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Heritage is a living, active part of our communities. Conservation needs to be both responsive to each individual situation and responsible within its own set of wider professional ethics. As conservators, we are aware that our work takes place within a larger cultural context.

Whilst preservation remains at the core of what we do, we are at the intersection of materials-based conservation and values-based approaches.

At the 2018 NZCCM Conference in Auckland, we welcome discussion on current conservation practices and the challenges we face. This is an opportunity to share and hear about treatment methodologies, advances in the use and research of materials, solutions for display and storage, and ways in which the context of an artwork or object has informed decision making.

HANGING ON THE EDGE: USING DIGITAL SCANNING AND COMPUTER NUMERICAL CONTROLLED (CNC) ROUTER TECHNOLOGY TO CREATE BESPOKE STORAGE FORMS.

ANNE PERANTEAU

An acquisition of three gowns by artist Lindah Lepou presented unique storage challenges. The gowns featured upcycled natural and plastic fibers and tapa cloth sewn over a foundation of cotton twill fabric. The substantial weight and volume of the garments,as well as storage space limitations, meant it was necessary to devise a method of safely hanging them. 3D photogrammetry scanning and computer numerical control (CNC) router carving were used to produce Ethafoam body forms which were subsequently converted into hanging supports for the gowns.

KEYWORDS: *costume mounting; costume storage; 3D digital scanning; CNC router carving; textile conservation*

1. INTRODUCTION

In 2017, Museum of New Zealand Te Papa Tongarewa acquired a significant collection of contemporary Pacific fashion garments by the artist Lindah Lepou, expanding on the holdings of Lepou's works already in the collection. Three gowns presented a particular challenge with regard to storage due to their weight, volume and delicate surfaces. As an example, the gown *Wild Victorian*, an award winner at Westfield Style Pasifika in 2005, features a strapless, fitted bodice and a full skirt with tiers of pandanus strips sewn to a cotton drill foundation (fig. 1). Transit of the gown in an oversized box was observed to result in fracturing of the pandanus and loss of material. Moreover, the volume of the garment meant that a storage box would be larger than the shelving could accommodate. Permanently storing the gowns on dressmaker's torsos on stands was ruled out due to lack of dedicated floor space in the Pacific store. A solution had to be found that would enable these gowns to be stored on a hanger. Fiberglass torsos are also not ideal for storage due to the off-gassing of the resin components. 3D scanning in conjunction with computer numerical controlled router technology was explored as a way of producing archival Ethafoam forms that could be customised to suit the requirements of three of Lepou's garments. The resulting forms allow the gowns to be hung in a manner that lessens the risk of damage and distortion of the garments.

2. LINDAH LEPOU'S GOWNS

Lindah Lepou is an award-winning artist of Samoan and European descent who identifies as fa'afafine. She works across music, film and at the confluence of art and fashion. Lepou uses the term "Pacific Couture" to describe how her practice is informed by a unique Pacific identity (http://www.lindahlepou.com/about-lindah/).

The gowns that were the focus of this project were made between 2005 and 2011. *EcoChic* (2009) is a full length gown with a train, made out of a sturdy black cotton fabric (fig. 2). Overlapping tiers of black plastic raffia have been machine sewn to the foundation over the shoulders and bust, and from the hips to the hem. The gown weighs approximately 4 kg. Similarly, *Wild Victorian* (2005) is full length with a slight train, constructed of a sturdy cotton drill foundation layer, covered with pandanus strips. The strapless bodice has been made by

weaving pandanus strips over the surface of the very fitted profile. This is contrasted by the voluminous skirts which have overlapping tiers of pandanus strips sewn to the cotton foundation layer. These pandanus strips were obtained by "unpicking" mats from discount variety shops (e.g. 2 Dollar Shop) and hence the strips have a regular crimp set into them. The strips are somewhat brittle and at risk of fracturing. Lepou's tapa wedding dress, *Siaposu'isu'i* (2011) was commissioned to feature alongside the *Unveiled* touring exhibition from the Victoria & Albert Museum, London. Strips of undecorated tapa cloth are machine sewn to a white cotton drill foundation, almost completely obscuring it. This gown weighs over 5 kg (fig. 3).

FIG. 1: Wild Victorian, 2005, by Lindah Lepou. Cotton and pandanus fiber. Te Papa (FE013157)

FIG. 2: EcoChic, 2009, Auckland, by Lindah Lepou. Cotton and polypropylene. Te Papa (FE013156)

FIG. 3: Siaposu'isu'i, Wedding Dress, 2011, Auckland, by Lindah Lepou. Cotton and barkcloth. Commissioned 2011. © Te Papa. CC BY-NC-ND 4.0. Te Papa (GH017349)

3. THE ROLE OF THE STORAGE FORM

It is widely recognized that costumes require preparation for display to achieve a convincing and compelling presentation. Choosing or creating the right display form also plays an important role of distributing weight in such a way that it is not borne by seams and areas of potential weakness, causing distortion or damage (Flecker 2007). In selecting the shape of the form on which to hang Lepou's gowns, an awareness that the weight of the skirts could put undue stress on the shoulder seams guided the choice of a hip-length form so that the garment would be supported through the lower torso area. In the case of the strapless gown, it could not be hung without "padding up" around the hip area to keep it in place. Fortunately, all of the contemporary gowns fit on a standard sized dressmaker's torso with minimal adjustments needed to achieve a good fit. The starting point for creating the hanging torso forms was an existing size 8 fiberglass dressmaker's torso.

