a virtual reality (VR) game with wearable sensory jackets and *Rattlin' Bog* is an interactive installation that includes a digital fabrication component with conductive inputs. Creating these works involved iterative processes of play, critical making, and art hack practices by the artist and her teams. The final projects incorporate 3D-modelled animal characters

1. Research website link: https://blurringartandlife.com/interfacing_unreal_physcomp/

Keywords Physical Computing, Critical Making, Art Hack Practice, Play, Virtual Reality, Interactivity, Digital Fabrication.
DOI 10.34626/2024_xcoax_005

and environments that, through viewer-participant interactivity, construct narratives around social and environmental systems.

To create *Mother Bear Mother Hen* and *Rattlin' Bog*, the artist and her undergraduate research teams engaged in configuring materials and code that would connect microcontrollers to the Unreal Engine, create unique experiences for viewer-players, and present concepts about 21st life that build empathy, contemplation, and consideration. Through these processes, the bounds of the technologies were tested. Nora O'Murchú writes that,

> *As technology plays an increasing role in our lives, artists are undertaking a process of opening up and extending our critical understanding of it. Engaging in processes of making and tinkering, artists are experimenting with material arrangements of data, algorithms, hardware and software to articulate particular stances and ideas through their production, and by making transparent the processes and thoughts that underpin their construction. (O'Murchú 2020)*

In art hacking events, artists and makers work collaboratively to create projects over a short time frame. Suzy O'Hara and the author-artist wrote that, "Artists are accustomed to thinking laterally and applying art-making methodologies across a variety of media. During an art hack, this occurs through experimentation with media and materials as part of the phases of project conceptualisation, prototyping and execution." (Bradbury and O'Hara 2016) This collaborative modality can also be applied to creating artworks over a longer span of time, with the same spirit of experimentation with concepts and materials.

Over the past two+ decades, artists have been creating alongside the infrastructure and tools lauded by the Maker Movement (Maker Faire, n.d.). They have done so while continuing to explore emerging and traditional methods of constructing sculptural, digital, and interactive interfaces for artworks that present critical social, political, or aesthetic ideas. In Garnet Hertz' 2012 interview with Matt Ratto, who coined the term *critical making*, Ratto states, "...making is a deeply conceptual activity, and deeply reflective, though not necessarily in the same way as critical thinking." (Ratto 2012) Making requires a knowledge of materials, gained through prior making, paired with an ability and willingness to play with combinations of materials that the practitioner may not have tried before.

Derek Ham writes about the importance of playfulness, or the ludic, in the design process, stating,

> *Many design methods begin with some element of play through the game of "seeing with the eye." Others might argue that play is involved from the initial process of creating things with your hands, building models, or even drawing. Then there are those who might say play is involved when they imagine themselves inside their creations while they are looking at a scaled model, a drawing, or a digital walkthrough. Play allows us to create in intuitive ways. It provides for moments of reflection and whimsical imagination. It is the key to being creative. (Ham 2016)*

During the production of the two artworks discussed in this paper, the teams maintained a playful outlook through troubleshooting the technologies and testing the aesthetic and conceptual directions of the

projects. Through rounds of designing and testing, configuring, and animating, the makers maintained an attitude of playfulness that is evident in the final project versions.

Using the *Mother Bear Mother Hen* and *Rattlin' Bog* projects as case studies, this paper presents the finished artworks, discusses the materials and modalities involved in their production, and relates research on critical making, art hack practices and play to the implementation of each.

2. *Mother Bear Mother Hen*

2.1 The finished artwork

Mother Bear Mother Hen[2] is a VR game with accompanying jackets that become part of the user interface. The bear and chicken jackets embed soft circuit sensory inputs and outputs, including stomp detectors, LEDs, and a mini speaker, all connected to the game through an Arduino Uno-style microcontroller, custom Unreal blueprint programming, and serial communication.

Fig. 1 Player, as the bear, peers into the chicken coops by opening the coop door with truncated bear hands.

