Digitally Displaying and Interacting with Historic Artifacts of Spatial, Temporal, Corporeal, and Kinetic dimensions

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Historic cultural artifacts with spatial, temporal, corporeal, and kinetic dimensions (STiCK) are large three-dimensional sculptures or structures that are performed by the body, occupy large amounts of physical space, and exist in their best physical form for a short period of time. They usually require a lot of space for storage, performance, and exhibition; are best understood in three-dimensions; are susceptible to decay and damage; and are not properly understood if displayed independent of the body. Using four traditional STiCK artifacts in the Trinidad Carnival as a case study, we illustrate how these artifacts can be displayed and interacted with using parametric computer-aided design, augmented reality, and embodied computer interaction. This work has potential implications for design, heritage, the Trinidad Carnival, and for historians, researchers, designers, and computer scientists.

Key words:
Augmented Reality, Embodied Interaction, Corporeal, Kinetic, Trinidad Carnival.

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1. INTRODUCTION

This paper discusses the challenges of displaying and interacting with cultural artifacts that have 'spatial, temporal, corporeal, and kinetic' dimensions (STiCK). It also presents three approaches to addressing these challenges by employing new technologies. STiCK artifacts are large three-dimensional (3D) sculptures or structures that are performed by the body, occupy large amounts of physical space, and exist in their best physical form for a short period of time. Using four (4) traditional STiCKs in the Trinidad Carnival (carnival) as a case study, we illustrate three ways of displaying and interacting with STiCK artifacts using (1) parametric computer-aided design (CAD); (2) augmented reality (AR) technology; and (3) embodied computer interaction. Our work began with analyzing existing literature, sketches, drawings, videos, films, and photographs that describe and feature the four STiCKs chosen. Developing a proper understanding of these artifacts involved researching their history, creation and development; their meaning; their movement and

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performance styles; the material practices associated with them; their scale and spatial dimensions; the colors and materials used; and their 3D form in relation to the body.

This paper is organized as follows: Section 2 begins with a brief background into the Trinidad Carnival, research in the field, and a review of work related to the application of new technologies in documenting, and displaying historic garments, and architecture. It then continues with an introduction to four STiCK artifacts in the carnival, how they have been documented, and the limitations associated with these current methods of documentation. After discussing the background to this study, in Section 3, Methods, we describe our three approaches to displaying and interacting with STiCK artifacts, then present our results in Section 4. In Section 5, we present the contributions of the work, and finally in Section 6, we discuss our findings and next steps.

2. BACKGROUND

2.1 The Trinidad Carnival and STiCK Artifacts

French planters introduced carnival to Trinidad in the 1780's, but it was reinvented by slaves in the 1830s (for a detailed discussion on the Trinidad Carnival see [Hill 1972; H. U. Liverpool 1998; H. Liverpool 2001; Noel 2015; Brown 1990; Lee 1991; Riggio 2004; Tull 2005; Ryan and Institute of Social and Economic Research 1991]). STiCK artifacts have existed in carnival since the 1890s with the Moko Jumbie [Hill 1985]. Newly freed slaves celebrated their emancipation, expressed their creativity, and reconnected with their history through the making and performance of these STiCKs in the carnival [Brown 1990].[1]

The University of the West Indies conducted the first methodical study of the Trinidad Carnival in the 1950s, approximately 116 years after its creation. Researchers then, traced some of the major traditions, origins, and traditional figures of the Carnival through text, photos, and drawings, to "serve as a basis for future documentation" [Carr 1956; Crowley 1956a; Pearse 1956; Procope 1956]. In 1985, scholar and playwright, Errol Hill called for the preservation and development of traditional figures in carnival through literature; photos; dolls; and museums. The carnival has a rich design history, has spawned more than 70 carnivals around the globe, and is one of the "most copied major carnivals in the world" [Riggio 2004]. In previous work, we have looked into design and making practices in the carnival, and experimented with how computation and digital technology might reinvent these making practices [Noel 2015, 2016a, 2016b, 2013, 2017].

Despite the carnival's rich history, local and global contributions, there are currently no established systems in place for archiving, displaying, or interacting with STiCK artifacts created for, and performed in the carnival. It is important that these artifacts be archived and documented since they each carry history and social relevance related to different aspects of life [Hill 1985]. Secondly, displaying these artifacts recognize and acknowledge those involved in creating and contributing to the nation's cultural capital. Third, these STiCKs are materializations of the knowledge, skills, ideas, values, and communication between people, their communities, and their society [Reddy 1979].

[1] The term Trinidad Carnival does not define its geographic location, but instead its origin and the main elements that define the carnival: mas', calypso, and steelpan [Noel 2015].

