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ZULU SAILING DRIFTER '*RESEARCH*' LASER SCAN SURVEY

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PROJECT SUMMARY SHEET

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Schedule	
Fieldwork	25TH–26TH MAY 2010
Report	JULY 2010

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CONTENTS

LIST OF ILLUSTRATIONS

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This document presents the results of a laser scan survey of the Zulu Class sailing drifter 'Research', currently located in the permanent collection at the Scottish Fisheries Museum in Fife. The survey was instigated on the request of the museum through concerns regarding the de-stabilisation of the vessel hull fabric. As such, the laser scan was proposed to create a full record of the vessel and establish a control for the continued monitoring of the hull condition. It is hoped that the laser scan survey will help inform the development of a conservation and management strategy for the vessel. A Method Statement was prepared to accommodate a full survey of the vessel which succeeded in providing a full and accurate 3D archaeological record in addition to the provision of useful 'engineering' data to help in the development of a conservation management strategy.

Illus 1
The laser scanning operation in progress

ZULU SAILING DRIFTER '*RESEARCH*' LASER SCAN SURVEY

by Dr. Dan Atkinson & Jürgen van Wessel

1. INTRODUCTION

This document presents the results of a laser scan survey of the Zulu Class sailing drifter *Research*, currently located in the permanent collection at the Scottish Fisheries Museum in Anstruther, Fife (**Illus 1 & 2**). Headland Archaeology (UK) Ltd. was commissioned by the Scottish Fisheries Museum to undertake the laser scan survey. A Method Statement was prepared to accommodate a full survey of the vessel prior to the implementation of plans for controlled stabilisation of the vessel and the long term conservation and management of the vessel through a Conservation Management Plan. These measures will be introduced by the Scottish Maritime Museum (hereafter the 'client').

2. HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

The development of the Zulu Class sailing drifter came about through the need for large, fast vessels capable of landing large catches and transporting the herring back to port and the markets as quickly as possible. The Fifie and Scaffie represented vessel types that were the mainstay of the Scottish fishing fleets into the latter half of the 19th century. Both vessel types contained design traits attractive to the need for good, fast sailing qualities and manoeuvrability – the raked stern and short keel of the Scaffie for speed and manoeverability, and the vertical stem of the Fifie for good sea-keeping qualities (McKee1983; Smylie 1999). In 1879, the first Zulu class sailing drifter – called Nonsuch - was designed by William Campbell, and built by W. Slater, both of Lossimouth. The Zulu design, with its sharply raked stern and deep forefoot, was an immediate success and soon became the mainstay of the east coast fishing fleet. The Zulus became the largest and most powerful sailing vessels in the UK fishing fleet, but their domination was short-lived, with few vessels being built after the Great War and the last Zulu fishing under sail into the late 1940s.

3. OBJECTIVES

The objectives of the survey were to:

- provide an accurate 3-dimensional archaeological record of the vessel to form the basis of further archaeological investigation and interpretation.
- provide an accurate 3-dimensional archaeological record to establish a 'control' to aid the development of a conservation management strategy and the production of a well informed plan.
- provide an accurate 3-dimensional record to inform any proposed engineering strategy prior to the implementation of any remedial works affecting the structure or fabric of the vessel, such as strengthening and hull support.
- provide an accurate 3-dimensional archaeological record prior to the implementation of any works affecting the structure or fabric of the vessel on the basis of proposals presented in a conservation management plan.
- To provide accurate data for any proposed archaeological interpretation and hull analysis, the production of models and interactives, or the construction of a replica vessel at any point in the future.

4. METHOD

4.1 Photographic survey

A complete photographic survey of both the interior and the exterior of the vessel were made using a digital SLR attached to the scanner unit and equipped with a 'fisheye' lens. The photos permit a complete 360º panoramic view taken from each survey station. Due to difficult lighting conditions, each photo was taken using 3 different exposures, which were then combined to create one properly exposed image. During post-processing these images were mapped onto the point clouds produced by the laser scanner to create a 3-D colour image of the vessel and its immediate environment.

4.2 Metric survey

A network of reference points was established using a Leica EDM. These points were all surveyed within the same local grid and were used as base stations for surveying the location of markers placed on the vessel. The position of these survey markers was used to accurately join the individual parts of the main laser survey.