When a viewer-player approaches *Mother Bear Mother Hen* in an installation context, they choose to wear either the chicken jacket or the bear jacket with the VR headset and controllers and then play the game in first person as their chosen character (Fig. 2). The jacket reacts to the gameplay and serves as an input device. Motion detectors strapped to the knees translate stomping movements and progress the player forward in the game. Lights and a speaker sewn into the jacket with conductive thread react to in-game experiences and light up or make sounds to indicate success or difficulty during gameplay. The jackets make the VR gameplay more performative for the player, who can hear the audio and experience the feedback from their stomping motion. The jackets also create a spectacle for non-playing viewers who see the costumed player as a reflection of the first-person character in the game.

The *Mother Bear Mother Hen* gameplay begins with a menu screen where the player selects which character they will embody: Mother Hen or Mother Bear. An omniscient narrator is heard providing vocal cues

2. Link to project website: https://blurringartandlife.com/vb/motherbearmotherhen.html

to guide the player through the story. He gives them auditory 'nudges' if they are not responding to visual cues. As Mother Hen, the player begins in the coop yard and then moves inside the coop, where they see three other hens roosting in nesting boxes. These hens are having a conversation about childbirth (egg laying) as they sit on their eggs, at times disparaging the player for her maternal negligence. Soon, the eggs in the fourth nesting box hatch and baby chicks (presumably belonging to the player) begin running around the coop floor. At the same time, a bear who has been lurking around the coop begins reaching in and grabbing at the baby chicks, trying to collect them (Fig. 4). A timer begins and the player, as Mother Hen, must grab her chicks and move them out of the bear's reach to 'win' the level. If she wins, she roasts one of Mother Bear's cubs over a fire. If she loses, she manifests in Mother Bear's kitchen, where she sees her chicks being boiled.

Fig. 2 [L] Player wearing bear jacket during gameplay. [M] Player wearing chicken jacket during gameplay. [R] Chicken jacket detail with Arduino Uno-style microcontroller and speaker.

As Mother Bear, the player begins in a kitchen and her two cubs enter the room complaining that they are hungry. The player leaves her home in search of food for the cubs. When she exits the kitchen door, she is teleported to the outside of Mother Hen's coop. After exploring the coop (Fig. 1) and knocking down a fence to enter the yard, the player notices baby chicks running around. The narrator enthusiastically encourages the player to grab the chicks. If Mother Bear is successful at gathering three chicks, she teleports back to her kitchen, where she boils the chicks in a pot for her cubs to eat. If she is not successful at grabbing enough chicks, she finds herself in the chicken yard where one of her cubs is being roasted over the fire. There is cartoonish violence in the game as the character who 'wins' essentially cooks the young of the other player.

Throughout the VR gameplay, the player moves through a story of antagonism and survival between a hen and a bear parent and their chicks and cubs. This game was developed during the COVID-19 pandemic, when lockdowns and remote work put caregivers into challenging circumstances (Bradbury 2022). Emotions were high between people not being able to access childcare to continuing pressures of work and productivity. When lockdowns and restrictions were lifted, many childcare facilities had shut down due to precarious financial support (Miller 2021). This left many without access to care, a problem that continues today. Parents were faced with providing remote learning to their school age children while schools opened and closed intermittently, with con-

tinued concerns about illness for themselves and their families. Rather than a robust social safety net stepping in to support caregivers and children (at least in the U.S.), individuals were left to fend for themselves to find childcare and keep their jobs, often at the expense of access to care for other children. The VR game *Mother Bear Mother Hen* aims to create empathy and visibility by placing the player in the desperate role of a caregiver tasked with protecting and/or feeding her children at all costs. Visually, the two cel-shaded levels in the game create a dream-like environment in which a player confronts a lose-lose situation that tests her fortitude and ability to survive and thrive.

2.2 The production process

Ludic modalities were present in the production of *Mother Bear Mother Hen*, particularly in creating and testing the bear and chicken jackets. The lead artist created these jacket-input-devices starting with found and thrifted extra-large jackets that would fit a range of players. For the chicken jacket, the artist sewed over 100 feathers from different types of fabric that were then machine and hand-appliqued to the jacket. Beads were sewn on top of the feathers to add detail and texture (Fig. 2, R). Sewable Neo Pixel LEDs were stitched to the jacket lapel and wired to an Arduino Uno-style microcontroller using conductive thread. A STEMMA (Adafruit n.d.) speaker-amplifier was stitched with conductive thread to the Arduino. This system was programmed so that the light and sound outputs would be visible and audible through the closed system of the jacket. The bear jacket was constructed similarly, although a faux fur coat (inherited from the artist's grandmother) was used as the base and a lapel was created to hang over the shoulders and around the back of the jacket (Fig. 2, L). The LEDs, speaker, stomp detectors, and Arduino Uno were sewn to the lapel so that this system could be modular and removed should the jacket need to be replaced.

