In the fall of 2013 and the summer of 2014, graduate students from East Carolina University's Program in Maritime Students, in collaboration with the UNC-Coastal Studies Institute, carried out a project recording six watercraft from a collection of historical small watercraft collected and maintained by the Whalehead Preservation Trust in Currituck County, North Carolina.

This volume contains six chapters that serve as the technical reports concerning these six vessels. Each chapter reports the process of recording the boats and their histories and also engages in interpretation and analysis of the form, function, and methods of construction. In some cases, examinations of modifications, repairs, and wear and tear are also made.

The publication intends to communicate the results of maritime-focused historic preservation activities concerning a small part of Currituck County's legacy of boat-building.

Project Partners:

Coastal Studies Institute
University of North Carolina

Whalehead in historic corolla

Currituck County

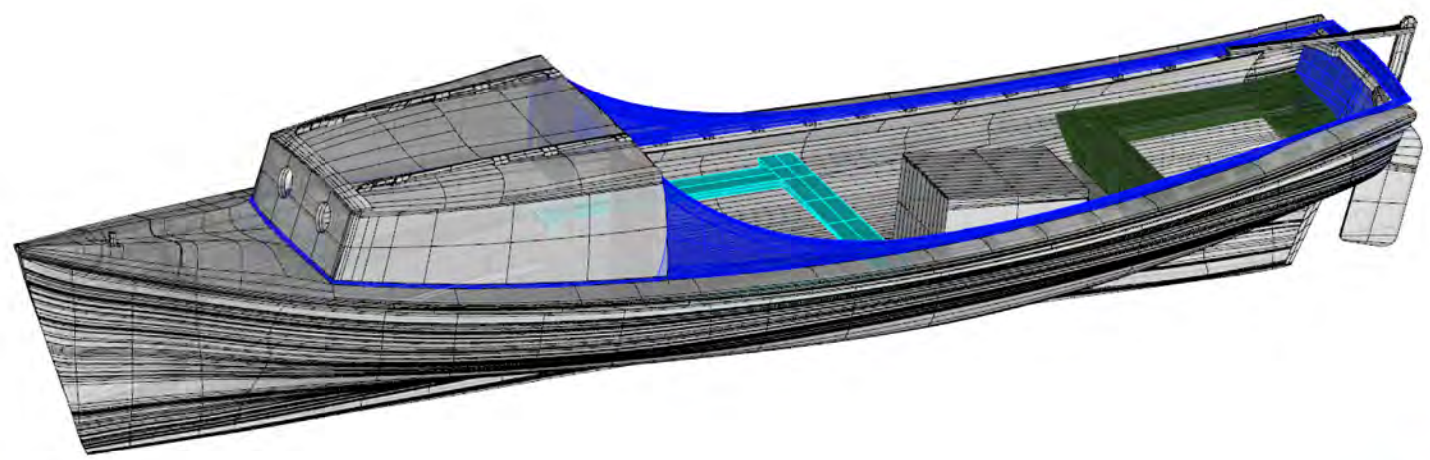
ISBN 978-1-365-44608-5
90000
9 781365 446085

Boats of Currituck (Richards and Stewart, eds., 2016)
Program in Maritime Studies Research Report No. 23 (East Carolina University)

Boats of Currituck:

An Analysis of Six Watercraft from the Whalehead Preservation Trust Collection

Edited by Nathan Richards and David J. Stewart



Program in Maritime Studies
East Carolina University
Greenville, North Carolina

East Carolina University

Research Report No. 23 (2016)

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Nathan Richards and David J. Stewart (editors)

Chapters by:

Jeremy Borrelli

Ryan Bradley

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Julie Powell

Alyssa Reisner

William Sassorossi

Emily Steedman

Sonia Valencia

Jeneva Wright

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ISBN 978-1-365-44608-5

Series Editor: Nathan Richards, Program in Maritime Studies, East Carolina University, Admiral Ernest M. Eller House, Greenville, North Carolina, 27858.

Cover: Three dimensional model of Hambone's Shad Boat by Nathan Richards from data recorded by Jeremy Borrelli and Ryan Bradley.

Cover Design Concept: Nadine Kopp.

DEDICATION

Dedicated to Ray Meiggs and Ann Sensibaugh, in thanks.

ACKNOWLEDGMENTS

The authors and editors of this report would like to thank the Whalehead Preservation Trust for providing us the opportunity to work with their watercraft collection. The UNC-Coastal Studies Institute and its staff are also owed thanks for providing us with the space and resources to successfully complete this project. Our home institution at East Carolina University and particularly the Maritime Studies Program (Department of History) provided the equipment and training to complete the recording and analysis of these watercraft. Dr. Calvin Mires is owed special thanks for assistance with preparations.