4.3 Laser scanning

The main data capture was performed using a Leica HDS6100 phase-based laser scanner, which produces a 360º scan of all surfaces within a range of up to 70 m from the scanner. Each measured point returns a 3D coordinate and an intensity value which depends upon distance, and on the nature of the surface it is reflected from. This gives the point cloud some 'texture' and allows recognition of features without relying on photo mapping (see above). A similar process was undertaken for the 1:12 half-model (2 scans). The scans were processed using Leica Cyclone 7.0.3 software applications that allowed accurate registering (or stitching) of the scans. The resulting point cloud was further manipulated in AutoCAD 2011 and Leica CloudWorx 4.0.

- *Accuracy and resolution* – The scans were carried out with the scanner set on 'High' which equals a point spacing of 6.3 mm at a distance of 10 m from the scanner. Due to the close proximity of scanning positions the effective point density will be much higher as the same surfaces are scanned several times. A total of 38 scans were carried out during the survey producing some 2.5 billion points and generating over 5.5Gb of raw data. Each scan produced a point-cloud to an accuracy of between 2 and 5 mm for individual points. However the high number of overlapping points means that this accuracy can be improved significantly. Part of the port side of the ship was inaccessible due to the proximity of a raised walkway – this can be seen as a break in line in the sections in appendix 2. The ship model was scanned at a higher resolution to bring out more detail with fewer scans.
- *Data processing* – A new software version has allowed the entire dataset to be loaded from the beginning, rather than a small subset as has previously been the norm. This means that the full resolution of the scan is available at all times, limited only by the performance of the computer. Once all 38 scans had been aligned, the 'Research' was clipped from the rest of the data and 'unified' – a process that gathers all the clouds together and produces one single, manageable dataset. From this it was possible to create sections, elevations and plans in AutoCAD. A similar process was undertaken for the 1:12 half-model. The model and the ship were aligned using a 'best-fit' method – it was challenging to establish a common baseline between the two as no two points are identical due to the distortion in the vessel. Each section through the model was then mirrored and scaled up.

4.4 Vessel Investigation

While the laser scan survey provides a very accurate archaeological record, the importance of the technique to provide 'engineering' solutions to gauge vessel stability and deterioration was an equally important consideration for this project. The provision of a 'control' provided by the survey is perhaps the most significant element of the survey brief. With the added scan of the builder's half model of the Carolina (also on display in the Zulu gallery), there was presented an ideal opportunity to understand the subsequent hull movement and deterioration since the vessel was moved to the present gallery approximately ten years ago. By comparing the scans of the Carolina half model and the Research it was possible to establish an initial control point from which to gauge all future movement in the surviving hull fabric.

In order to illustrate the difference between the two scans a series of cross sections at intervals through the hull were created – the scan of the *Research* superimposed onto the scan of the half model (**Illus A2a & A2b**). This produced some interesting results, the observations for which are discussed below.

Illus 2a
Scanning the interior of the hull at the stern

Illus 2c
View along the starboard side of the vessel showing the current support technique for the hull

Illus 2b
Scanning the Carolina half model

5. RESULTS

5.1 The laser scan survey

The main result of this survey comprises a stitched 3D point cloud of the *Research*. This cloud should be seen as a high quality data source – it will provide any information necessary for measuring, illustrating and modelling of the ship as required in future. Such manipulation is possible using specialist software that is designed to handle the substantial volume of data.

The results of this survey are therefore presented as a number of static and interactive views of the processed cloud. It must be emphasised that these are merely illustrative. Although they are metrically accurate, they are intended only to give an overview of the data captured, and as an aid to visualising the ship.

- *Static views* – These include one external elevation and one internal elevation, as well as a plan (Appendix 1), a series of illustrated comparative sections (Appendix 2), and some perspective and detail views (Appendix 3) show the scope of the scan.
- *Interactive views* – In order to provide a sense of the richness of the gathered data, a selected series of interactive panoramas have been provided on the DVD included with the report. There are three different views for each selected scan position; a Quicktime VR interactive panorama (best for visualisation), and two measurable 'TruViews', one mapped with photographs, the other with point intensity. All three views can be panned, zoomed, annotated and printed, allowing the most convenient access to the point-cloud data. Details of the separate views can be found on the index page of the DVD.