Fig. 3 Play testing Mother Bear Mother Hen in the New Media VR Lab at UNC Asheville with the lead artist [R] and game developers Thomas Townsend [M] and Sarah Hendricks [L].

Connecting the Arduino code to the VR game and adding the stomping input was one of the most complex and playful challenges undertaken in the production process. Many Sundays[3] were spent in the lab (Fig. 3) with the Unreal programmer, Thomas Townsend and the special programming assistant, Nolan Scobie, first making the communication between Unreal and Arduino possible and then troubleshooting the stomp mechanic between Arduino and Unreal. A motion detector is strapped to a knee of the player so that when they engage in a stomping motion, the Arduino receives notification. The Unreal Blueprints receive this data (through serial communication) and replace the teleport trace in VR to cause the player to move forward. Because the player is stomping with their own body, this forward movement in the game does not cause them to feel unsteady, as their body expects this sensation.

Creating the narrative VR gameplay involved a standard game development process of ideation, storyboarding, and character development. The character design, modeling, rigging, and animation were led by team member Clara Tracey with assistance from Keithon Turner. Play testing the game was important to finesse the layout and timing (Fig. 3). This was particularly key for the heightened part of the gameplay in which, as Mother Bear, the player tries to catch as many baby chicks as possible during a timed segment and, as Mother Hen, they try to keep the chicks from being caught by the bear (Fig. 4). The Level Sequencer in Unreal Engine 4 was critical to developing parts of the game that acted as "cut scenes," or sections that established the non-player characters (NPCs), the story, and the mission of the player as the first-person character.

Fig. 4 Bear grabs at chicks inside the coop. Player is embodying the Mother Hen character here and trying to keep her chicks from being grabbed by the bear.

The *Mother Bear Mother Hen* game sits within the horror genre. There is a feeling of suspense as the player navigates the darkly lit levels. Al-Zubeidi, DeLaney, and Seo discuss the elements that created a sense of unease in the VR game "A Walk Alone." This game intends to help players empathize with the fears that some women experience when they walk home alone at night. They state that in developing "A Walk Alone" that, "...our main takeaway consisted of dimly lit environments and eerie sound design to elicit emotional unease from the viewer." (Al-Zubeidi et al. 2022) This strategy was also used in the production of *Mother Bear Mother Hen*. The character design and lighting complement David Freund's sound design and composition to create suspense for the player. Humorous and playful aspects are also present in *Mother Bear Mother*

3. Sundays are mentioned here to underscore that extensive time was spent on this troubleshooting process that extended beyond conventional business hours. The programming assistants were paid for their time on the project regardless of the days of the week worked.

Hen. Some of the horror elements, including the bear and hen's first-person arms with exposed bone and flesh (Fig. 1), and a hard-hearted hen smoking a cigarette, play into this effect that is both eerie and absurd.

2.3 Critical Making and *Mother Bear Mother Hen*

In devising and designing *Mother Bear Mother Hen*, the artist aimed to create an experience that is both serious and playful while telling a compelling story and creating empathy in a viewer-player. She also aimed to create an artistic game that considered viewer-player embodiment both inside and outside of VR using costumes that connect to the gameplay through physical computing inputs and outputs. While these aims were clear, achieving them would require her to apply existing skills, build new combinations of technologies and tools, and guide a team of undergraduates to do the same. Through this process, the project would innovate by creating new modalities of connecting physical computing with VR and by telling stories from a caregiver's perspective that don't make their way into mainstream game media.