4. 3D SCANNING/CNC

In recent years, the affordability and ease of use of 3D scanning technology has resulted in it being adapted by heritage professionals for documentation, replication, garment storage and display (Wachowiak and Karas 2009, Niinimaa and Sundstrom 2017, Scaturro and Healy 2017). The workflow generally consists of four steps: scanning, editing, CNC routing (or 3D printing) and post-production finishing of the forms.

Scanning is typically carried out using either laser line scanners or by using a photogrammetric process. Put very simply, the laser scanner method uses incident and reflected light beams to triangulate distances as the scanner is moved around the object (or as the object is rotated), thereby generating a mesh map of the scanned surface. Photogrammetry uses photographs and pixel data to create surface maps. The selection of method depends on variables such as desired accuracy and resolution of detail, the scale of the object, structure or area being scanned, and whether colour information needs to be captured (http://www.factum-arte.com/pag/701/3D-Scanning-for-Cultural-Heritage-Conservation). Once the scan is complete, software is used to correct any flaws or gaps in the model and to prepare the file for 3D printing or CNC routing. For routing, additional software is needed to communicate a set of coordinates (XYZ and rotating AB axes) in g code.

To generate the Ethafoam dressmaker's torso for the gowns, a fiberglass torso was scanned using a photogrammetric process. A Canon 600D fitted with a Speedlite flash was used to capture 150 images of the torso form as it was rotated on an automated programmable turntable. Images were processed using Lightroom, 3DFlow Zephyr and Meshlab software to obtain a 3D file ready for routing. The g code for the router was processed using Aspire 3D software. The time required to capture and process the file was approximately 2 hours. The forms were milled in two halves with the join oriented along the sides, from neck to hip (fig. 4). Taking into account the thickness of the Ethafoam plank, this minimized the number of joins and allowed for the insertion of tubular aluminium hanging hardware.

FIG. 4: The Ethafoam forms being milled by the CNC router at the Te Mahi workshop.

5. POST PRODUCTION

The surface of the milled Ethafoam was initially slightly prone to shedding residual bits of polyethylene foam but it was free of any sharp edges. Once the forms, still in halves, were received from the CNC routing workshop they were fitted with the tubular aluminium hardware (fig. 5). The hardware was approximately T-shaped, consisting of a horizontal bar positioned

below the form joined to a long stem terminating in a hook portion to facilitate hanging. The hook portion extended 200 mm above the top of the neck of the torso form, allowing for the volume of the plastic raffia around the neckline of the *EcoChic* gown. The hardware was set in to a central axis carved in the forms and the halves were joined with hot melt glue.

After the forms were joined and fitted with the hardware, they were covered with a layer of thin, heat-fused polyester felt and 100% cotton jersey. Prior to covering the form for the strapless gown, *Wild Victorian,* it was additionally modified to ensure that the gown would remain in place and not slip down off the form (fig. 6). Cylindrical rods of closed cell polyethylene foam 70 mm in diameter were cut in half and the flat edge was hot glued around the form just below the waist. Additional padding was inserted around these lengths of foam and the form was covered in cotton jersey (fig. 7).

The area where the gowns will be stored is also a work area, so there are implications for light exposure for those garments stored in hanging bays. To protect the garments from light and dust, garment covers were made from silk or calico, depending on the gown (fig 8). Prior to storing the gowns, they were imaged on mannequins for the museum's Collections Online platform and to create a baseline record of their condition in the KEmu database.

FIG. 5: Tubular aluminium hanging hardware being inserted into the forms at the Triptych workshop.

FIG. 6: Modification of the form for *Wild Victorian*

FIG. 7: *Wild Victorian* on the hanging bodyform.

FIG. 8: Gown hanging on the storage form with covers made

6. CONCLUSION

The acquisition of Lindah Lepou's gowns posed a storage challenge that provided an opportunity to become familiar with a relatively new technology. The fact that the gowns were contemporary rather than having an historic period silhouette meant that little time was required for additionally modifying the milled Ethafoam torsos; one shape could be easily modified to suit the three gowns. The good state of the cotton fabric that Lepou has used as the foundation layer for her gowns meant that although there was some surface fragility, the gowns were essentially robust and suited to hanging storage.

The technology saved a significant amount of staff time when compared to other methods for creating shaped storage forms made out of carved Ethafoam discs. Fosshape, a heat-set semi-rigid felt, has also been used to support some types of objects for storage and on display. It would have been equally time consuming to create storage forms using Fosshape and the material is not rigid enough to bear the weight of these gowns when hanging. The cost of each form was based on the production of 5 forms and was approximately $575 (hanging hardware inclusive), making these forms slightly more expensive than a standard fiberglass dressmaker's torso and stand. However they are preferable for long term storage because the Ethafoam has been Oddy tested and unlike fiberglass does not contain volatile resin components that off-gas over time. The felt and fabric coverings have not been Oddy tested but the polyester felt is resin free and heat bonded, and the fabrics have been washed to remove any fabric finishes.

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SOURCES OF MATERIALS & CONTRACTED SERVICES

3D scanning
Z3D
https://www.z3d.nz/
Wellington
New Zealand
+ 64 4 390 3322

CNC routing
Te Mahi
https://www.temahi.co.nz/cnc-router/
Wellington
New Zealand

Hanger hardware
Triptych Conservation
triptych.co.nz
Wellington
New Zealand

Polyethylene foam rod
AE Karsten
www.karsten.co.nz
Auckland
New Zealand
+64 9 266 2781

Polyester felt, 150 gsm, needled
Textile Products, product PTN5020
Auckland
New Zealand
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Cotton jersey
John Rainger
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