NATIONAL ENDOWMENT FOR THE HUMANITIES

DIVISION OF PRESERVATION AND ACCESS

Narrative Section of a Successful Application

The attached document contains the grant narrative of a previously funded grant application. It is not intended to serve as a model, but to give you a sense of how a successful application may be crafted. Every successful application is different, and each applicant is urged to prepare a proposal that reflects its unique project and aspirations. Prospective applicants should consult the NEH Division of Preservation and Access application guidelines at http://www.neh.gov/divisions/preservation for instructions. Applicants are also strongly encouraged to consult with the NEH Division of Preservation and Access staff well before a grant deadline.

Note: The attachment only contains the grant narrative, not the entire funded application. In addition, certain portions may have been redacted to protect the privacy interests of an individual and/or to protect confidential commercial and financial information and/or to protect copyrighted materials.

Project Title: Archiving Performative Objects

Institution: Georgia Tech Research Corporation

Project Director: Michael Nitsche

Grant Program: Research and Development

NEH Research and Development: TIER I: Archiving Performative Objects

1 Significance and Project Description

The Georgia Institute of Technology (Georgia Tech) and the Center for Puppetry Arts (CPA) hereby apply for funding for the **Tier I** project ***Archiving Performative Objects***. These funds will be used to design and implement a game-like system that remediates puppets' functionality and offers interactive access to the operation of 3D objects themselves. The goal is to prototype a game like system that allows users to "play" with the digital objects and that is flexible enough to support such virtual interaction for different conditions and objects. This system is developed as an integrated part into a small sample database to ensure a valid and effective extension of existent technologies. The original data set will consist of 3D scan data of 12-15 objects from the CPA's archive. The researchers will optimize these sample data for the game-like engine that allows direct manipulation of the 3D digital objects on desktop PCs as well as in a VR experience. All results will be publicly shared.

If 3D data is integrated in archives at all, it is used for 3D visualization and reproduction through 3D printing of scan data. *Archiving Performative Objects* adds a third dimension: a virtual interaction platform to explore the operation of the digitized objects. The targeted object category is performative objects, namely objects that only can be experienced through human participation in their functionality defined by a shared human-object activity. Unlike, for example, 3D scanned archeological sites or 3D scanned busts that can be investigated by close visual examination, these objects cannot be captured by their appearance alone. And unlike machines that can be virtually simulated, these objects are activated through human interaction and thus depend on a shared activity. This category includes tools, clothes and weapons but also theater props, instruments, and puppets. Puppets were chosen because they represent many of the underlying complexities of this type of objects. They offer highly variable control schemes, are all unique in appearance and operation, and differ in size and materials. Another reason to focus on puppets is the fact that they so far have been largely neglected in digitizing efforts.

Puppets are liminal objects. They are active bridges between the animate and inanimate worlds and as such they have transcended many fields of the humanities. "They have been powerful conservators of social values, but also political subversives." (Blumenthal, 2005) This particular in-between status of puppets infused them with a lasting cultural heritage. 11 forms of puppetry are currently recognized by the UNESCO as intangible cultural heritage and there are numerous national collections of puppets and performative objects. One of the biggest, the Center for Puppetry Arts, will be a collaborator on this project.

The **problem** is that their liminal characteristics also make them largely inaccessible to scholars and audiences. Puppets are material through their physical bodies and immaterial through the manipulation that brings them to life. As puppeteer and director Robert Moore noted: "a puppet is a thought in your hand." An essence of this thought is its liveness and active performance. Puppets have a presence, what Frank Proschnan called "material image" (Kaplin, 1999), that carries elements of life – and even death (Williams, 2015) – through their manipulation delivered by the puppeteer. The "coming into being" of puppet objects "capable of existence" (Jurkowski, 1990) is encapsulated

in their performative moment. Drucker argues for such performative materiality that it "has to be understood in terms of what it does" (Drucker, 2013). It is action that describes and clarifies a performative object. They have to remain "unstable rather than fixed, simulated rather than real" and need to be "produced" through our interaction (McKenzie in (Schechner, 2002)).

But this moment is lost in a static archive. Even though there are numerous puppet sections in larger museum collections (e.g. the American Natural History Museum, the V&A, the Smithsonian), as well as specialized performance collections (e.g. the Center for Puppetry Art or the Ballard Institute in the US), this defining element of the puppet as objects coming to life through interaction remains obscured. Scholars and practitioners have severely restricted access to puppet objects due to their fragility and the only access to a historic performance itself is through film material – if at all. The actual manipulation remains largely impossible.

The same challenges are found in other performative objects such as tools, weapons, clothes, instruments, any object that can be captured only through inclusion of its actual functionality through the human hand and body.

This project asks: **How can digital media conserve and present performative objects' functionality through 3D technology and interaction design?**

The proposed approach is the development of an extendable game-like system that goes beyond 3D visualization as it allows direct manipulation of the virtual puppet objects. This system will be designed in a way to connect directly to the existing database at the CPA. The project is designed as an extension – not replacement – of existing digital archives of such objects and aimed to tie into current efforts. Thus, it will document its best practices and make the technical and design results openly accessible for further adjustment and adaptation.

Many collections and museums have started to 3D scan their objects and a range of these data is available online. For example, Sketchfab.com is optimized for online viewing and thingiverse.com focuses on download and 3D printing – both include data from renowned collections such as the British Museum or the Metropolitan Museum of Art. However, interactions beyond visualization of 3D files and access to 3D printing are far less explored. Such digitally remediated functionality goes beyond visual conservation and possible 3D-printed reconstruction. It allows access, comparative study of objects, and even experimental alteration of a digital object. It furthermore becomes increasingly important as new 3D interaction modes, such as VR, become more widespread and accessible and pose new questions for digital archiving. The proposed new archiving tool provides two key new access points:

1) an archival remediation of the 3D digitized object's operation
2) an experimental platform for object manipulation and alteration.

