RECORDING AND REPLICATING A TSIMSHIAN STONE MASK BY CLOSE RANGE PHOTOGRAMMETRY

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ABSTRACT

The replication of "fine art objects" presents unique problems to the conservator. The fragility and sensitive nature of the object's elements requires alternatives to the direct contact replication techniques presently used (i.e. moulding and casting).

This paper describes a method to produce a precise replica of one of Canada's most prized ethnographic treasures. The method employs the use of close-range stereophotogrammetry in combination with the work of the skilled model maker and conservator. Accuracy, cost and minimal object contact supported the choice of the use of photogrammetry. An evaluation of the accuracy of the replica is presented.

RÉSUMÉ

La reproduction d'objets d'art pose des problèmes uniques de conservation. En effet, la fragilité et la délicatesse de leurs éléments nécessitent des méthodes plus sûres que les techniques d'empreinte et de moulage généralement employées.

Cette communication décrit une méthode qui a été utilisée pour la reproduction de l'un des plus précieux artefacts du Canada. Cette méthode repose sur l'utilisation combinée de la photogrammétrie à courte distance et des travaux d'un maquettiste expert et d'un conservateur. Le recours à la photogrammétrie se justifie par des raisons de précision, de coût et de contacts minimisés avec l'objet. Une évaluation de la précision y est aussi présentée.

1.0 INTRODUCTION

1.1 The Artifact

The Tsimshian mask is a unsighted stone mask (Fig. 1) collected by Israel Wood Powell (then Superintendent of Indian Affairs for British Columbia) on a trip North in the summer of 1879 at the Tsimshian Indian village of Kitkatla on Dolphin Island. In December of the same year, he sent the artifact to Ottawa where it is now in the Museum of Man.

Seven years earlier a young French explorer by the name of Alphonse Pinart had collected a similar but sighted mask in the village of Metlakatla, and returned to Paris placing this artifact into the Musée de L'Homme.

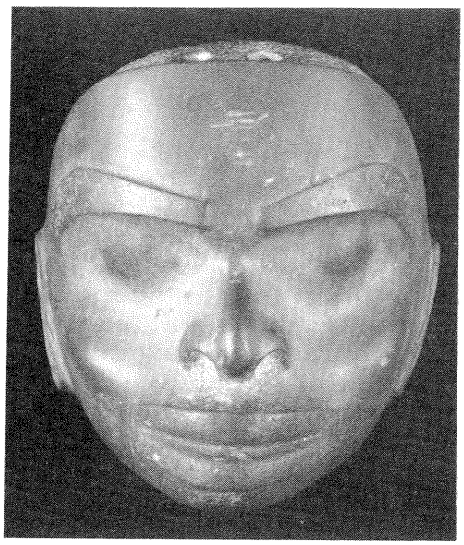

Fig. 1 The Tsimshian Stone Mask

In 1975 an international exhibition held in Vancouver, Canada entitled "Images Stone BC" brought the two artifacts together for the first time. It was discovered that the slightly more delicate face of the sighted mask from Paris fitted snugly inside the unsighted mask thus revealing that the two masks are twins. (Fig. 2).

The Canadian mask, weighing 4.75 kg, is approximately 235 mm long, 225 mm wide and has a depth of 155 mm. Conservation analysis has identified the mask to be of soapstone with painted areas of red iron oxide and green earth pigments.

The Canadian mask is regarded to be one of the country's finest treasures. It is planned to be on prominent display in Canada's new national museum due to open in 1988. The impact and significance of this display would be sadly lacking if its twin from Paris would not be present.

Fig. 2 The Canada and French Masks

1.2 Purpose of Replication

Museum policy is to have significant artifacts technically analysed prior to display. One of the government agencies entrusted with this responsibility is the Canadian Conservation Institute (CCI).

Their mandate with respect to the mask was complete analysis including effective and safe replication. Reasoning for the emphasis on replication is seen as an alternative solution to one of the countries giving up a national treasure.

The poor adhesion of the pigments and the soapstones' porosity precluded the use of traditional moulding and casting techniques. The use of close-range photogrammetry was selected as a viable alternative.

Environment Canada's Heritage Recording Services (HRS) section was retained to undertake the detailed recording. The record produced was to provide the following:

a) detailed artifact documentation for spatial analysis and posterity;[1]

b) an accurate, non-destructive method for replication;

c) baseline data for conservation, archaeology and anthropological research for a subsequent detailed comparison between the Paris and Ottawa masks.