In A *Mini Review of Presence and Immersion in Virtual Reality*, Wilkinson, Brantley, and Feng consider the use of multi-sensory feedback in VR to increase immersion, stating,

> *One way to enhance presence is to increase immersion. [...] Multi-sensory feedback is also another way to increase immersion. [...] The use of haptic feedback is now commercially viable and may serve as another sensory feedback system to supplement traditional visual and auditory stimuli. It is also possible to create haptic feedback outside of the VR environment. (Wilkinson et al. 2021)*

In *Mother Bear Mother Hen*, bespoke jackets serve as input/output devices that have the potential to increase immersion for the viewer-player during gameplay. They also allow the immersion in the game to begin *before* entering VR through the act of putting on the jacket. The immersive experience is simultaneously increased for the non-playing audience; they observe the VR gameplay on an adjacent monitor but can also enjoy seeing the player in the jacket as they stomp and the LEDs light up and the speakers output reactive sound (Fig. 5).

Fig. 5 Player in bear jacket and crowd viewing onscreen gameplay and player performativity at the New Media Caucus's *Future Bodies Symposium Exhibition* at Virginia Tech. September 2022.

Garnet Hertz writes in the Introduction to *Critical Making*, that, "I generally think that innovation occurs out of pouring your ideas and processes into a field that you're not familiar with, and actually doing this on a regular basis is a crucial part of practicing inventiveness" (Hertz 2012). Creativity emerges from a process that centres making. The artist and team creating *Mother Bear Mother Hen* were guided by a storyboard and technical goals, but it was the iterative process of making the game and the jacket accessories that led to the aesthetic and material combinations that comprise the final artwork.

The experience of the viewer-player is important to consider when developing virtual reality works because of the possibility of nausea or unease when in the VR space. People who enter VR are taking their understanding of the physics of everyday reality with them into the game. A critical understanding of this can help a VR artist/designer/developer to draw upon the viewer-player's bodily knowledge of physics to create a new experience in VR that isn't possible in day-to-day life. David Chalmers states that, "Virtual reality takes the immersiveness and interactiveness of everyday reality and brings in the role of the computer in generating this reality artificially." (Chalmers 2017) One example of this is the use of anthropomorphized characters and asking a viewer-player to embody the Mother Hen or Mother Bear character in the game. While playing as an animal character, the player still draws upon their human-sized sense of space and movement.

When a viewer-player is immersed in the role of Mother Hen or Mother Bear, they can have the experience of wanting their side to "win" (which inflicts violence against the other protagonist). They can then switch roles and play as the other character, viewing the story of survival and desperation from the opposite side. Chris Milk talks about the potential for VR to create empathy when he says, "VR represents a technology communicating to us using the same language in which our consciousness experiences the world around us: the language of human experience." (Milk 2016) While *Mother Bear Mother Hen* uses anthropomorphized characters to represent the human, it aims for the viewer to embody these characters and see the story through their eyes. Seeing and using one's disembodied animal hands in first person VR gameplay, while also wearing a jacket that represents that animal, the viewer-player is placed in a state of mind in which they can be empathetic of the character they are playing. After playing through the game as both Mother Bear and Mother Hen or watching someone else experience the game as these characters, a viewer can contemplate their role(s) in the game, the cartoonish violence they perpetrated or experienced, and how this relates to everyday life for themselves or for caregivers in society.

3. *Rattlin' Bog*

3.1 The finished artwork

Rattlin' Bog[4] is an interactive installation that uses digital fabrication, conductive surfaces, and the IF Magic microcontroller to engage a viewer in an animated onscreen bog ecosystem. It is displayed as a single-channel projection with an adjacent interactive wall sculpture (Fig. 6).

4. Link to project website: https://blurringartandlife.com/vb/rattlinbog.html

Fig. 6 *Rattlin' Bog* installation and link to demo video: https://youtu.be/pz65jtaPLEc

The viewer-participant controls the temperament and behavior of the animals onscreen by fitting the muskrat, snake, and eagle into magnetic conductive cut-outs on the sculptural device. When this triad is in place, it triggers the water in the bog to rise, the vegetation to bloom, and the snake and eagle to calm (Fig. 7). The squirrel chitters and flits between the snake and eagle on the tree. When the animal puzzle pieces on the device are removed and the water is low, the snake and eagle onscreen appear to be more agitated. A button on the sculptural device changes the virtual camera to display the animals and scene from different views. Beneath the tree is the muskrat character, a metaphor for the everyman.[5] The muskrat constantly strives whether the water is high or low (Fig. 8).