At the same time, such a tool helps VR to expand. For VR to live up to its potential in the digital humanities, it cannot restrain itself to passive object presentation format – mimicking dated forms of presentation where objects cannot be touched. Instead, it needs to experiment with interactive access to these objects and realize the procedural qualities of digital media that allow direct manipulation and operation of those virtual objects. The proposed tool tackles this challenge not as a disconnected technological question but in the humanistic perspective of an ancient cultural form: puppetry.

The researchers will have to tackle a number of **challenges** in this project that deal with how well can a digital model present a puppet's construction and operation. The expertise from the CPA will help to inform, for example, how virtual materials can assist in the construction of the digital puppet body. For example, how well does a modern game engine reflect cloth behavior in the reconstruction of a hand puppet such as Punch? How detailed can a virtual puppet reflect special components such as feathers or lace? Puppets use their own balance point – how well can a digital system present e.g. the weight of a wooden puppet head in relation to a lighter body made out of cloth or foam? Or represent mixed-material puppets? Can digital technology incorporate varying translucency (as used by numerous shadow puppets) as well as their dynamic shadow effects? How can other material demands from the operation of joints to effects of gravity and physical deformations such as seen in foam-based puppets be represented in an interactive system?
Most importantly: What are best practices to incorporate the countless control mechanisms in a way that fits the far more standardized interface design approaches in digital media? And what optimizations are needed on the 3D models (e.g. do all objects have to be rigged)?
The intention cannot be to attempt a complete recreation or simulation of existent puppets but to develop a critical remediation that allows for expressive quality within the still prevalent technical constraints. Creating this balance is the core task of the collaboration between Fritz, Baumgartner and the CPA on the one hand and Nitsche and the Digital Media GRA on the Georgia Tech side.

The project's **impact** will expand accessibility of digital objects in archives on several levels. Many modern collections cannot present their full material. In the case of the CPA, even a recent new exhibition expansion will allow the Center to display only a fraction of its over 3,600 puppets. Most objects are in storage on-site as well as in additional storage space in the Atlanta History Center. These objects are accessible only through the curating staff at the CPA. Original puppets need to be handled by Fritz personally, which greatly limits access to the collection and audiences ranging from puppeteers, scholars, historians, or puppeteers and fans have to schedule special appointments to gain access to particular puppets.
Physical storage of puppets is costly and not always permanent. For example, the National Puppetry Archive (UK) had to hand over large parts of their collection to other institutions when storage space became inaccessible. While some puppets remain accessible, "the majority of them rarely see the light of day" which particularly affects "anyone researching the actual tangible puppets" (Dixon, n.a.). Even if they are on display, they remain detached from audiences because their materials are fragile. Puppet materials and designs differ between regions, cultures, and periods. For example, African pieces are usually wood, Asian pieces typically have textiles with wooden features, shadow puppets are often made of leather, while many modern puppets are made of mixed materials. This complicates conservation and makes direct access impossible. One example from the CPA collection is the Henson collection: Henson puppets often used polyurethane as filling material for many of the original puppets, but polyurethane has a limited lifespan. Other puppet conservation tasks face

problems based on the history of the specific puppets. For example, the heavy use of Indonesian Wayang Golek puppets means that they are often re-painted over their lifetime. Restoring the puppet to its "original" color means neglecting the other performance conditions. A virtual model of the puppet allows opportunity for experimental adjustments. Scholars can re-texture them with different colored textures and access the multi-facetted presentation of the puppet's appearance over time. Finally, puppets of renowned puppet creators and troupes such as Bil Baird, Andy Spradbery, or Jim Henson are often spread across many different archive and never combined to a full ensemble again as the original objects are conserved at different collections. A digital "play" system allows for the first time to bring these objects back together. It also allows for comparison of expressive means across different puppet traditions, locally owned and hosted puppet objects, and international puppet collections.

Digital 3D technology for effective visualization of historic sites and artifacts has been widely discussed and largely accepted as an important part in the digital humanities. One recent example is the Digital Humanities grant for *Character Modeling in Humanities 3D Environments* (HD-51944-14). 3D techniques are addressed in NEH workshops like the current *Advanced Topics in the Digital Humanities Summer Institute*. They deal mostly with data acquisition and visualization e.g. in the field of architecture, digital heritage, or tribal art. In parallel, large institutions (e.g. the *Smithsonian*) experiment with 3D scanning technology. As with other objects in the area of virtual heritage, puppets would gain a lot through 3D visualization. A 3D model provides detailed and complete overview over the puppet's body, texture, and scale from every angle. But performative objects such as puppets have their own particularities that differ vastly e.g. from archeological sites. The most important being their role as performing objects and visualization alone is not sufficient to capture the expression of the "object in use." It is not just the form and shape but especially its handling and operation that define a puppet.

What is needed is access to this operational quality and this access can be provided by modern Human Computer Interaction and Game Design. Various digital technologies have proven most effective in capturing this behavioral component.

Within interaction design, the tangible and embodied interaction community has experimented with various forms of interface designs from using Wii-motes (Shiratori & Hodgins, 2008) to input gloves (Bar-Lev, Bruckstein, & Elber, 2005), to Leap motion detectors (Oshita, Senju, & Morishige, 2013), to Kinect puppetry implementations and haptic feedback devices (Kim, Zhang, & Kim, 2006), to custom-built sensor-embedded play shapes (Gupta, Jang, & Ramani, 2014).