5.2 Archaeological comment

Although the purpose of the survey omits an extensive archaeological discussion the results of the survey in relation to the archaeological aspects of the vessel provide interesting observations. The laser scan survey has enabled the description of the vessel with great accuracy and extraordinary detail **(Illus A1 & A2)**. Perhaps of note is the apparent condition of the vessel, which on the whole, and despite some deterioration, is favourable. Note has also been made of areas of the hull structure and fabric that have witnessed degrees of deterioration since the housing of the vessel in the current gallery. Initial interrogation of the scan data gathered for both the *Research* and the *Carolina* half model allowed for the following observations:

- The cross-sections show that there is loss of lateral shape and hull integrity from a position approximately 24ft from the bow aft towards the stern – confirming recent observations made by museum staff.
- The results suggest that there has been movement both longitudinally and laterally (sagging, pinching and expanding). Examples of this were noted in the sternpost which has visible convex curvature. Given the nature of the raking stern, this area of the hull highlights perhaps the most instability due to the great weight and stress requiring support.
- There are inferences to be made between the builder's half model and the archaeological evidence presented in the hull of the *Research* – for example variations in the nuances between the vessel as 'designed' and the vessel as 'built'.
- Cross-sections towards the bow perhaps indicate a 'hogging' effect with the narrowing or 'pinching' of the hull.

Consequent interrogation of the scan data will allow for the possibility for accurate archaeological interpretation and analysis. Subsequent accurate drawn records could also be obtained – all of which could be integrated into a conservation management strategy.

6. PRODUCT APPLICATIONS

- *Archaeological Record* – The point cloud forms a highly detailed record of the vessel in its current state. This is essential in the development of a robust conservation management plan.
- *Engineering aid* – The point cloud can be used to produce line-drawings and ortho-photos of areas of interest, for example to inform engineering proposals and to produce more comprehensive reports of the vessel's condition and stability analysis.
- *Digital 3D products* – with a suitable time investment, the point cloud can be transcribed as a digital 3D model. This will allow the production of a number of multimedia products – fly-around videos, visualisations for vessel reconstructions within architects designs, or animations of the possible deconstruction process, for example. Depending on the desired purpose, such models could be created to varying degrees of detail – a simple model for display on a museum website, through to film-quality renderings of the ship battling the open sea.
- *Physical products* – Through the crafts of model-making or 3D printing, it is possible to use the scan data to produce physical representations of the ship at any scale. Again, this can be used in museum displays and merchandising.

7. REFERENCES

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March, E J, 1972 *Sailing Drifters: the story of the herring luggers of England, Scotland and the Isle of Man David & Charles*