In climate change's proliferating wake, we experience the destruction that water brings when there is more than the ground can handle. Too little water also causes harm– without enough to sustain life, water's absence leaves landscapes to shrivel and burn. Like the *Rattlin' Bog* folk song[6], the animals here appear caught in a repetitive chorus, affected by the state of the ecosystem around them.

Fig. 7 *Rattlin' Bog* tree and landscape with snake in a calm state and squirrel with acorn on the trunk. The bog is filled with water.

5. The everyman is a character type that represents the common person.

6. *Rattlin' Bog* is a cumulative, repetitive Irish folk song.

Fig. 8 The busy muskrat in the onscreen animation with the water level low.

3.2 The production process

The onscreen content for *Rattlin' Bog* was produced first, with the scene and environment design being modeled by the lead artist in Unreal and then the character design, modeling, rigging, and animation being undertaken by team member Clara Tracey. Next, the animations, scene, and soundscape were combined with Blueprint programming in the Unreal game engine by team member Sarah Hendricks. The program was designed for the animals to coexist in the bog ecosystem and for them to move in a looping fashion with some randomness. Physical computing inputs were added to the Blueprints to cause the water in the bog to raise and lower and to allow the camera view of the scene to change to show different angles and compositions (Fig. 7 and 8).

The sound design for *Rattlin' Bog* is by composer David Freund (Fig. 9, L). The rattlesnake sounds were recorded at the North Carolina Zoo in May 2022. Dustin Smith, Curator of Reptiles, Amphibians, Fish, and Invertebrates, invited the lead artist and sound designer to record the zoo's rattlesnake, an event which also served as a training session for a new snake handler. All of the other sounds in *Rattlin' Bog* were recorded live in the mountains of Western North Carolina (Fig. 9, M-R).

Fig. 9 David Freund [L], *Rattlin' Bog* Sound Designer and Composer behind the rattlesnake enclosure at the NC Zoo. [M-R] Freund's microphones while field recording near Western North Carolina waterfalls and streams to capture audio for *Rattlin' Bog*, 2022.

To create the *Rattlin' Bog* physical computing device, the lead artist built a working wood prototype before designing and implementing the final version. The piece uses an IF Magic microcontroller from the Brooklyn-NY-based company, Indistinguishable From Magic (IF Magic, n.d.). The lead artist met the IF Magic developers at the IEEE-GEM conference at Yale University in 2019 when she exhibited her *Blue Boar VR* project. IF Magic aims to make physical computing inputs and outputs

straightforward to implement. An IF Magic shipment includes a device, a variety of interchangeable physical computing modules, and code that facilitates the process of connecting to Unreal and other game engines. The *Rattlin' Bog* team found the integration between Unreal and IF Magic to be smooth and troubleshooting time in the lab was reduced due to choosing this microcontroller for Unreal integration.

3.3 Critical Making and *Rattlin' Bog*

At a mid-stage in project production, *Rattlin' Bog* incorporated RSS feeds to bring news headlines into the Blueprints and print these on-screen as if the squirrel character were telling the snake and eagle the current news. Two news feeds were used, one from a conservative U.S. new source one from a moderate U.S. new source, to contrast the headlines and make the squirrel appear as a double-dealing informant in the bog ecosystem (Fig. 10). The project remained in this state with the RSS feeds from Spring 2022 through Autumn 2023 as the lead artist progressed the physical computing aspect of the project.