These approaches emphasize that novel interfaces can map effectively onto puppet controls and they often show that these controls work successfully with various audiences. However, there are three key problems with HCI based approaches. First, they focus on the technological challenge. Thus, when discussion "guidelines and best practices" for digital puppet systems, Hunter and Maes focus entirely on technological solutions related to computational challenges, not the performance of the puppets themselves (Hunter & Maes, 2013). Second, the projects do rarely include actual puppet experts – or other digital archivists – to consult and make sure that the digital

representation is appropriate. Their primary audience is other HCI experts, not puppeteers. Third, the majority of projects demonstrate a single innovative mapping or mapping approach. Consequently, each project allows for a digital encounter with one kind of set up only and comparisons between different mappings are impossible.
The most developed projects deal with Asian shadow puppetry. They clearly position the puppetry practice in a larger and valued cultural tradition, one they often see endangered by more modern media developments such as video games see (Huang et al., 2015; Lu et al., 2011). Nevertheless, they develop strong computational methods for the shadow puppetry practice. For example analyzing minute movement changes for means of procedural animation (Lin et al., 2013) or scanning and translating human bodies into shadow puppets (Huang et al., 2015). More accessible is the *ShadowStory* project, which uses custom-built sensors as input devices to control self-made shadow puppets. *ShadowStory* was conceived as an educational project and highlights the necessity for a digital intervention to widen access as the project notes that only 1 out of the 36 Chinese school children participating had ever encountered shadow puppetry as a live art form. To counter this, Lu et al. implemented a project where students can design own virtual shadow puppets and control them via customized sensors to develop and share stories (Lu et al., 2011). The outreach component reflects the projected educational impact of the “Digitizing Puppets” project but in *ShadowStory* it remains limited to custom-built hardware and specialized (and inaccessible) software. Furthermore, *ShadowStory* does reference the cultural depth and history of shadow puppetry but the project still did not include puppeteers in the design and development process nor does it use historic puppets.

The virtual models are not replacements for the original puppets but reference copies of the originals made accessible through **game technology** and **game design**. Video games become increasingly relevant for virtual heritage but their application remains a field of much further study “to grasp the value, promise and problematic natures of game-based learning applied to interactive history and digital heritage” (Champion, 2015). *Archiving Performative Objects* builds on serious games elements to include virtual functionality through interactive options in a digital archive without replacing the historic specific object. Instead the virtual object becomes a playable reference for the original. The notion of such reference objects is not new to puppetry archives. Fred Tickner, a master of Punch and Judy puppets, had planned to create a “standard set” of Punch and Judy figures for the National Archive (Dixon, n.a.). Likewise, when performances use historic puppets they often have to recreate puppets and objects that are too fragile for active performance settings. In that way, the *Puppet Story*’s performance of *Shakespeare: The Puppet Show* (2014) was based on the puppet collection at the V&A but had to recreate puppets for the actual performances. Similarly, object data provided by this project will not serve to replace existing historical artifacts but to offer an additional layer of reference for scholarship (as seen in the case of Tickner) and performance (as seen in the case of *Puppet Story*). Key design and technological concepts for this addition will be adapted from game studies and more specifically Serious Games.
Serious Games have been defined as games with “an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement." (Abt,

1970). The field uses game technology and approaches for knowledge dissemination as well as for knowledge production, for example for chemical processes (Khatib et al., 2011), archeology (Antoniou, Lepouras, Bampatzia, & Almpanoudi, 2013), or history (Jenkins, Klopfer, Squire, & Tan, 2003). Serious game design principles and technologies have found an entryway into cultural heritage and the humanities at large (Mortara & Bellotti, 2013). Their procedural powers, allowing for flexible content presentation and engaging access have been noted as important tools (Gee, 2004). They have found significant attention in educational media practice and theory but are underrepresented for archival approaches, even though through their technological core criteria they are bound to allow novel forms of access (Manovich, 2001; Murray, 1997). One reason for this hesitation is the variety of archived objects that call for different forms of interactive access. It is daunting to find different interactive designs for different objects. To develop the necessary flexibility in such a system, puppets are a prime starting point. Puppets offer a range of highly diverse mechanisms that pose the necessary challenge for a system that cannot offer a “one size fits all” approach but instead is meant to test the flexibility of an archive-game-system.
Playing video games has itself been associated with a form of puppetry (notably from Games Studies scholars (Westecott, 2009) as well as HCI scholars (Calvillo-Gamez & Cairns, 2008) as well as from puppet scholars (Kaplin, 1999)). Various of the aforementioned projects use game technologies to either provide effective input methods, rendering output, or both. Their accessibility, affordability, and stable performance make game controllers a suitable input option. Another valuable feature is the extendibility. Performative objects, such as puppets, often have widely varying control mechanisms with unique mappings and effects. The task, thus, cannot be to develop a single control scheme but to test one that is flexible enough to fit many other objects. Especially in international projects this element of flexible scalability is important, as noted in the NETConnect program that involved multiple European partners in a digital heritage development and ultimately used game input and output technology for its purpose (Amicis, Girardi, Andreolli, & Conti, 2009). Game technology allows for this kind of scaling as well as integration of compatible and accessible technology.

The central deliverable of the proposed research is a combination of a traditional digital archive with a 3D system that provide access to the **operation** of the virtual objects. While there are solutions to visualization and reproduction, virtual object manipulation remains an open question for digital archives and will be the focus of this project.
The development of the game system will be conducted in connection to the data scheme and formats that currently allow for representation (2D and 3D). In order to allow a future integration of the new system into existent digital archives, it will be developed in relationship to the existent database structures. The focus will be the design and implementation of the necessary interactive system allowing users to “play” with the virtual objects for desktop and VR. This new component is developed as a new digital opportunity standing next to existing digital object archiving options such as file download for 3D printing or 3D visualizations. It is not meant to be disconnected from these components and will reference e.g. the same meta tag system as the existing

database as well as data optimization that re-uses as much existing data structures (such as obj data files).