Fourth, not only are these artifacts susceptible to physical decay and destruction [Karadag 2014; Chen et al. 2005], but as time evolves some of them may disappear from the carnival [Hill 1985; Crowley 1956c]. Finally, archiving and displaying STiCKs serve educational and research purposes about history, design, visual, and performing arts associated with the carnival. Some challenges involved in displaying and interacting with STiCKs (Fig. 1), include:

1. The lack of physical space and resources needed for permanent storage, performance, and exhibition as these artifacts can be up to 20 feet tall and/ or wide;
2. A viewer's inability to interact with them using the movement of their body, since they are currently only documented and displayed two-dimensionally in text, photos, and video;
3. Their lack of permanence since they are designed and built to last for a short period of time, after which they may be damaged, destroyed, or materials salvaged for re-use;
4. A viewer's loss of understanding of the artifact's scale, three-dimensional quality and relationship if presented independent of the body; and
5. The increased cognitive load required to synthesize text, photos, and video of STiCKs to develop a three-dimensional understanding of its kinetic qualities and expressions.

This work seeks to illustrate how digital technologies might be used to address some of these challenges.

Figure 1. STiCK artifact being performed by a masquerader in the Trinidad Carnival (2010). Photo by author.

2.2 New Technologies in STiCK artifacts

STiCK artifacts are large and can be difficult to exhibit. Architects Nagakura and Sung [2014] in their work on augmented reality in architectural exhibitions, used low-cost AR technology to synthesize and condense architectural drawings, textual descriptions, photogrammetry, and 3D printed models to address this issue of scale and site for the exhibition of architecture in galleries. Like Nagakura and Sung, this work seeks to allow the display of artifacts that may be too large to fit in a room, and where the site – in this case the body as site – inextricably linked to the artifact for proper understanding. Fashion designer Kathi Martin, and computer scientist Hyeong-Seok Ko [2009] brings to life the display of historical garments on a virtual body to allow digital archiving of historic fashion and movement of the body. They also present tools and technologies for developing digital archives to interpret, examine, and contextualize historic fashion, and experiment with design [2011]. Kang et al. [2013] used 3D technology to reconstruct, render, and simulate traditional costuming from the 18th century, while Martin and 3D modelling animator Mauriello [2013] represented the movement of historic garments' fabric on the body with motion capture. This project situates itself amidst these works on displaying large historic artifacts with corporeal qualities, and our body's interaction with them using new technologies. Like these aforementioned works, we are also attempting to reconstruct traditional costuming and allow interaction between the body and these historic artifacts using a motion-sensing device. STiCK artifacts reside at the scale between architecture and fashion/ clothing. Although they are worn and performed by the body, they are not clothing, but in fact have three-dimensional, spatial, and structural qualities to them like buildings do. This paper currently focuses on (1) defining what a STiCK artifact is, and (2) displaying and interacting with four traditional STiCKs from the Trinidad Carnival using digital technologies.

2.3 A Case Study - Existing documentation of STiCK Artifacts

The four STiCK characters from carnival that we use in this case study are: the Moko Jumbie, the Bat, the Imp, and the Children of the Moon. Below we discuss the history of the characters, their significance, and what they represent. In figures 2-5, we show some of the existing text, sketches, and photos describing these STiCKs.

2.3.1 The Moko Jumbie

The Moko Jumbie shown in Fig. 2, first appeared in carnival in 1895, and like many those formerly enslaved in Trinidad and Tobago, its origin has been traced to West Africa [Nicholls 1999; Crowley 1956c; Martin 1998; Hill 1985]. It is performed on stilts 10-15 feet high, and represents "the spirit of Moko, the Orisha (god) of fate and retribution who emphasizes that even [though] he [has] endured centuries of brutal treatment he remains tall, tall, tall [Martin 1998]."

The Moko Jumbie dances a jig lifting its legs and stilts up and out. It was revived in the carnival "as a result of a self-conscious effort at education by cultural researchers" [Riggio 2004, p. 242].

TEXT

"Moko Jumby, the ***stilt dancer*** *[…] In Trinidad he was played, nearly always by men, on* ***stilts as high as 10 or 15 feet****. The stilts were brightly painted in stripes, and the masquer wore a long full skirt and a jacket or "eton" of* ***brightly-coloured satin or velvet****. His* ***hat*** *was made of tòshô, the dried pulp of the wild cucumber which was fashioned into an "Admiral's"* ***hat with long peaks in front and back****, and with the crown of the hat* ***decorated with feathers****. Moko Jumby was sometimes* ***accompanied by a dwarf*** *in similar costume but without stilts, to accentuate Moko's height."*

Crowley, Daniel J. 1956. "The Traditional Masques of Carnival." Caribbean Quarterly 4 (3/4): 194–223.

SKETCH

Crowley, Daniel J. 1956. "The Traditional Masques of Carnival." Caribbean Quarterly 4 (3/4): 194–223.

PHOTO

Martin, Carol. 1998. "Trinidad Carnival Glossary." TDR (1988-) 42 (3): 220–35.

Figure 2. Existing documentation on the Moko Jumbie in visual (sketches, photos, video not shown), and textual form. (Sketch Copyright: Carlisle Chang; Photo Copyright: Carol Martin).

2.3.2 The Bat

The Bat in Fig. 3, first appeared in the carnival in 1899 [Hill 1985], and is said to have been invented after a rabies scare on the island in the 1930s ["Callaloo by Minshall" 1986]. The costume is traditionally "fabricated from wire and bamboo to a wingspread of 12 to 15 feet" [Crowley 1956c]. Performers wear a black or brown skintight suit with wings attached to the feet and shoulders [Crowley 1956b; Hill 1985].