Additionally, a number of individuals must be thanked for their generous donation of time and expertise. Special thanks to the boat builders of Currituck County and the custodians of these historic resources: Travis Morris, Carl Ross, Wilson Snowden, Levie Bunch, Newton Hampton, Sonny Briggs, Bobby Sulivan, Colin Grandy, Oscar Roberts, Patrick H. O'Neal, J.I. Hayman, Lawson Dowdy, Richard Dowdy, Blanton Saunder, John Guard, Sinclair Lewis, Otis Dough, Wilton Walker, & Horace Bell. Staff at the Whalehead Preservation Trust, Ray Meiggs, Ann Sensibaugh, Jill Landen, Jenn Sweigart, Jeannie Meiggs, and Carolina Gordon collaborated with the research team to enable the work to occur. Finally, thanks to the Lost Colony Foundation (Bill Coleman and Terry Fowler) for allowing us to rent lodging at Morrison Grove during the fall of 2013 to undertake the work.

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PREFACE

Nathan Richards and David Stewart

For many years, graduate students in the Program in Maritime Studies at East Carolina University (ECU) have had the opportunity to enroll in *HIST6885: Recording Small Watercraft*. Working under the supervision of Dr. Lawrence Babits, Dr. David Stewart, Dr. Lynn Harris (all past or present ECU faculty), and Dr. Paul Fontenoy (with the North Carolina Maritime Museum in Beaufort, North Carolina), these students have been exposed to a diverse array of local vessel types and have experienced firsthand the challenges of recording these complex artifacts from North Carolina's boatbuilding past. While this exposure itself is a critical learning experience for individuals being trained in maritime historical and nautical archaeological research, it also comes with additional benefits – the details of construction and the three-dimensional complexities of recording small watercraft has been found to be a pivotal learning experience for underwater archaeologists, who faced with additional challenges (such as dark, cold, and deep waters where they are unable to easily communicate with team members) must be able to think creatively about the methods they use in recording other kinds of complex sites underwater. Hence, the experience of recording North Carolina's small watercraft has, over time, moved closer to the core set of lessons that students at ECU learn as they become professional maritime archaeologists.

However, not all exposure to small boats comes in the class mentioned above – periodically circumstances emerge that provide additional opportunities to record vessels both large and small. For example, ECU faculty member Dr. David J. Stewart has been engaged in previous studies of the 16th-century Swedish warship *Vasa*, Pacific schooner *Wawona* (Seattle, Washington, see Stewart 2008), Hellenistic Greek ship from Kyrenia, Cyprus, and the Danish fishing boat *Hanne Frank* (Houston, Texas, see Stewart 2012) – all projects that involved a significant amount of student participation and instruction.

In 2013, an opportunity arose out of a collaborative agreement between the Whalehead Preservation Trust (WPT) and the UNC-Coastal Studies Institute's Maritime Heritage Program (affiliated with the Program in Maritime Studies [PMS] at East Carolina University). A part of WPT's mission is the preservation of a collection of over two dozen small watercraft representing a cross-section of local boat types once common on the waters focused on, or adjacent to, Currituck Sound, in North Carolina's northeastern region. The collaboration between WPT, CSI, and ECU first started under the supervision of Dr. Lynn Harris in the Spring of 2013 during weekend *HIST6885* boat recording activities at Corolla, NC. Later that fall, a field school with many of the same students and supervised by Dr. Nathan Richards and Dr. David J. Stewart would return to the area. In this case, while Richards focused on maritime archaeological sites adjacent to Oregon Inlet, Stewart would follow up on the earlier 2013 recording activities with an intensive study of four WPT watercraft (transported to the UNC-Coastal Studies Institute at Wanchese). During this project Stewart would expose students to many of the techniques and theories promulgated by scholars such as W.M. Blake (1935), Howard Chappelle (1941), J. Richard Steffy (1984, 1989, 1994), D.W. Dillon (1992), Paul Lipke (et al. 1993), Richard K. Anderson (2004), Frederick M. Hocker (1991, 2003, 2004), and John Gardner (1996, 1997). Subsequently, two of these students would also be awarded the 2014 Currituck County Maritime Heritage Fellowship and would spend the summer of 2014 recording two additional boats in similar detail.

This report represents a compilation of six reports produced by seventeen students from spring 2013 to summer 2014 – each of which has been translated into the chapters of this report. The first four chapters represent the results of four group recording activities that occurred during the fall field school in 2013 under the supervision of Stewart. These follow in the numeric order of the vessel registration numbers (WPT#2013.09.02, 2013.09.04, 2013.09.06, and 2013.09.08, respectively). The next two chapters are reports from the 2014 Currituck County Maritime Heritage Fellows (supervised by Richards). This section is also arranged chronologically by registration number (WPT#2005.03.01, and 2013.09.14).