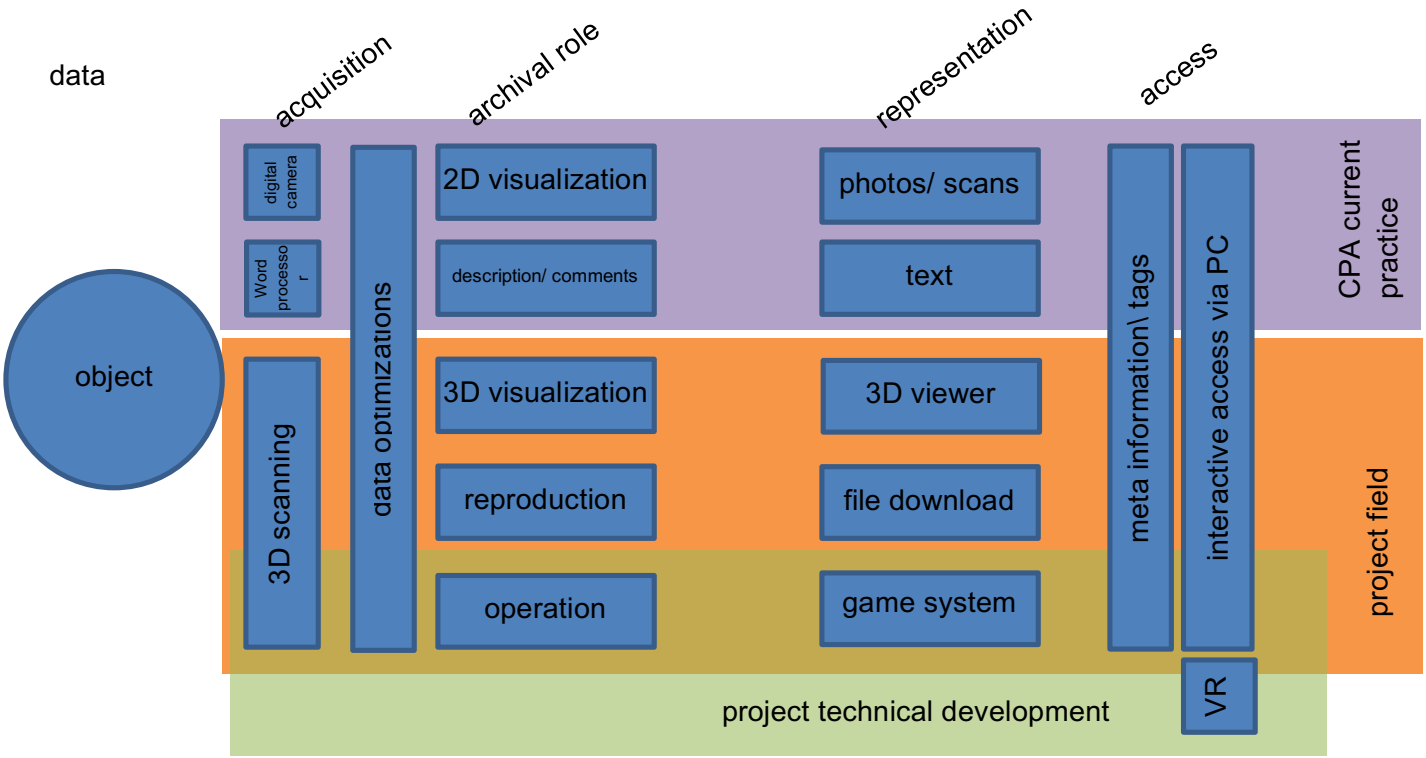

Figure 1 simplified breakdown of object data acquisition, optimization, functionality and accessibility in the proposed system and in the existent archive

The acquisition of the 3D data through scanning and modeling sets the ground for the actual research at hand and allows a clean data set. 3D scanning itself is only the data gathering stage to allow for the main deliverables of the project: the **development of a game-like system to provide access to virtual manipulation of 3D objects and the integration of this system into a sample database**.
The chosen game engine (Unity) does support import of the same file format most 3D printers use (obj) but needs additional information such as texture maps, mesh clean up, and further treatment of 3D files such as object separation and material assignment. All 3D objects need to be optimized for real-time 3D representation and later for manipulation. Technically, this includes geometry optimization, material assignment, possible rigging, and export of the data.
The main deliverable is the create of a flexible game-like system that allows direct manipulation of virtual objects to explore not only their appearance but also their functionality in 3D. This system needs to be flexible enough to remain relevant for later adaption to other performative objects. Thus, the researchers will sample 12-15 puppets for four very different key puppet control principles: shadow, rod, hand, and string. Using tangible interfaces and game design approaches, we will design different mappings for each of the controls and implement them. Users will have access to these mappings in **two conditions**:

1) **consumer level home computers systems** (PC and Mac), which will support home users and kiosk-like installation booths;
2) **current market level VR technology** (Oculus Rift and/ or Vive), which will support more immersive knowledge spaces.