Carnival designer Peter Minshall, used the Bat as the foundation on which he developed a variety of new structural forms for costuming in the carnival [Gulick 2000; Minshall 1990; 2000].

TEXT	**SKETCH**	**PHOTO**
*"**The typical bat costume** is black or brown skinfit, dyed long underwear, jersey or velveteen. The kandal is short like swimming trunks, and is **made of frayed bag, swansdown**, or sometimes yarn rug, material. The **head mask**, usually made by a professional, fits over the entire face and head and is made of swansdown with **papier mâché** face, teeth, nose barb, and round eyes. […] A pair of **shoes** are made in **leather with metal claws for toes**, or regular shoes are covered with long wool socks to which metal claws have been attached, and a second sole is attached to the bottom of the shoe soles to protect the stockings. **Wings are fabricated from wire and bamboo** to a wingspread of **12 to 15 feet**, and are covered with the same cloth as the skinfit. They are fastened to the costume by hooks-and-eyes, zippers, or sometimes by sewing. In any case the masquer is sewn into his clothes with his arms permanently fastened to the wings. His hands are covered with matching gloves.*		
Crowley, Daniel J. 1956. "*The Traditional Masques of Carnival.*" Caribbean Quarterly 4 (3/4): 194–223	Crowley, Daniel J. 1956. "*The Traditional Masques of Carnival.*" Caribbean Quarterly 4 (3/4): 194–223	Stegassy, Ruth. 1998. "*John Cupid: We Have Been Called Carnival People: An Interview.*" TDR (1988-) 42 (3): 96–107. Photo by Jeffrey Chock.

Figure 3. Existing documentation on the Bat in visual (sketches, photos, video not shown), and textual form. (Sketch Copyright: Carlisle Chang; Photo Copyright: Jeffrey Chock).

2.3.3 The Imp

The Imp in Fig. 4, first appeared in 1912. It wears wings and tails, and "dart[s] and skip[s] about continuously" [Procope 1956; Hill 1985]. In the carnival, these imps are attached to the ends of long chains or ropes and constantly goad and restrain other characters – Beasts and Dragons.

They are seen as "creatures of hell", full of "mischief, and devilry" [Procope 1956; Harris 1998].

TEXT	**SKETCH**	**PHOTO**
*"**The imps wear face masks with horns, and tights with wings and tails.** The imps dance a chipping step with a slight ' swaying movement of the hips, and prance, twirl, dart and skip about continuously." - Procope* *"There are also bands of red, green, or blue devils dressed like the Imps of a Dragon Band with **short kandal, tails, and pitchforks**, but with their **bodies covered in ruku or green or blue powder**." - Crowley*		
Crowley, Daniel J. 1956. "The Traditional Masques of Carnival." Caribbean Quarterly 4 (3/4): 194–223.	Procope, Bruce. 1956. "The Dragon Band or Devil Band." Caribbean Quarterly 4 (3/4): 275–80.	http://www.caribbeanmemoryproject.com/approo-narrie.html#/ ("Narrie Approo" 2017)

Figure 4. Existing documentation on the Imp in visual (sketches, photos, video not shown), and textual form. (Sketch Copyright: Carlisle Chang; Photo Copyright: Narrie Approo).

2.3.4 Children of the Moon

The "Children of the Moon" in Fig. 5, is a contemporary costume presented in 1984 by Peter Minshall [1990, 1987; "Callaloo by Minshall" 1986]. Designs are composed of a unifying element of the circle and display an "abstract lunar quality", with subtle differences evoking the various origins of people of Trinidad & Tobago - Africa, India, Europe, and China ["Callaloo by Minshall" 1986].

TEXT	**SKETCH**	**PHOTO**
"The Children of the Moon, all costumed according to a basic design concept of ***white circular and conical shapes****. All costumes carry the unifying element of the* ***circle around the head****, reflecting the sense of common humanity with is at the core of the work."*		
"Callaloo by Minshall". 1986.	Minshall, Peter. "Minshall: Works in the Mas Presented in the Carnival of Trinidad". 1987.	Minshall, Peter. "Minshall: Works in the Mas Presented in the Carnival of Trinidad". 1987.

Figure 5. Existing documentation on the Children of the Moon in textual and visual form (sketches, photos, video not shown). (Copyright: Peter Minshall).

3. METHODS

This section describes our approach to using digital technologies to display and interact with STiCKs that are documented in text, sketches, photos, and video. As illustrated in Fig. 6, these include:

(1) Developing parametric CAD models of STiCKs;

(2) Displaying STiCK artifacts in augmented reality environments; and

(3) Embodied computer interaction with motion-sensing devices and interaction technology.