Interested parties should note that a full list of the Whalehead Preservation Trust catalog is available on the Currituck County Maritime Heritage Projects Website (http://blog.ecu.edu/sites/currituck/), which serves as the record for a series of ongoing maritime heritage-themed collaborations. Additionally, all the raw data collected by the Program in Maritime Studies and the UNC-Coastal Studies Institute since 2013 in their small boat recording activities reside at East Carolina University and have also been given to the Whalehead Preservation Trust for use in future research, preservation, and education initiatives.

REBECCA: A NORTH CAROLINA FLARE-BOW V-BOTTOMED MOTORBOAT
(WPT Vessel 2013.09.02)

Jeremy Borrelli, Kelci Martinsen, Michele Panico, and Sonia Valencia

Introduction

A part of North Carolina's coastal heritage, boatbuilding traditions have endured for many generations. This is often a result of coastal families picking up boat construction methods from their elders and subsequently passing the information down to newer generations, adding their own unique touch along the way (Alford 1990:1). As a result, North Carolina has many boats that vary in appearance and type, yet were built with operational environment and function in mind. *Rebecca* (Figure 1) is one such example. The vessel was built by an avocational boat builder, Oscar Roberts, who created the boat for familial use. *Rebecca* was used by the family for almost half a century until his son donated this unique representation of North Carolina boat building technology to the Whalehead Preservation Trust (WPT). Analysis of the boat's construction reveals the methods used by Oscar Roberts, along with how or why he chose certain details over others. This chapter discusses the history of the boat, and analyzes the exterior and interior construction of the boat, as well as the features that make this craft a special addition to the maritime cultural heritage of the communities of the Outer Banks.

Figure 1. *Rebecca*'s bow, showing flare and deadrise (Photo by Jeremy Borrelli, 2013).

Background

The coastal environment of North Carolina contains a strip of sandbars, shoals, and sandy islands that stretch from Virginia Beach down through a large part of North Carolina's coastline. Prior to the construction of bridges and railroads, the main sources of transportation were boats. The reliance on boats, whether for transportation, fishing, or recreational use, has led to the development of a boatbuilding tradition by coastal communities who had an intimate knowledge of water conditions and the type of vessel best adapted for it (Alford 1990:xiii).

Watercraft were designed to suit the environment as well as its intended function (Alford 1990:xiii). The vessels were built in the front yards or back yards of individuals or families who used methods that were passed down from generation to generation. These methods were often altered and improved upon as purpose and function changed. This led to many different styles of watercraft that are indicative of individual aesthetic preferences, community traditions, and intended uses (Alford 1990:16; Conoley et al. 2008:32).

Vessel 2013.09.02, or *Rebecca*, is one such vessel. Based on an interview with Mark Roberts on September 25, 2013, his father, Oscar Roberts built the boat in 1958. A plaque that reads "Robert's Craft, Coinjock, NC" fixed in the forward center section just below the coaming confirms this. According to Mark, Oscar Roberts learned his boatbuilding techniques from a local boat builder, Patrick H. O'Neal. The boat was named *Rebecca* after Oscar Robert's wife's middle name (Mark Roberts, 2014, pers. comm.). During the boat's operation, it had a registration number of "400 NC" which is visible in the forward section, starboard side of the boat, directly under the rub rail and beneath a layer of white paint. The vessel may have been registered in Coinjock Marina of North Carolina. Research has revealed that *Rebecca* is a type of flare-bow v-bottom (deadrise) outboard motor boat.

Boats are generally larger than a skiff and boats have decks or half-decks whereas skiffs do not (Alford 1990:43). The bow of the boat has a concave shape with a pronounced curvature that extends upward and outward from the waterline. The flare of the bow improves seaworthiness of the boat and allows it to achieve greater speeds as it cuts through the water. The technique of flaring the bow was developed by Brady Lewis during the 1930s in Salter Pass and Harkers Island, North Carolina. Boats of this type were used for fishing and yachting (Alford 1990:16).

Rebecca is a V-bottom boat because if the vessel is observed at a cross-section, the lower portion of the boat displays a v-shape that is sharper at the bow and flatter towards the stern, which is indicative of a v-bottom boat (Alford 1990:11). This construction type is also known as deadrise (Alford 1990:11,44). In North Carolina, a boat building tradition for v-bottomed boats is to run the bottom planks length-wise instead of athwartships (which is the method used for flat-bottom boats) (Alford 1990:2,11). Observations of the underside portion of the vessel reveal large planks which run fore-and-aft (Figure 2). This feature confirms the North Carolina distinctive style of v-bottom boat construction.