The controls in both conditions do not intend to accurately recreate the actual physical puppet controls but will be remediations of the original controls. That means that they necessarily differ from the original mechanisms (e.g. we cannot simulate the weight of a marionette through a controller) but they use game-inspired mappings to translate key components of the puppet's expression into the virtual. The VR component will have different interface mappings than the desktop solution (the HTC Vive has its own freehand controls that differ significantly from the desktop keyboard and mouse conditions). We will test all of these mappings with puppeteers from the Center for Puppetry Arts (see section *7 Sustainability and Evaluation* below). Identifying and implementing these mappings is a core research task for the overall project.

The final version targets an **open and flexible platform**, allowing for fast additions of more puppets not only from the Center for Puppetry Arts' archive but also from other collections such as the Ballard Institute. The tool will be freely available for download (hosted by Georgia Tech), allowing experts as well as interested amateurs access to this novel archiving and research tool. It will run stationary (e.g. as a museum kiosk) as well as locally (e.g. in a private home).

2 Background of Applicant

The project combines expertise in technology and digital media (Georgia Tech) with expertise in puppetry and puppet archives (Center for Puppetry Arts).
The School of Literature, Media, and Communication (LMC) at the Georgia Institute of Technology operates under the mission to apply "humanistic perspectives on a technological world." It is part of the liberal arts college in a top ranking technical institution. Within the School of LMC, the **Digital Media program** hosts the school's graduate programs: a M.Sci. in Digital Media, a co-taught M.Sci. in Human Computer Interaction, and a Ph.D. in Digital Media. The unit is located in the Technology Square Research Building (TSRB) at Georgia Tech and is part of the interdisciplinary GVU research center within Georgia Tech. Nitsche's own lab focuses on the design and development of interfaces that support creativity through new forms of access and expression. The lab is located in TSRB (room 325) and equipped with high-end computers for software and hardware development, to build and test equipment, microcontroller programmers, digital cameras, large-screen displays, projectors, a surround sound system, a 3D scanner, and other electronics tools. Additionally, the lab has a range of physical construction and craft tools, such as a workbench and a soldering station. The lab includes space for demos and installation pieces, and for undergraduate and graduate students to meet and collaborate. The lab also has multiple laptops and desktops, a Cintiq station for 2D work, VR tools (Oculus Rift dk 1 and 2, HTC Vive), fixed and mobile projectors, Pelican cases for equipment transportation, and prototyping equipment for fieldwork. The DM unit has its own system administrator, who is maintaining the server infrastructure for the school of LMC. The server for this project will be run through Georgia Tech's OIT.

PI Nitsche also has access to the facilities of the collaborative GVU research center that include an own prototyping lab that provides a variety of rapid prototyping and physical fabrication equipment. This includes a machine shop for metal/woodworking, 3D printer, laser cutter, and various other tools for milling, physical computing, and rapid prototyping. Other facilities include a usability lab, various meeting and conference rooms, as well as administrative support.
Nitsche's past work focused on 3D digital media (e.g. (Nitsche, 2009)) and interaction design (e.g. (Nitsche, 2011; Nitsche & Kirschner, 2013)). It has dealt with various elements of puppetry, including puppet interfaces for game environments (Hunt, Moore, West, & Nitsche, 2006), for cell phones as controllers (Nitsche & Nayak, 2012) and NSF funded work on puppets as tangible interfaces (Nitsche, Mazalek, & Clifton, 2013). His practical work included artistic collaborations with the CPA (as part of their Experimental Theater Workshop 2011) as well as collaborations with the Center for Puppetry Arts' educational programs (Peer, Nitsche, & (La)Schaffer, 2014).

The **Center for Puppetry Arts** (CPA) opened to the public on September 23, 1978. Today, the CPA is the largest non-profit organization in the country solely dedicated to the art of puppetry. One of Atlanta's most accessible arts institutions, CPA provides approximately 70,000 free or greatly reduced admissions to underserved audiences each year. With an annual budget of $3.5 million and a full- and part-time staff of 70, CPA offers a permanent museum and temporary exhibitions in addition to more than 1,200 performances, tours, workshops, and other events annually. CPA focuses its activities on three interrelated areas of programming – Museum, Performance, and Education. With a collection of over 3,600 puppets from around the world, as well as an extensive puppetry library and archives, CPA's Museum serves scholars and the general public alike. The Jim Henson Family selected the CPA as the home for the bulk of their collection. This includes over 500 objects from the Jim Henson Family Collection. CPA's main facility resides in the former Spring Street Elementary School. The library and museum storage spaces occupy old classrooms that have been retrofitted for collections storage. A new 7,500 sq ft exhibition space to the Center opened in Fall 2015 featuring a global gallery, containing over 150 objects from the museum's international collection, and the country's most comprehensive exhibit of Jim Henson's work. The Education program presents more than 1,000 workshops annually for children and adults. Using webinars and two-way interactive videoconferencing technology, CPA's Distance Learning programs have been broadcast in 49 states and four other countries. CPA has a broad and diverse audience, representative of the demographics of Atlanta as a whole. Of the more than 250,000 annual admissions to ticketed CPA programs (including performances, workshops, and exhibitions), over 50,000 admissions annually are exclusively for the CPA's on-site museum exhibitions. The CPA's museum audience is 46% minority, a figure that reflects the demographics of metro Atlanta as a whole. Since 1983, CPA supports the humanities also through traveling exhibits, starting with *Puppetry of China*, in 1983. Since then, CPA has produced numerous temporary and traveling exhibitions on a variety of topics and puppeteers, such as: Karagöz and Turkish shadow theatre, masks, Julie Taymor, and puppetry in India. Many of these exhibitions also included gallery catalogs and were created in collaboration with humanities scholars from various institutions.