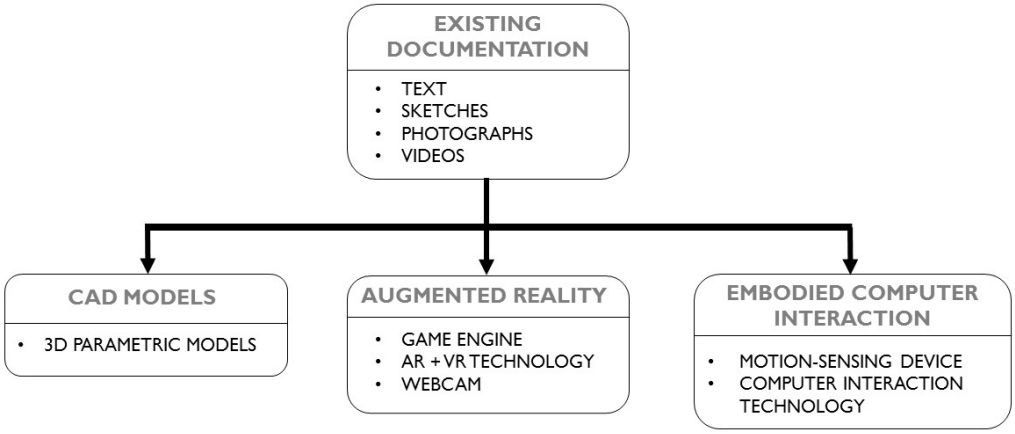

Figure 6. Methods used to represent, display, and interact with cultural artifacts with spatial, temporal, corporeal, and kinetic dimensions (STiCK).

3.1 Parametric CAD Models

In Rhino3D, a stick figure representing the body was drawn with lines connecting nodes at the center of the head, the neck, shoulders, elbows, wrists, waist, hips, knees, and feet. Using the body as a site, existing information describing STiCKs in text, sketches, photos, and video was examined, and interpreted to model and parametrize the designs of the STiCKs. The Moko Jumbie was 3D modelled in digital space, and the height and diameter of the stilts were parametrized. The wing of the Imp was abstracted as a circle with parameters such as the height of the wings in relation to the body, its radius, and the number of radial divisions of the wing. The Children of the Moon STiCK was modelled with circles enclosing space around the body with parameters such as circle locations and radii.

3.2 Augmented Reality displays

The second part of this approach addresses the physical space required to display STiCK artifacts; the inability to understand their scale, 3D quality, and relationship independent of the body; and the cognitive load required to synthesize two-dimensional information into three dimensions. We developed 3D displays of the STiCKs in an augmented reality environment using the 3D parametric CAD models, the game engine Unity 3D, and the augmented reality program Vuforia. 3D models of the human figure and the STiCK were exported into .obj files for use in Unity 3D. After placing the .obj

model on the target in Unity, it was positioned and scaled as desired. Lighting was added to the environment, then the scene played to activate the camera device on the computer which in our case was a handheld webcam. The marker was placed in front of the camera then the AR STiCK artifact(s) were visible on the target on the computer screen. By moving the webcam and/ or the marker, the STiCK could be examined in three dimensions.

3.3 Embodied Computer Interaction

The next challenge addressed was the inability of viewers to interact with STiCKs using movement of their bodies. Dourish [2004] defines embodied interaction as the "creation, manipulation, and sharing of meaning through engaged interaction with artifacts" that are part of our physical and social world. In this work, we focus on interactions with technological artifacts. To accomplish this, we used the parametric CAD models of the STiCKs, a motion-sensing device (Kinect), and the Grasshopper plug-in Firefly - which takes real-world data of the human skeleton to influence digital models. We created a program that would take the human skeleton as input from the Kinect, then display that skeleton in the Rhino3D interface. Because our CAD model used the joints and limbs of the body as scaffolding for the designs, when the real body moved, the digital model and the STiCK moved simultaneously. This combination of algorithmic descriptions, motion-sensing, and real-world data collection allowed embodied interaction between users and digital STiCKs. Figure 7 shows the visual program that enabled interaction with the Moko Jumbie. On the left the Kinect collects real-time data on the spatial location of joints and limbs of the body, and the algorithmic description of the Moko Jumbie is on the right. Data coming from the movement of the feet (left and right foot), causes movement of the stilts on the body in digital space.