2.0 METHODOLOGY

2.1 Photography and Control Survey

The delicate nature of the mask required for recording purposes, that it rest in a horizontal position. A Wild P31 metric camera, custom fitted with a 1.0 m focusing ring, was positioned above the artifact, perpendicular to the surface supporting the mask. Displacing the camera in the horizontal direction allowed stereograms of the mask's interior and exterior surfaces to be taken. Additionally, from the ground, with a vertical camera base the left side view of the mask was photographed. For photogrammetric mensuration, black and white glass negatives (Kodak Type M, ASA 32) were used while for conservation analysis colour reversal film (Kodak Ektachrome 64) was selected.

Control points located on the surface supporting the mask were coordinated by direct measurements and levelled, not to be in error by more than ± 0.2 mm in X, Y and Z.

Stereograms of the original mask only, were taken in June 1983, a second set of stereograms imaging both the original and replica beside each other were obtained in November 1985.

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1 It is HRS mandate to ensure that all negatives and data are sent to the Public Archives of Canada.

2.2 Photogrammetric Mensuration

The stereograms taken in June 1983 were evaluated in HRS's Wild A7 stereoautograph, to produce full size contour and planimetric plots of all photographed views of the mask. A 2 mm contour interval was selected, with spot elevations accurate to $\pm$ 0.3 mm and mask features located within $\pm$ 0.2 mm of their true position generated. (Fig. 3)

To evaluate the accuracy of the replica, the second set of stereograms was evaluated in the autograph, generating a series of vertical profiles at 2 cm interval through the original and mask replica.

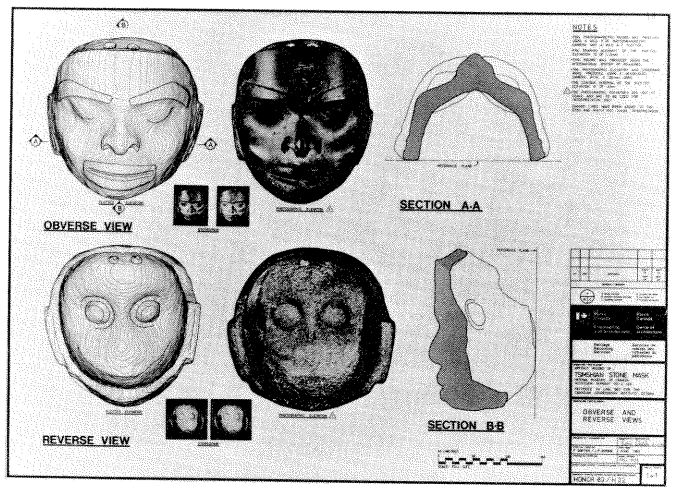

Fig. 3 Photogrammetric Drawing

2.3 Replication

The Company of Topographics Ltd. located in Markham, Ontario produces topographical, architectural and engineering models. The making of three-dimensional models consists of taking a topographical map of the area of interest and using their pattened machine to cut a terraced model. This is done by fixing the topographical map to the left-hand side of the machine. The operator then moves the cursor around each contour line of the map. The cursor's movements are translated to a cutting head by means of a lightweight pulley and cable system and a rolling carriage. The carriage moves along the table to give the 'X' component the pulleys and cable give the 'Y' component. The 'Z' element or depth of contour cut is set by moving the table up and down in scaled increments.

By using this system a model of the topographical map is cut in high density polyurethane foam.

Using the above method it was possible, from the photo-grammetric data supplied by Heritage Recording Services, to cut a three-dimensional model of the mask. The resultant model was highly accurate in three dimensions but lacked smoothness. (Fig. 4)

The final phase to produce a true replica was undertaken by the skilled conservetors of CCI. This phase consisted of infilling and sanding as required to produce the surface texture

and detail of the original. When this was completed, this intermediate replica was moulded with silicone rubber and the final replica was cast using pigmented epoxy resin. The resin model was filled with marble chips and lead shot to simulate the mass of the original; painting with acrylic paints completed the replica.