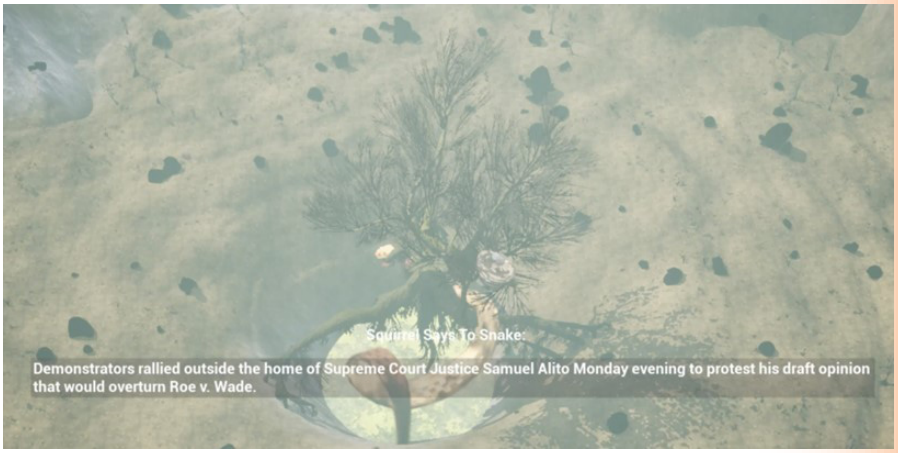

Fig. 10 Sample news headline from *Rattlin' Bog* mid-point version with RSS feeds printed to screen.

As news headlines continued to go from bad to worse, particularly in Autumn 2023, the artist no longer supported including them in the project. She removed the RSS feed link from the code and allowed the bog ecosystem to exist on its own alongside the physical computing device. This emphasized the environment, water, and animal aspects of the piece, as well as the aesthetics of the sculptural device and the onscreen content. Lucas Evers states that, “In Critical Making, there is no longer a divide between critical theory and artistic practice, but the practice itself is critical and philosophical.” (Evers 2017) The choice to add and later remove the headlines evolved from a critical making process and iterative testing of the onscreen content alongside the interactive device.

The process of creating the *Rattlin' Bog* physical computing device demonstrated radical experimentation with physical and digital materials. Screenshots of the tree were imported into Photoshop (Fig. 11) and edited to create a detailed background that was etched on a laser cutter. The wood was passed through the laser cutter to draw 11” wide sections over a 12-hour engraving session. The animal puzzle pieces were initially designed as vector graphics by team member Shiasia Beasley and then cut and etched on the laser cutter by the lead artist.

Building the device involved testing conductive materials, including graphite paint, wire, and copper sheeting, to allow the device to send a

signal to the IF Magic and the Blueprint programming code to make the onscreen water rise. In the final piece, hidden magnets sandwiched in the puzzle pieces hold the animals in place on the backing board. When all of the pieces are in place, the conductive paint on the back of the animal pieces connects with copper sheeting on the etched device to pass a positive electronic signal through the microcontroller to the running game.

The *Rattlin' Bog* interface intends to be straightforward to navigate while aesthetically compelling and visually complex. The interactive component of the device was designed with simplicity in mind. A 'toddler puzzle' modality was used to design large, easy-to inset animal pieces. When a viewer sees the puzzle pieces and the cut-outs on the device, it is easy to guess how to interact – by inserting or removing the pieces. The button on the device looks like a conventional button and therefore encourages viewers to press it and experience the resulting camera movements.

Fig. 11 Photoshop and Illustrator were used to combine pieces of the tree from the onscreen content and create an etching that would be laser-engraved onto the wood in sections on the Glowforge laser cutter.

Fig. 12 The final *Rattlin' Bog* device created with laser etching, conductive materials and IF Magic microcontroller.

Rattlin' Bog was first exhibited at Black Mountain College Museum + Arts Center's {Re}HAPPENING 12 at Lake Eden in April 2024. This event-based setting made visitors relaxed and ready to engage with the project. In the {Re}HAPPENING iteration of the *Rattlin' Bog* installation, the artist observed visitors interacting with the piece and noticed that many enjoyed trying to figure out how to engage with the sculptural device. Visitors tried different combinations to see how interacting with the sculpture affected the onscreen content. Some visitors devised that the possibilities for interaction and onscreen change were more complex than they actually are. For example, some participants thought that if they removed a particular animal and then pressed the button that this would cause the onscreen virtual camera to move to that animal. Others concluded that as each of the three animal puzzle-pieces was removed, that the water would rise to that animal's level onscreen. In truth, however, the onscreen water movement is binary – it is either high or low. Many people found the screen-based content to be uncanny – not quite realistic with at times jerky movements and a dream-like patina to the lighting and water. Some visitors even spontaneously laughed at the content onscreen and seemed to find the muskrat character to be particularly humorous and relatable.