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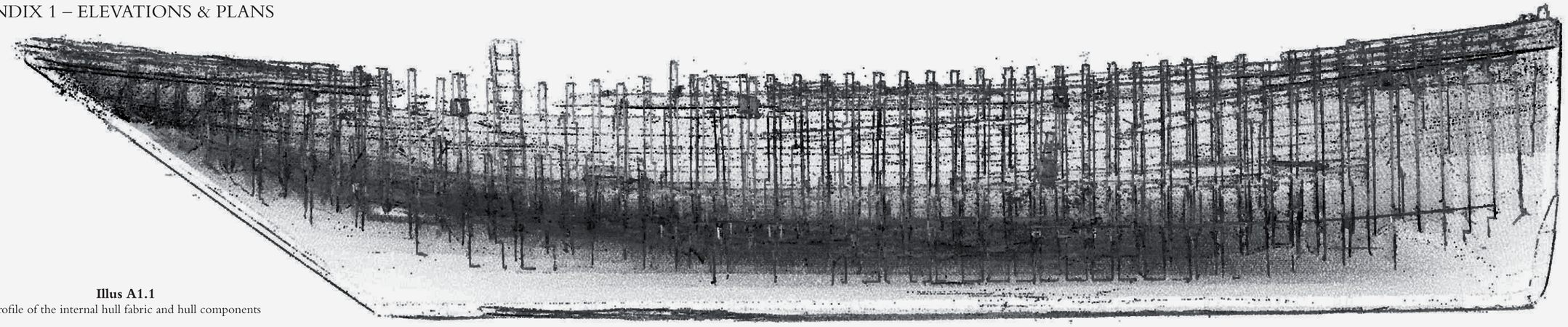
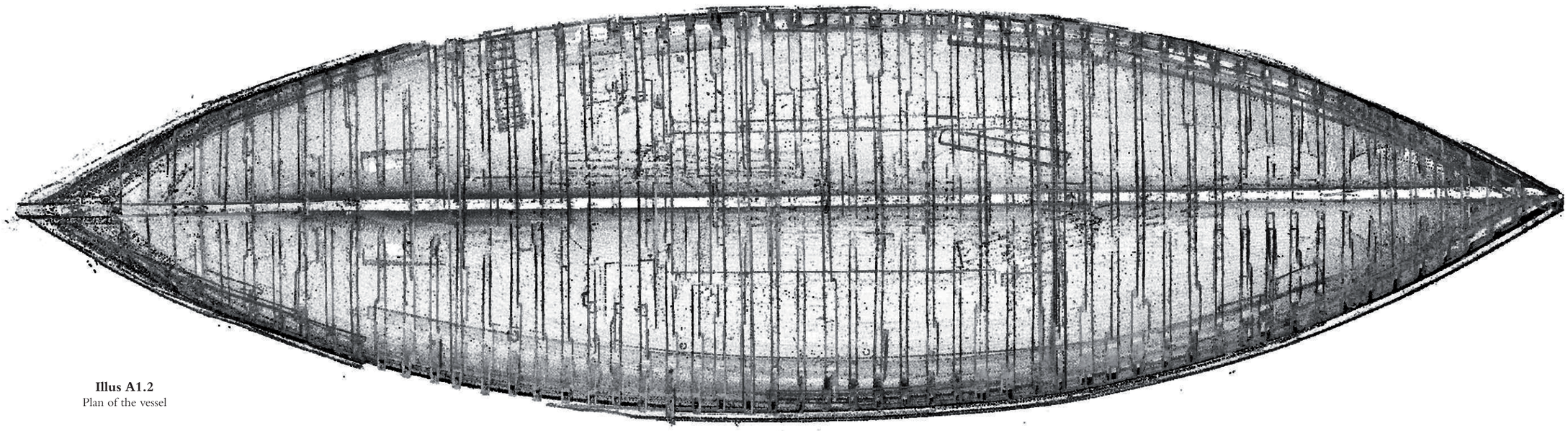
Underhill, H 1950 *Lines and constructional details of the Zulu drifter Muirneag*