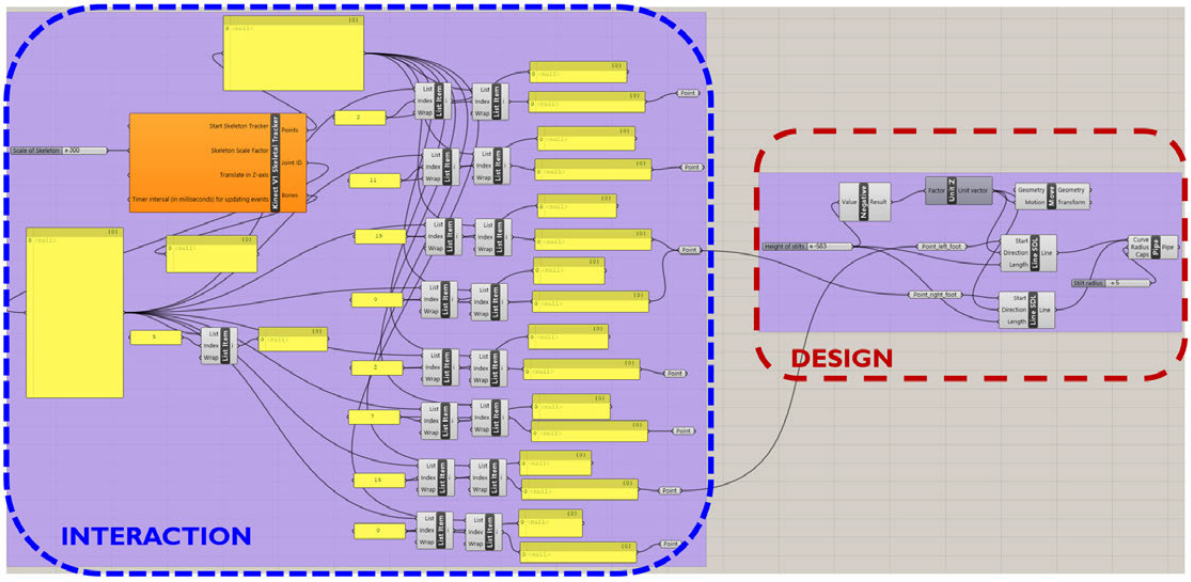

Figure 7. Firefly interaction program in Grasshopper that takes the skeleton as input for the design of the STiCK.

4. RESULTS

Presented next are images showing the displays and interactions resulting from the three approaches described previously.

4.1 Parametric CAD Models

In figures 8-11, we illustrate the textual and algorithmic descriptions, and the resulting digital representations of the STiCKs. Note the abstract representation of the human form using a single-line figure connecting joints of the body. By manipulating the parameters for the STiCK, one can alter aspects of their design to generate different design options.

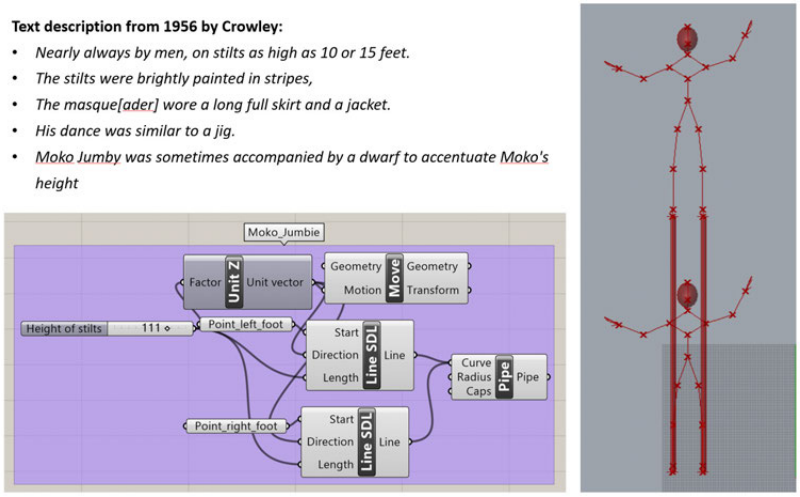

Figure 8. Moko Jumbie descriptions in text (top left), parametric algorithmic description (lower left), and visual representation (right).

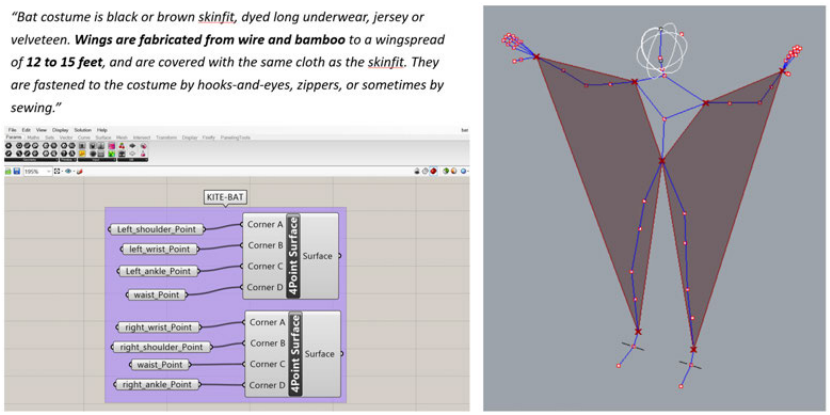

Figure 9. The Bat - descriptions in text (top left), parametric algorithmic description (lower left), and visual representation (right).