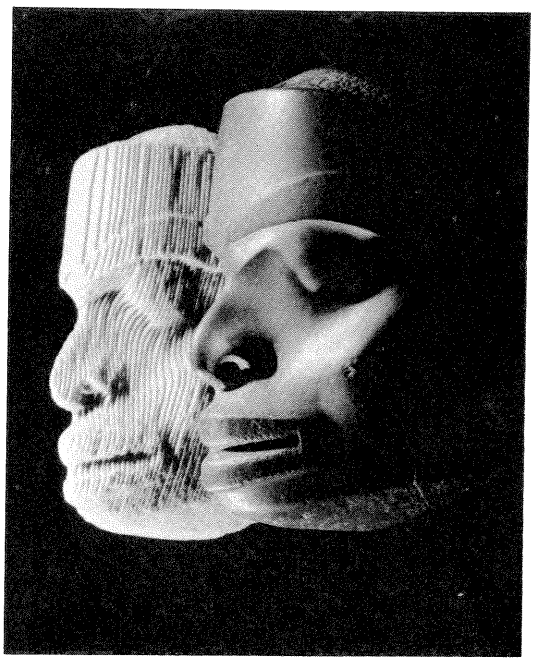

Fig. 4 Original and Model.

3.0 PHOTOGRAMMETRIC ANALYSIS

As mentioned in section 2.2, both replica and original mask were rephotographed for purpose of comparison.

A graphical comparative analysis, using photogrammetrically derived vertical profiles revealed that approximately 80% of the replica compared within $\pm$ 1 mm of the original. The remaining 20% of the replica, notably confined to details located in areas of steep relief around the perimeter, agreed within $\pm$ 3 mm.

4.0 RESULTS

With the assistance of the photographic staff of CCI, it was possible to complete the photogrammetric survey work in one day. From the survey data, the planimetry, contours and sections of the mask were produced. With a photo scale of 1:11 accuracies of $\pm$ 0.2 mm would be realized.

From the contour drawings Topographics Ltd. produced three models, each taking approximately 2 days. The main problem they encountered when cutting the model was that of interpreting details where the contour spacing was close (i.e.) ears and chin.

The infilling and sanding of the model, used to give it the texture of the original and the subsequent moulding, casting and painting were the most demanding and thus time consuming stage of the replication. The finished replica is a testament to the skill and dedication of the staff of CCI.

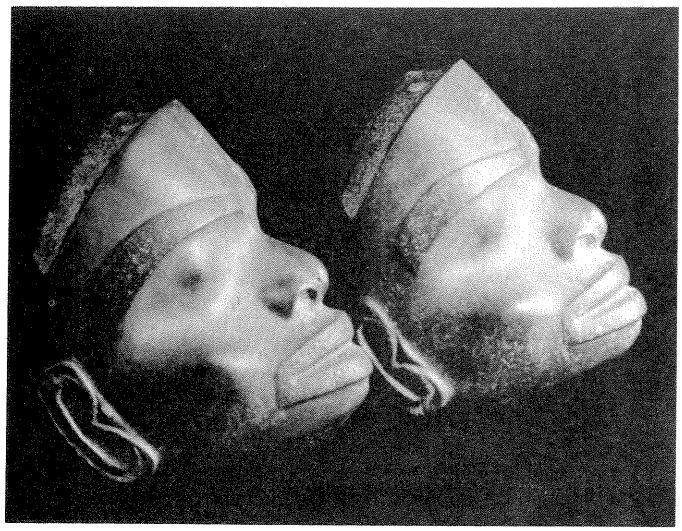

Fig. 5 Original and Replica.

5.0 CONCLUSIONS

Close-range photogrammetry has proven to be a fast, safe, accurate and non-destructive method to document "fine art objects". From photogrammetrically derived data, an accurate three-dimensional replica of a Tsimshian stone mask was produced, without inflicting damage to the original. (Fig. 5)

It can be concluded that the photogrammetric method could be used throughout the museum environment, to assist in the replication of petroglyph, pictograph and archaeological sites for purpose of analysis and display in museums and interpretive centres. Furthermore, consideration should be given to the inclusion of the use of photogrammetry to the technical analysis of all national treasures.

6.0 DISCUSSION

The replication method described in this paper was adopted, primarily because of the low cost, simplicity, proven technology and available equipment and technical expertise. It is acknowledged that other technologies such as the use of holography, laser scanners and digitally-controlled carving tools could serve the same purpose.

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