Garnet Hertz states in the introduction to his Zine series, *Critical Making*, "...doing something yourself [...] is a crash course in understanding how something actually works [...]. The process of being humiliated by things that you think are easy or mindless is a valuable experience..." (Hertz 2012). This sense of being flustered by materials was integral to the process of creating the *Rattlin' Bog* physical computing device (Fig. 12). It is the most complex laser etching that the lead artist has created to date. The incorporation and functionality of the puzzle-pieces, which include embedded magnets, involved trying and testing materials. Staining and glazing the device, both before and after laser etching, required the artist to draw upon experience with oil and acrylic painting. Using copper sheets and wire to create a circuit that was essentially one button press (inserting the puzzle pieces and having the water rise onscreen as a result) required knowledge of simple circuits and the properties of conductive materials[7]. To create the final input mechanism on the *Rattlin' Bog* device, a momentary switch was embedded to allow the visitor-participant to press and change the camera views onscreen. Through two straightforward input methods (the puzzle pieces and button), the *Rattlin' Bog* viewer-participant can have an engaging interactive experience and sense that they are a part of the piece and the connected ecosystem.

4. Conclusions and Future Work

Call it Art Hacking, Critical Making, or making with a sense of play, creating *Mother Bear Mother Hen* and *Rattlin' Bog* applied processes combined through building, observing, and play testing, by the artist and her teams, over a three-year period. While the notion of an art hack may connote an organized event in which a group of collaborators create a digital artwork over a short specified period of time, this paper aims to expand the notion of art hacking to encompass modalities in which artists, as individuals or teams, use technological materials to create

7. These skills were practiced and honed when the artist co-taught *The Glass Electric* class at Pilchuck Glass School with Mark Hursty in 2019. This class examined various ways to create conductive circuits that connected glass materials with code and onscreen digital content (Bradbury and Hursty 2019).

artworks through a trial and error process that includes making with digital and physical materials.

Both projects discussed in this paper use Unreal as the game engine with which to compile the assets and link the physical computing components. The Arduino Uno-style microcontroller used in *Mother Bear Mother Hen* allowed for a variety of inputs and outputs, including light, sound, and movement, to be connected to the VR game through serial communication. Using the IF Magic microcontroller for *Rattlin' Bog* allowed for a more seamless integration between the game engine and the sculptural component because the company distributed the Blueprints necessary to begin working with serial communication to and from Unreal. This allowed the artist and team to focus on the aesthetic, conceptual, and technical concerns inherent to creating the device prototype and the final laser engraved interactive piece.

The lead artist and her team used play as a method for making and testing the components throughout the production processes of *Mother Bear Mother Hen* and *Rattlin' Bog*. Play is also evident in the engagement of viewer-participants with the final works. This was observed as audiences gathered around the players in the bear and chicken jackets when *Mother Bear Mother Hen* was installed in the *Future Bodies Symposium Exhibition* and in the exhibition of the *Rattlin' Bog* device at the {Re} HAPPENING, where visitors tried different combinations of interacting with the button and animal cut-outs while they observed the changes onscreen. Future projects from the artist and her team will be available on her website.[8]

8. www.victoriabradbury.com

Acknowledgements. Epic MegaGrant Program, The University of North Carolina Asheville Department of New Media.

Research Assistants (*Mother Bear Mother Hen*): Concept Development: Lead Artist, Clara Tracey; 3D Modeling and Rigging: Clara Tracey, Keithon Turner; Game Development: Thomas Townsend; Music Composition and Sound Design: David Freund; Web and Social Media: Kayla Hammonds, Keithon Turner; Voice Acting: Joshua Lassiter (Narrator), Xavier Hursty (Baby Bears); Physical Computing and Jacket Construction: Lead Artist; Arduino-Unreal Integration: Nolan Scobie.

Research Assistants (*Rattlin' Bog*): Concept Development: Lead Artist, Clara Tracey; 3D Modeling and Rigging: Clara Tracey; Game Development: Sarah Hendricks; Sound Design and Composition: David Freund; Web and Social Media: Kayla Hammonds; Physical Computing and Digital Fabrication: Victoria Bradbury; Digital Fabrication Design Assistance: Shiasia Beasley; Rattlin' Bog uses an IF MAGIC microcontroller.