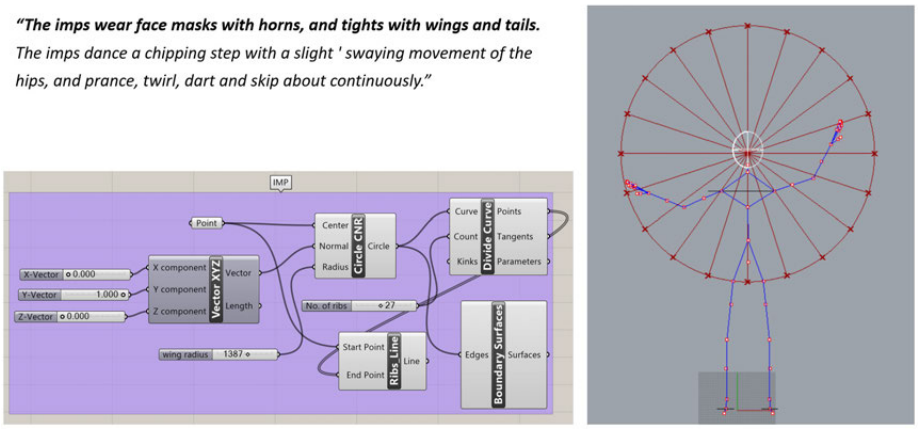

Figure 10. The Imp - descriptions in text (top left), parametric algorithmic description (lower left), and visual representation (right).

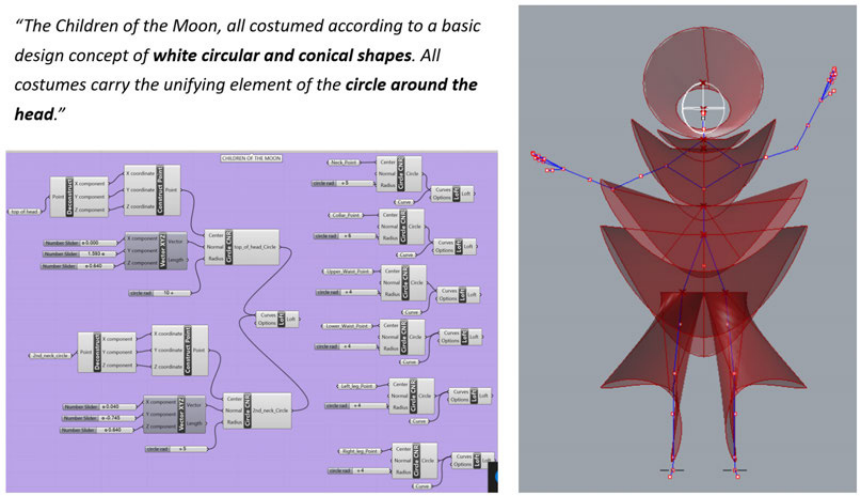

Figure 11. Children of the Moon - descriptions in text (top left), parametric algorithmic description (lower left), and visual representation (right).

4.2 Augmented Reality displays

In figures 12-15, we show AR displays of three STiCKs inside the Unity scene and on its marker. AR models allow navigation of the artifact in three dimensions, going up close to the digital models, seeing what it looks like in the front, back, and sides from above and below. We also altered the colors of elements of the STiCKs.

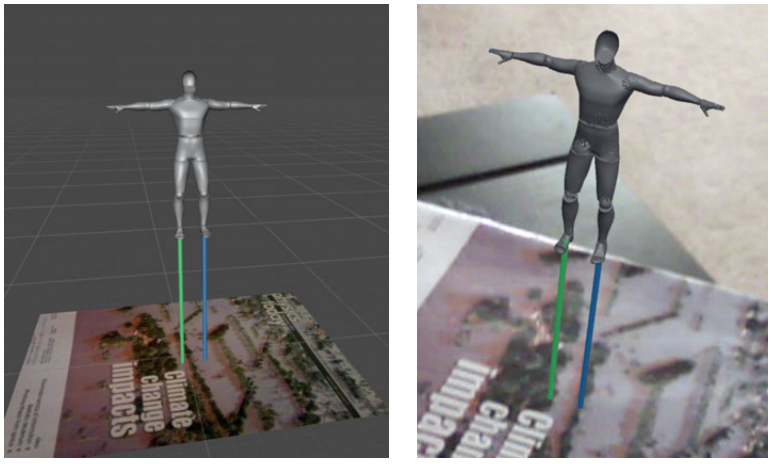

Figure 12. Moko Jumbie – Augmented reality model in the Unity 3D environment (left), and webcam view of model on augmented reality marker (right).

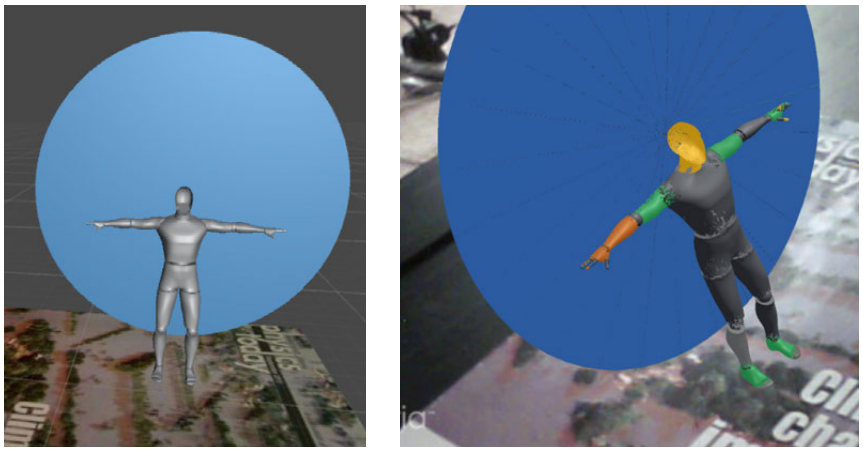

Figure 13. Imp – Augmented Reality model in the Unity 3D environment (left), and webcam view of model on augmented reality marker (right).