APPENDIX 1 – ELEVATIONS & PLANS

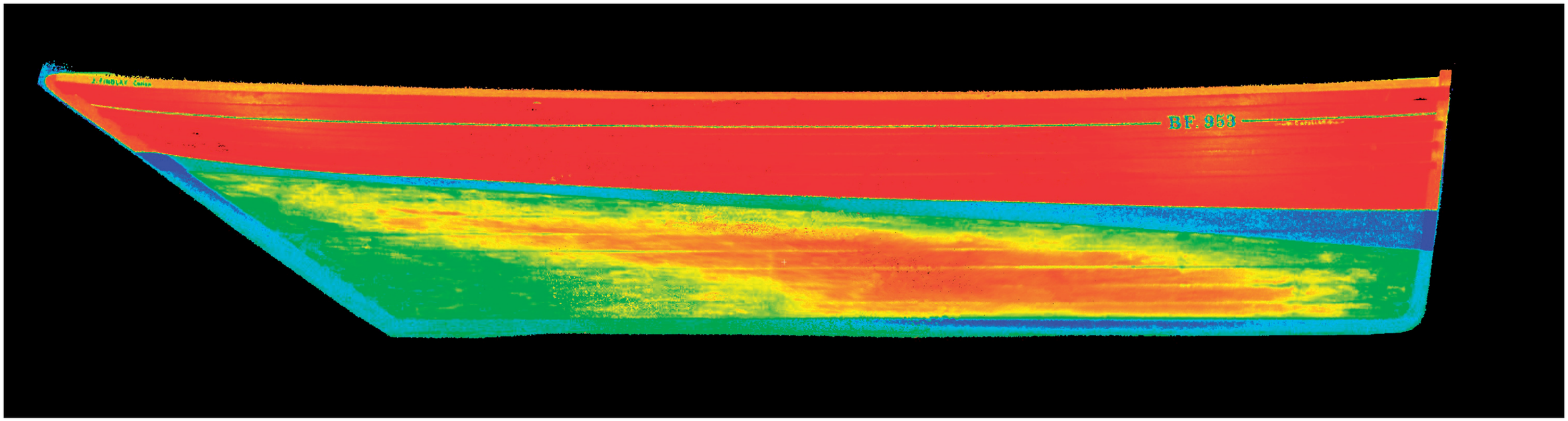


Illus A1.1
Profile of the internal hull fabric and hull components



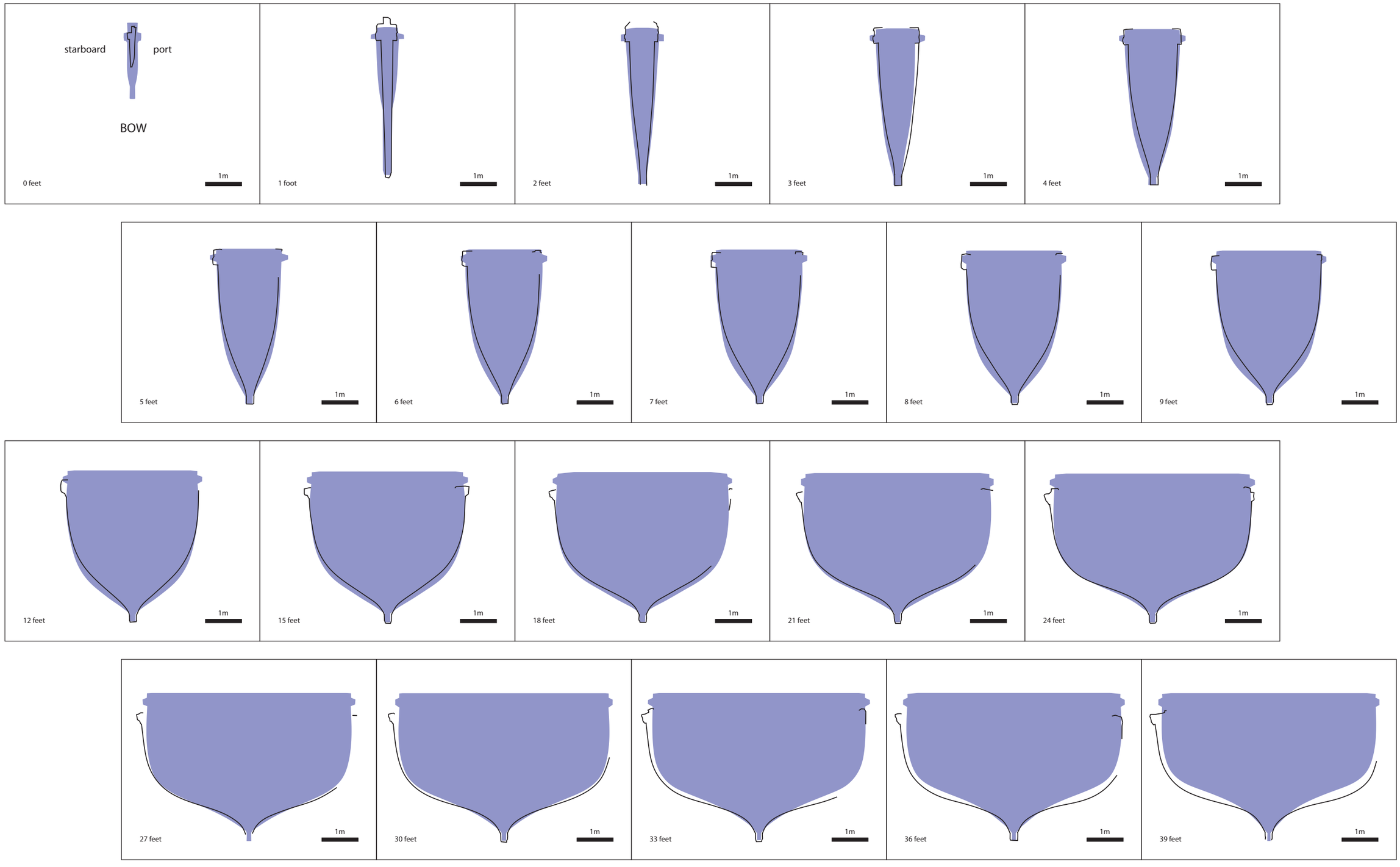
Illus A1.2
Plan of the vessel

Illus A1.3
Colour render of the exterior profile of the vessel