References

Adafruit.
n.d. “Product 3885.” Accessed February 1, 2024. https://www.adafruit.com/product/3885

Al-Zubeidi, Eman, Julia DeLaney, and Jinsil Hwaryoung Seo.
2022. “Evoking Sympathy Through Immersive Experiences in A Walk Alone.” *ISEA Proceedings*. Barcelona: 71-75. https://isea2022.isea-international.org/wp-content/uploads/2023/02/ISEA2022-BCN-Proceedings.pdf

Bradbury, Victoria.
2022. “X is for Xavier: Art and Parenting in the Field of New Media.” In *The Book of X*, edited by Miguel Carvalhais, André Rangel, Luísa Ribas, and Mario Verdicchio, 121-130. Porto: i2ADS: Research Institute in Art, Design and Society.

Bradbury, Victoria and Mark Hursty.
2019. “The Glass Electric.” Pilchuck Glass School. Stanwood, WA. https://blurringartandlife.com/theglasselectric/

Bradbury, Victoria and Suzy O’Hara.
2020. “Introduction.” In *Art Hack Practice: Critical Intersections of Art, Innovation and the Maker Movement*, edited by Victoria Bradbury and Suzy O’Hara, 3-11. New York: Routledge.

Bradbury, Victoria and Suzy O’Hara.
2016. “Evaluating Art Hacking Events Through Practice.” *ISEA Proceedings*. Hong Kong: 27-35. https://sure.sunderland.ac.uk/id/eprint/13317/3/ISEA2016_Proceedings.pdf

Chalmers, David.
2017. “And the Mind Bleeds Into the World: A Conversation with David Chalmers.” *Edge Foundation*, January 24, 2017. https://www.edge.org/conversation/david_chalmers-the-mind-bleeds-into-the-world

Evers, Lucas.
2017. “The Role of Critical Making.” *Waag Futurelab*, July 11, 2017. https://waag.org/en/article/role-critical-making/

“Everyman Definition & Meaning.”
Merriam-Webster, www.merriam-webster.com/dictionary/everyman. Accessed 23 Apr. 2024.

Ham, Derek A.
2016. “How Designers Play: The Ludic Modalities of the Creative Process.” *Design Issues* 32 (4) (Autumn 2016): 16-28, Cambridge: The MIT Press. https://www.jstor.org/stable/24916296

Hertz, Garnet.
2012. “Introduction.” *Critical Making*, edited by Garnet Hertz, November 23, 2012. Hollywood CA: Telharmonium Press. http://conceptlab.com/criticalmaking

IF Magic.
n.d. “Indistinguishable From Magic.” Accessed February 1, 2024.
https://ifmagic.io/

Maker Faire.
n.d. “The Maker Movement.” Accessed February 1, 2024.
https://makerfaire.com/maker-movement/

Milk, Chris.
2016. “The Future of Virtual Reality (and why it’s causing us to change our name).” *Within*. June 16, 2016.
https://medium.com/@Within/welcome-to-within-c7d3daba2b55

Miller, Claire Cain.
2021. “The Pandemic Created a Child-Care Crisis. Mothers Bore the Burden.” *NYTimes*. May 17, 2021.
https://www.nytimes.com/interactive/2021/05/17/upshot/women-workforce-employment-covid.html

O’Murchú, Nora.
2020. “Critical Making as a Model for Curating or Making Exhibitions as Things to Think With.” *Art Hack Practice: Critical Intersections of Art, Innovation and The Maker Movement*, edited by Victoria Bradbury and Suzy O’Hara, 165-175. New York: Routledge.

Ratto, Matt.
2012. “ Matt Ratto Interview by Garnet Hertz.” *Critical Making*, edited by Garnet Hertz, November 23, 2012. Hollywood CA: Telharmonium Press.
http://conceptlab.com/critical-making

Wilkinson, Michael, Sean Brantley, and Jing Feng.
2021. “A Mini Review of Presence and Immersion in Virtual Reality.” *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 65(1), 1099-1103.
https://doi.org/10.1177/1071181321651148