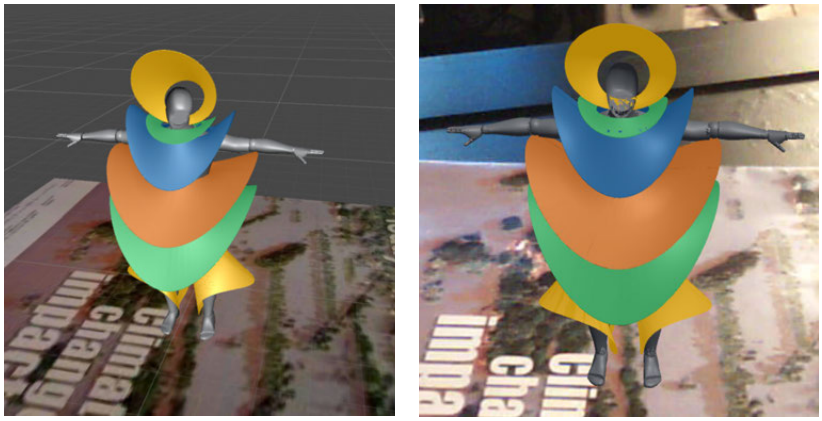

Figure 14. Children of the Moon – Augmented Reality model in the Unity 3D environment (left), and webcam view of model on augmented reality marker (right).

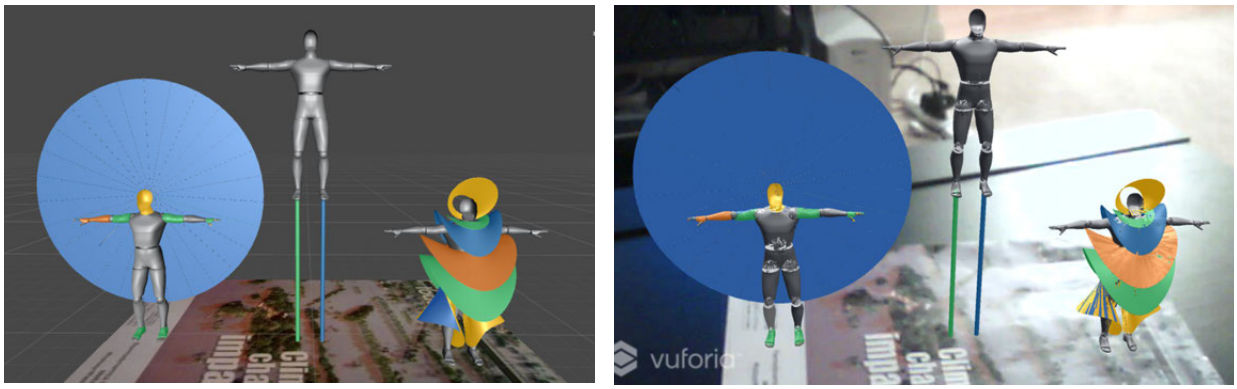

Figure 15. Augmented reality models in the Unity 3D environment (left), and webcam view of the 3 models on augmented reality marker (right). From left to right: The Imp, the Moko Jumbie, and Children of the Moon.

4.3 Embodied Computer Interaction

In Fig. 16a, the user is dancing with the digital STiCK Moko Jumbie on the left, and with the digital Imp on the right (Fig. 16b). In figure 17, two users are interacting with the same digital STiCKs. On the right of figures 17a and 17b, a video displays what the Kinect sees, on the left is a representational display of the Users' skeletons (joints and limbs), and the STiCK designs in the Rhino3D interface.

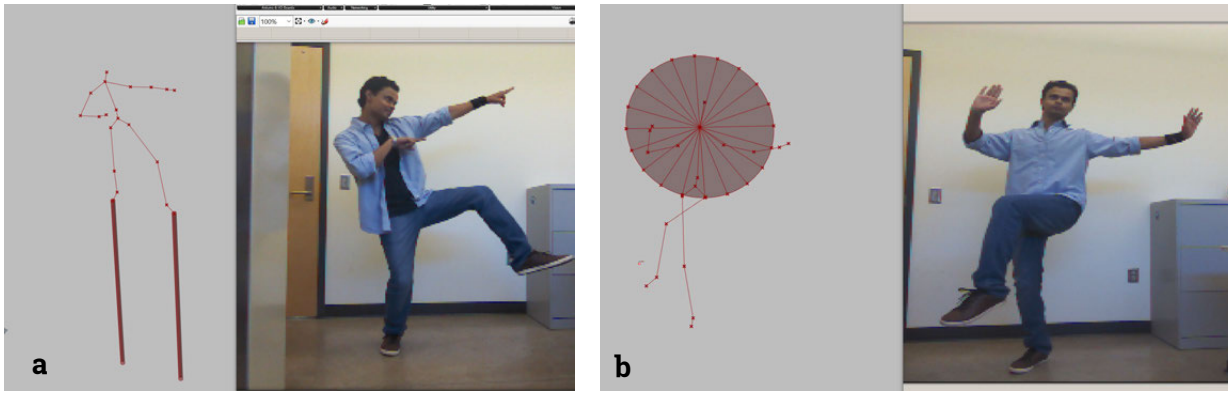

Figure 16. User interacting with Moko Jumbie STiCK on the left (a), and with the Imp on the right (b).