3 History, Scope, and Duration

Existing work at other institutions include Chen et al., who exemplify a meta-data scheme for cultural practices using puppet objects as their example (Chen, Chan, Huang, & Lin, 2006). They particularly focus on an inclusion of the crafting and puppet production process in the data collection. This offers some reference but Chen's motivation did not originate from puppets as objects themselves but from archival documentation of production techniques. We know of no other critical work that would relate to puppets as archival data objects. In comparison, 3D technology has been widely discussed and largely accepted as an important part in the digital humanities.
There are a number of relevant puppet collections in the United States including collection at the Cook/ Marks Collection (Seattle, WA), the Detroit Institute of the Arts (Detroit, MI), the Fowler Museum of Cultural History at UCLA (Los Angeles, CA), the CPA (Atlanta, GA), the Ballard Institute and Museum of Puppetry at the University of Connecticut (Storrs, CT). All of these collections have substantial physical archives and present relevant cultural collections but due to wear and tear, they cannot make these collections available for direct interaction to students, visitors, practicing puppeteer, or scholars. There is no lending program or shared database of historic puppets. If a scholar wants to explore a particular puppet e.g. at the CPA, one must travel to Atlanta and visit the center during opening hours to request access to the puppet. Even then, it will only be handled by the staff and will not be handed out to the visitor.
There are also numerous international puppet collections but a survey of their online offerings highlights the shortcomings. Even laudable and large-scale efforts are difficult to adapt. The international *Union Internationale de la Marionette* (UNIMA) supported the *Portail des Arts de la Marionnette* online database project includes video, scanned images and texts, as well as photos. It has an impressive amount of entries (UNIMA claims over 30,000 exhibits) but due to its focus on French collections, it is not representative for the overall field (e.g. Henson, as a seminal US puppeteer is not included), it is structured along a range of pre-defined "chapters" and French meta-information might not suit other collections. The Dutch *Poppelspel Museum* includes an online archive of 4,000 items but focuses on posters and print. Other archives have very limited online offerings. For example, the *English National Puppetry Archive* shows 20 entries, the *Scottish Mask and Puppet Centre* has no online presence. The biggest national collections in the US are held in the *Cook/ Marks Collection* (Seattle, WA) (basic images of selected museum exhibits are online, no searchable archive), the *Detroit Institute of the Arts* (Detroit, MI) (only 16 online entries classified as "puppet"), the *Fowler Museum of Cultural History* (Los Angeles, CA) (14 puppet objects online), the *CPA* (a rich "chapter" based online presence, no advanced database functionality), the *Ballard Institute and Museum of Puppetry* (Storrs, CT) (no online archive). None of these archives uses 3D scanning and none has any form of interactive "play" functions. It is apparent that the field is critically underdeveloped in terms of archive development even compared to other domains such as architecture, fine art, or literature.
Some digital puppetry approaches were realized as educational project (e.g. (Bottoni et al., 2008; Widjajanto, Lund, & Schelhowe, 2008)) but these lack integration into existing archives. The danger here is to fully focus on the "playfulness" of the interactive puppet and neglect the role of the archived object.

Nitsche's own work includes various prototypes using different control mechanisms from cell phones (Nitsche & Nayak, 2012), to custom-built interfaces for puppetry and film production (Nitsche & Kirschner, 2013), to the use of puppetry in cognitive science (Mazalek et al., 2011), to novel puppetry construction approaches (Peer et al., 2014).

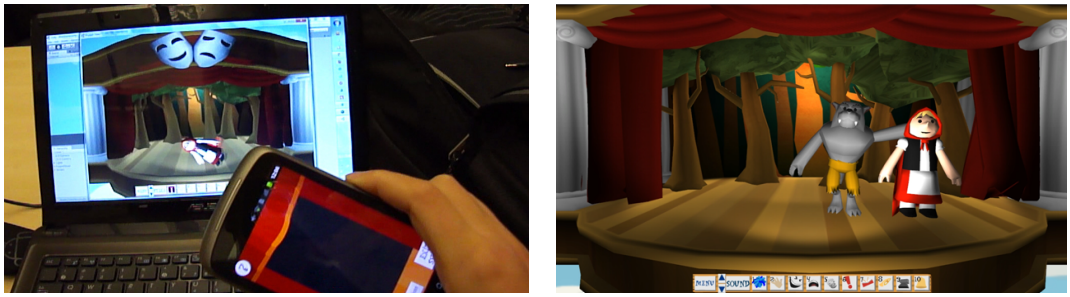

Figure 2 Cell Phone Puppets (Nitsche & Nayak, 2012): puppet control using cell phones

These Georgia Tech-based projects remained focused on the technical exploration but eventually led to a direct **collaboration** between PI Nitsche and the Center for Puppetry Arts started in 2011, when he co-directed a hybrid puppetry performance for their Experimental Theater Workshop. This collaboration has continued since with puppeteers and educators presenting in classes taught by Nitsche and Georgia Tech researchers attending workshops at the CPA.
The proposed work builds on the expertise collected in these projects to optimize a more general and accessible system with the help of Fritz and Baumgartner as the key consultants from the Center for Puppetry Arts. To explore the particular challenges that puppets pose to 3D scanning, students at Georgia Tech collaborated with the Center for Puppetry Arts on **preliminary 3D tests** to scan puppets and puppet parts.