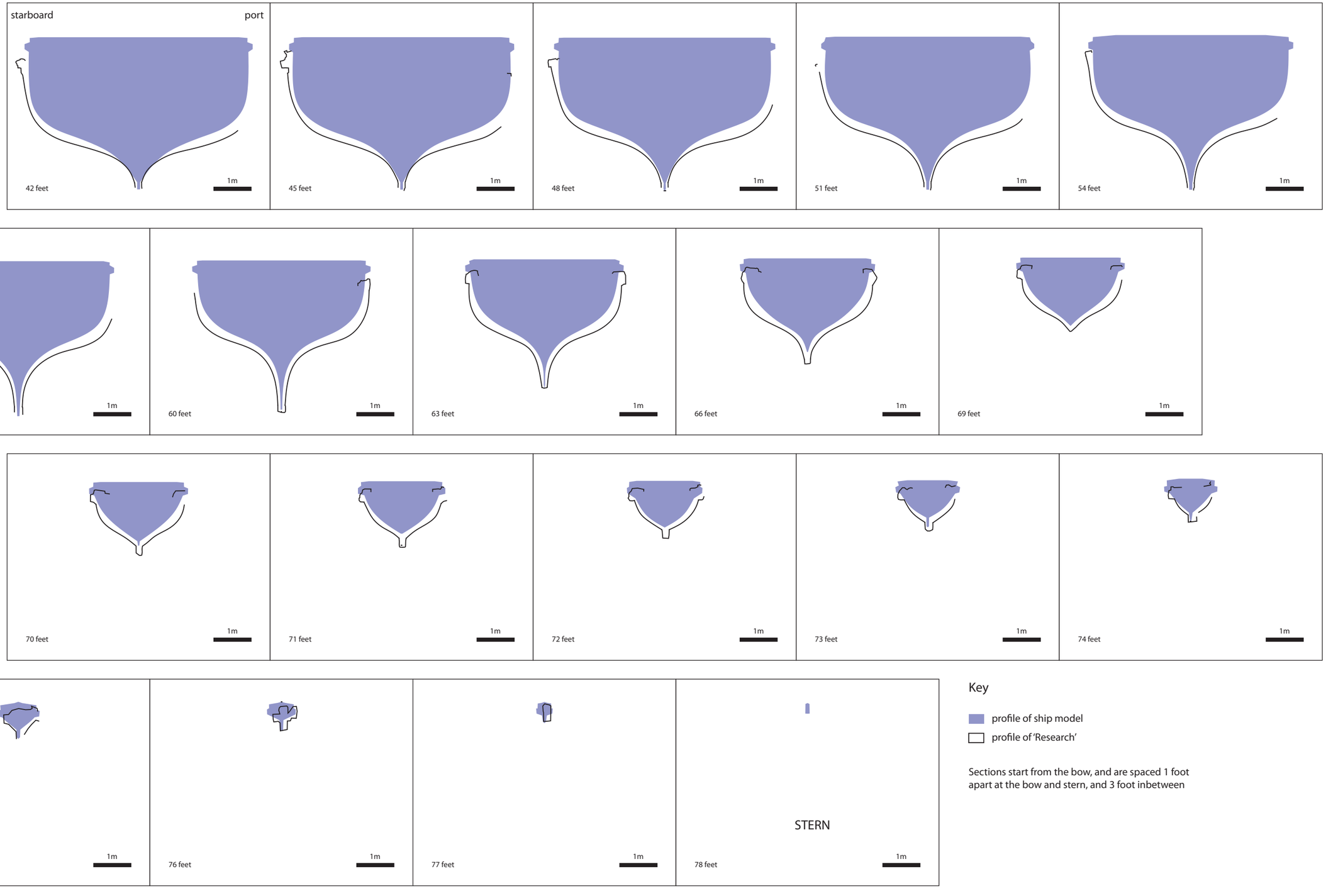


Illus A1.4
Raw scan data for the Carolina half model

APPENDIX 2 – VESSEL CROSS-SECTIONS

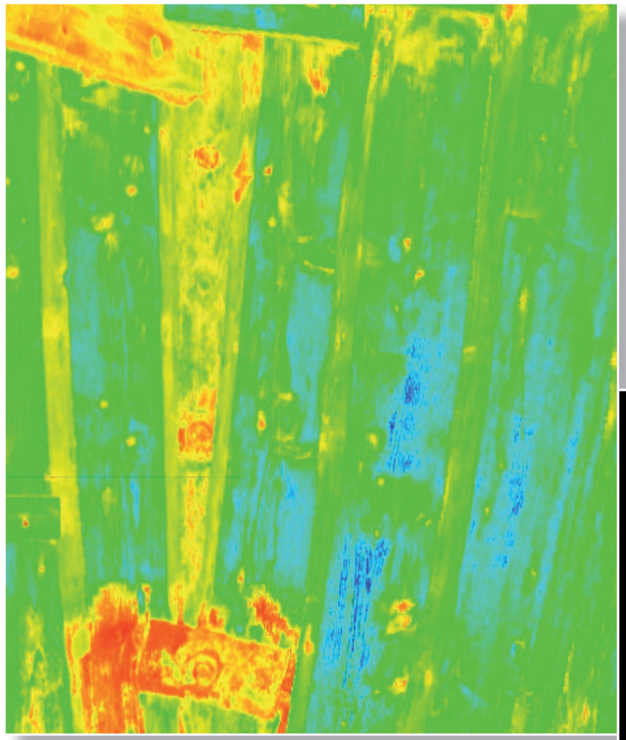


Illus A2.1
Comparitive sections through the 'Research' and the shipbuilder's model



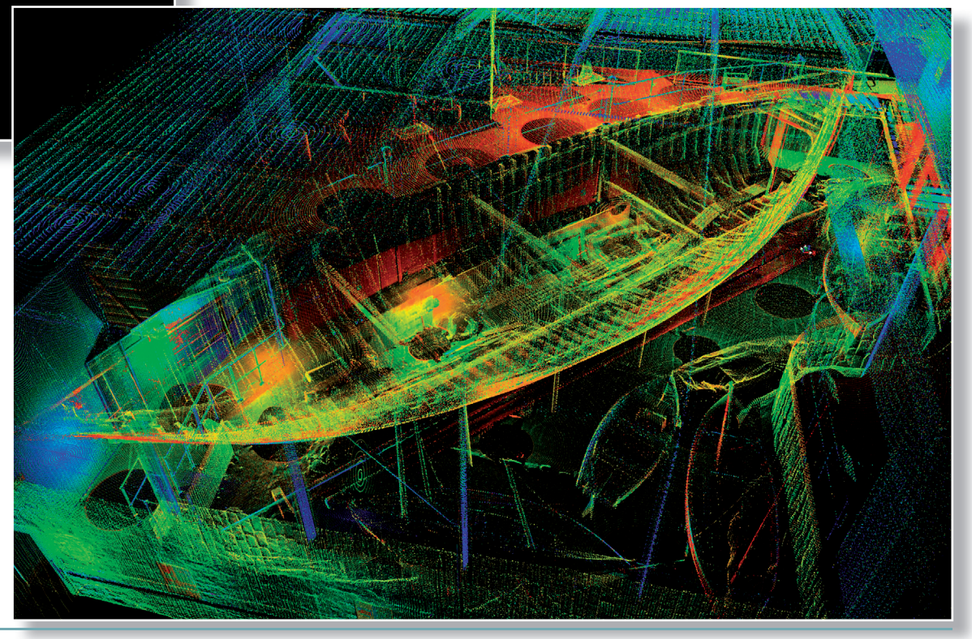
Illus A2.2
Comparitive sections through the 'Research' and the shipbuilder's model

APPENDIX 3 – ASSORTED VIEWS



Illus A3.1
Detail of a section of hull from the raw scan data

Illus A3.2
Isometric view of the colour rendered scan of the vessel



Illus A3.3
Raw scan data of the entire scan within the gallery