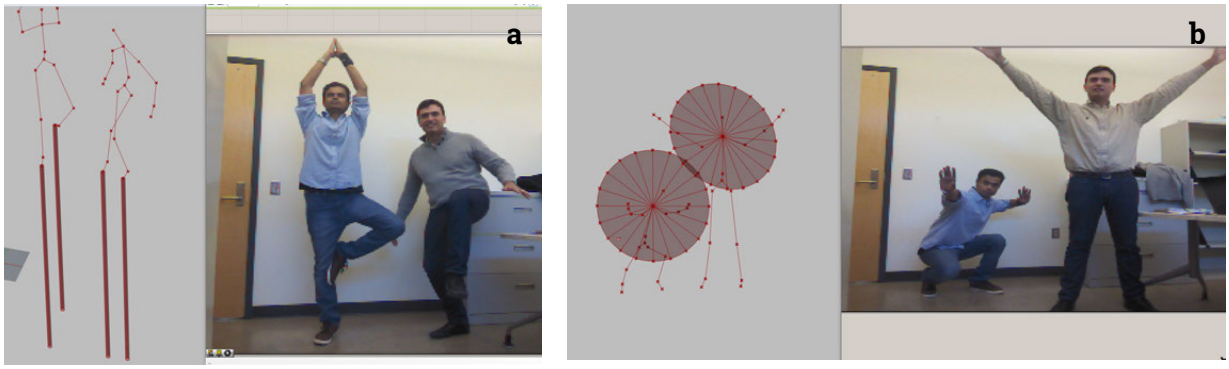

Figure 17. Users interacting with the Moko Jumbie (a), the Imp (b), and each other through the interactive program.

5. CONTRIBUTIONS

This work has promising contributions for cultural and digital heritage when it comes to artifacts with spatial, temporal, corporeal, and kinetic dimensions. First, we have started to define and create a space for research into STiCK artifacts of the past, present, and future. Second, we offer a low-cost approach to displaying and interacting with STiCKs in a manner not possible through text, sketches, and photographs. Third, we offer digital algorithmic descriptions of four STiCKs in carnival with parametric CAD modelling. Finally, through this work we offer a space for potential collaborations between those involved in carnival, computational designers, historians, researchers, educators, students, computer scientists, curators, and members of the general public.

6. DISCUSSION & NEXT STEPS

Using the Trinidad Carnival as a case study, we demonstrate how challenges associated with STiCK artifacts and their current documentation – large physical space needed for storage and exhibition; the lack of embodied interaction with text and photos; their temporary nature; and the cognitive load

required to synthesize 2D data to understand their 3D kinetic qualities - can be addressed through digital technologies and processes. Since these artifacts are parametrically modelled in CAD, they allow the generation of different design options, and the creation of new design parameters for STiCKs. These three approaches can be pedagogical tools for design in carnival, rule-based design, and research. We acknowledge that our work in AR models is a first step and the beginning of future development of STiCKs in augmented reality, however, users can still use this approach to examine 3D aspects of the designs, thereby reducing the amount of information and details that might be missed. Users can also explore and experiment, for now, with changing the colors of the STiCKs which adds another layer of interaction and aids in design decisions. In the embodied computer interactions, users were able to move freely without being physically attached to suits or technologies. Additionally, when it came to dancing the jig like the Moko Jumbie, they could perform the dance without being constrained by the physical size of the room, which would not be possible with the real Moko Jumbie. This has implications for architecture since it implies the design and construction of smaller museums to house large artifacts of this type. We also noticed that when two users interacted with the artifacts at the same time, they also interacted with each other: human to human interaction facilitated by the digital STiCKs. By employing and further developing the embodied computer interaction approach we might be able to teach others how to correctly perform these STiCK artifacts in carnival.

One limitation in the embodied interaction part of the study was that users were limited to being indoors with no access to the external environment in which the actual event of carnival takes place. Next steps might involve research into how we address this physical limit. A second limitation is that the real context in which STiCKs are performed in carnival, were not represented in the displays. Next steps might involve capturing and representing this context in the displays. Future studies shall include the animation of AR STiCK models either by design or real-time motion-sensing information; the development the AR display on a mobile platform; the embedding of metadata and educational information in the digital models and representations; digital archiving; and creating a searchable digital database of more detailed descriptions of elements of past, present, and future STiCKs in carnival.

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