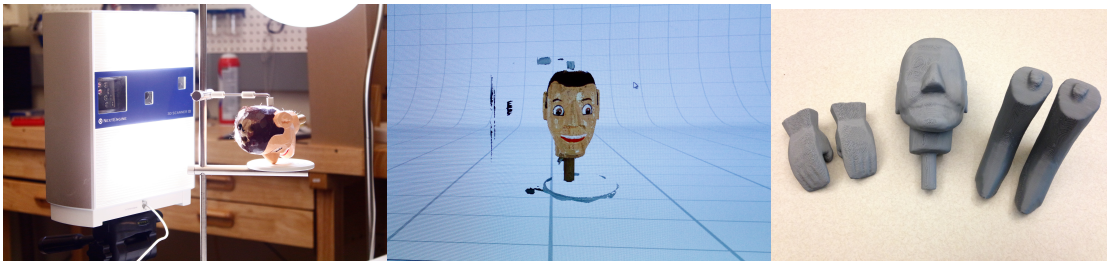

Figure 3 Puppet object scan test from initial scan of individual parts to 3D model in the CPA's archive to the 3D data, and the 3D printed reference model

Two technologies were tested: a Skanect set up, which uses the widely available Kinect sensor, and a Next 2.0 3D scanner. The Next scanner is currently among the best-selling 3D scanning devices on the market and one possible benchmark technology due to its ease of operation and price. The aim was to test feasibility of the scanning set up, including mobility, level of detail, and re-use for 3D printing. Skanect was quickly rejected as a feasible option due to level of detail issues. The Next scanning process was tested in the Digital Media labs as well as in the archive of the Center for Puppetry Arts. A sample workflow from scanning to the ScanStudio software to 3D print outs of the models is illustrated above (fig. 3). However, the same tests also presented challenges that puppet materials pose to 3D scanning (fig. 4).

Figure 4 Harlequin puppet scan test from handling in the archive, to scan, to initial 3D data

While the Next scanner is principally portable (it operates as a standing unit), the preliminary test indicated that a more flexible approach would be better suited to scan not only bigger models but also provides higher portability. The project targets the use of the *Scanify* scanner by *Fuel3D*, a handheld device with slightly lower resolution but it does not depend on the rotation that the Next uses to scan a whole object.

4 Methodology and Standards

Archiving Performative Objects targets the integration of an interactive digital game-like system (desktop and VR) into an existing digital archive. The underlying question is how to provide access to an object's functionality "in use" by people through remediation. *Archiving Performative Objects* builds the foundation for larger work to follow. Its scope does not allow the full adjustment of an existing database and instead focuses on developing and populating a sample data schema. The main research addresses the development, design, and implementation of this system. But this development is conducted in reference to the existing practices.

It works with the puppet collection at the CPA, which uses the PastPerfect database to maintain a digital record for each collected object. These records contain information provided by donors as well as research completed by museum staff. In order to avoid compromising the existing database, the project will create a sample database build around the original entries. To structure the metadata, the project will explore the Metadata Object Description Schema (MODS) and the Metadata for Architectural Contents in Europe (MACE) model. Both schemas are XML-based. Particularly MACE is suited for 3D content as it was developed to connect architectural 3D data sets across Europe (Boeykens & Bogani, 2007) but it is not (yet) optimized for performative objects. The goal here is not to design a full new data schema but to test a prototype that covers the functionality of the digital object. A completely new data schema for functionality would be more object-based and include elements such as different weight of components, their material, or operational relationship to each other instead of focusing e.g. on real world location (a particular addition in MACE). Developing a complete new data schema is not in the scope of *Archiving Performative Objects* but the project will present a working prototype for future work focused on such as task.

3D files will be originally stored as Object files (.obj) which can be either ASCII or binary (.mod). Texture data will be saved as .jpg or .tif. Each 3D model will need to be prepared (e.g. rigged) for interactive control and re-exported.

The 3D game system will be based on Unity and operate as a single standing application that loads the prepared 3D files. Unity supports export of its game projects

into multiple platforms, including mobile, various game consoles, browser-based, PC/ Mac, and VR. *Archiving Performative Objects* focuses on desktop and VR design. Unity supports additional scripting in an own scripting language (Unity Script) and C#. Since Unity 5 was launched they focus on C# support, which supports flexibility of the underlying engine. All project files will be made openly available to allow scholars direct manipulation and experimentation with the material developed for this project.

5 Work Plan

January – May 2017

- Purchase and installation of equipment (Nitsche)
- Selection of sample puppets from the Archive (Fritz, Nitsche)
- Scan on sample objects (GRA supervised by Nitsche, consulted by Fritz)
- Optimization of 3D data (GRA, undergraduate students, supervised by Nitsche)
- Set up of sample database (GRA supervised by Nitsche, consulted by Fritz)
- Technology test of game engine (desktop version) (GRA supervised by Nitsche)

> Deliverable: 3D data; initial database set up; technology selection complete; technology sample tested

June – August 2017

- Set up project web site (undergrad, Nitsche)
- Design of the game system mappings (Nitsche, Fritz)
- Revisions and adjustments (Baumgartner, Fritz, Nitsche)
- Launch project web site (undergrad, Nitsche)
- Test export of 3D files to preliminary engine (Nitsche)
- Desktop version test with existent puppets (Nitsche, undergrad)

> Deliverable: interaction mapping design for the game system (first iteration); online documentation; continued workflow testing; 3D models working in engine

August – December 2017

- Finalize game system (GRA, Nitsche)
- Test and re-iterate game system (GRA, Nitsche)
- Align the interface controls for VR version (GRA, Nitsche, undergrad)
- Include game system to online portal of CPA (undergrad, Fritz, Nitsche)
- Evaluate system: object expression (Baumgartner, Nitsche)
- Evaluate system: archive (Fritz, Nitsche)
- Write White Paper on system (Nitsche, GRA)

> Deliverable: game system; preliminary expert evaluation; white paper summary; constantly updated online documentation

6 Staff

Michael Nitsche (Project PI) Associate Professor in Digital Media at the School of Literature, Media & Communication, Georgia Institute of Technology. Nitsche will supervise the 3D work, tool design and development as well as its dissemination and release. He will also organize the collaboration with the CPA. Nitsche holds a Ph.D. in Architecture from the University of Cambridge, UK and a M.A. in Drama from the Freie Universität Berlin, GER. He is the Director of Graduate Studies for the Digital Media program at the Georgia Tech where he combines Performance Studies, craft research,

HCI, and media studies. He has received funding from the NSF, Alcatel Lucent, Turner, and GCATT. His publications include the books *Video Game Spaces* (2009) and *The Machinima Reader* (2011, co-editor), both MIT Press.

Kelsey Fritz (Advisor/ Consultant) Exhibitions Director at the Center for Puppetry Arts. Fritz will be the main consultant on the digitalization of the selected historic puppets from the Center's archives and the modifications to the existing database, which she maintains at the CPA. Kelsey Fritz holds an M.A. in history and public history from American University and a B.A.in history from Georgia State University. She has been with the Center for Puppetry Arts since 2012. Originally the Collections Manager, Ms. Fritz has been working as the Exhibitions Director since October 2013. Prior to CPA, Ms. Fritz worked as an exhibitions technician with the National Archives and Records Administration in Washington, DC.

Aretta Baumgartner (Advisor/ Consultant) Educational Director at the Center for Puppetry Arts. Baumgartner will be the main consultant in the initial design of the virtual operation mapping and assist in the organization of the evaluation. Baumgartner joined the CPA in 2011 and has over 20 years of experience as a teaching artist and puppeteer. She has performed nationally and internationally and is member of numerous puppetry organizations including UNIMA-USA. Baumgartner has a Master of Arts in Communication Arts from the University of Cincinnati and a Bachelor of Arts in Theatre Arts from Ashland University.

The project will fund one **Graduate Research Assistant**, who will be responsible for the technical implementation of the tools and the web site. The GRA will be recruited from the Digital Media MS program at Georgia Tech.

The project will furthermore involve **Undergraduate Assistants**, hired on an hourly basis, to assist in the data optimization and database implementation. These will be recruited from the Computational Media program at Georgia Tech.

7 Sustainability and Evaluation

Evaluation of the project will be conducted through the participating archive experts (especially Fritz) and expert puppeteers at the CPA (facilitated by Aretta Baumgartner). Key evaluating criteria for this Tier I project will be functionality of the chosen designs in the context of existent digital archives and the efficiency of capturing an object's expressive range.

Evaluation of the **digital archive integration** will be conducted through Kelsey Fritz at the CPA. In addition, the results will be distributed to other puppetry research centers – such as the Ballard Institute (University of Connecticut) – particularly John Bell (Director) and Emily Wicks (Program Assistant). Neither of them will be involved in the development phase and their feedback will help the researchers to assess feasibility.

Evaluation of the **interactive features** will be conducted through Aretta Baumgartner and expert puppeteers at the CPS. For this evaluation, the puppeteers will perform basic puppet movements (e.g. walk, gesture, jump, or sit down) and the performance of the virtual puppet will be judged in comparison to the digital one through a comparative

visual test set up. Evaluation will be conducted in the usability labs at Georgia Tech. The nature of a Tier I grant does not allow for a full-fledged comparative usability study but the project targets a first probing evaluation with these expert groups.
In addition, Nancy Lohman Staub, founder of the CPA's museum and current member of the UNIMA Heritage Commission, will advise the project throughout its stages and provide for a channel to disseminate the result within UNIMA.
To implement the findings of this Tier I proposal on a larger scale, PI Nitsche and the collaborators from the CPA will apply for a NEH Digital Humanities Start Up and/ or a NEH Implementation grant to implement the archiving of these objects' functionality on a larger scale in the Center's collection and test it in other locations. With the prototype in place, we also look at other usage of such a tool e.g. for technical museums and their archives. A second target will be industry funds that support innovative use of novel interface technology in the humanities – such as Samsung or Google Research grants.

8 Dissemination and Intended Audience

The initial domestic audience of the research are puppet **archives** of performative objects. These archives inform the work of scholars domestically as well as internationally in many fields from performance studies to history and religious studies. They are also important references for performers, directors, and puppet builders. The first target remains the archivists at the Center for Puppetry Arts followed by the Ballard Institute at the University of Connecticut but the results can also inform wider collections such as the Smithsonian's.
Internationally, the first target audience will be the *Union Internationale de la Marionette* (UNIMA), the leading international puppetry association. UNIMA is the central body for international puppet art and research efforts and has been involved in various conservation and heritage efforts itself. The Center for Puppetry Arts is the home institution for the US branch of UNIMA and the researchers are already in contact with Nancy Lohman Staub from the UNIMA Heritage Commission about the project.
To publish the findings as wide as possible in the community, the researchers will target a publication in Puppetry International, the leading journal in this field. Technical details will be targeted at publications like the ACM Journal for Computing and Cultural Heritage and the Journal of Cultural Heritage.

The project deploys **game design and human computer** interaction approaches to develop the necessary procedural system. In return, findings will apply to these fields and inform virtual heritage research within the Digital Humanities as well as interface design in HCI. The project relates to and informs the context-focused shift in HCI research that sees every interaction as situated in a social and cultural context. Particularly VR remains in need of such work.
That is why, beyond the area of puppetry, results will be disseminated at relevant events, including Digital Heritage but also interaction design conferences with social science components (particularly threads at the ACM conferences CHI and TEI).

All results, designs, and data schemata will be openly shared on the project's web site. Where possible, the 3D data will also be shared freely. Technical findings regarding 3D scans of puppets will be described in a White Paper and also freely distributed.