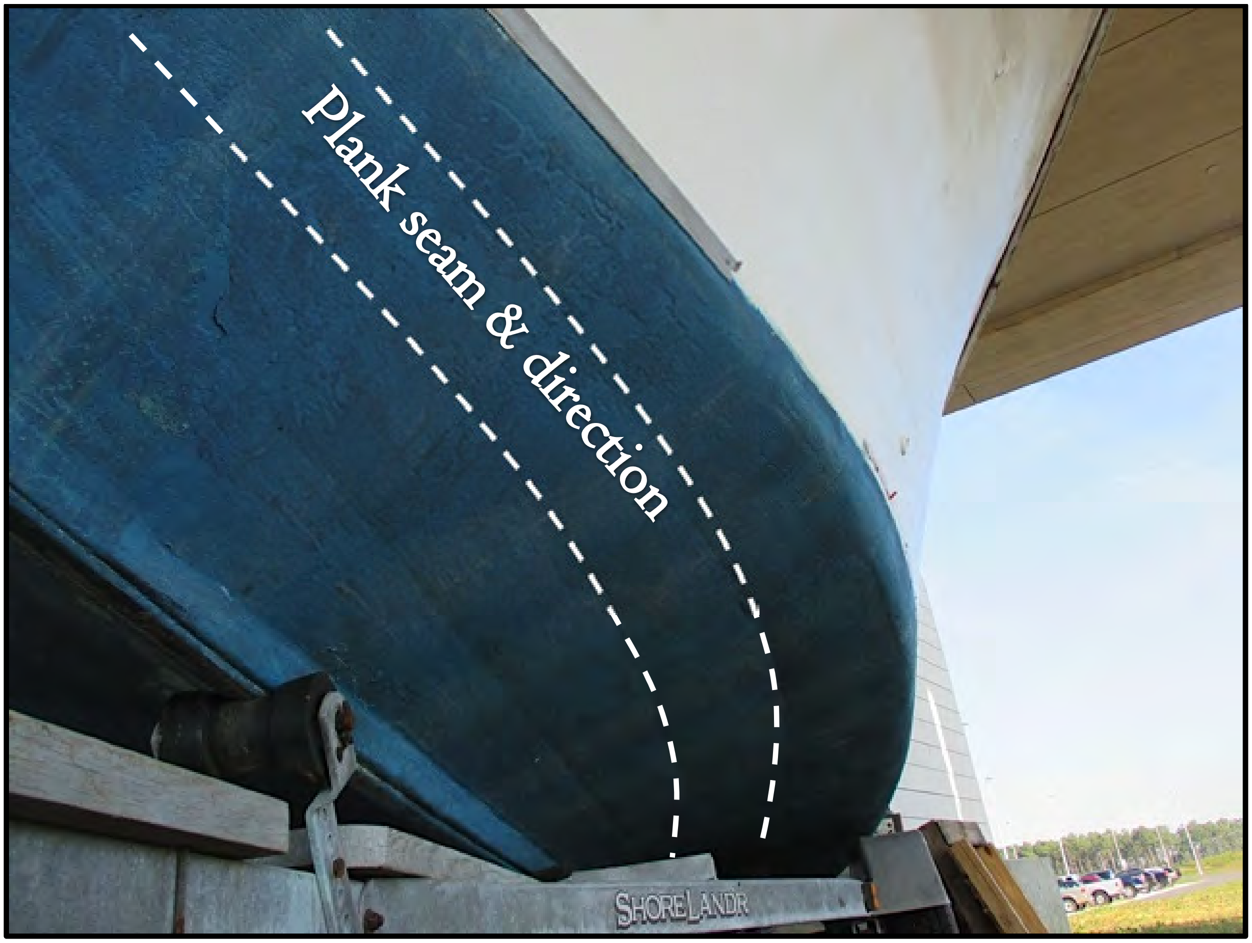

Figure 2. Fore-and-aft running hull planks (Photo by Jeremy Borrelli, 2013).

The v-shaped bottom of a v-bottom boat is designed to aid the boat in its handling of rough water (Alford 1990:11). This detail indicates that the vessel was designed not only for the sounds, rivers, and canals of North Carolina, but could operate in the open ocean as well. During the interview with Mark Roberts (2014, pers. comm.), he informed that the boat was used primarily in the ocean for blue water fishing and trawling, but also in the rivers, canals, and sounds of North Carolina.

There is an outboard motor on the transom at the stern of the boat. The motor is a Mercury brand two-stroke 50 horsepower (hp) single propeller engine. According to Mark Roberts, the first motor installed on the boat was an outboard motor of 25 hp. This motor was replaced with a more powerful 40 hp outboard motor. The 40 hp motor was later replaced by an 85 hp motor. The 85 hp motor was removed and replaced with a 50 hp motor, which is the motor that is currently on the boat (Figure 3). The reason for the changes in motor power was to try and find a good maximum speed for the boat. According to Mark, Patrick H. O'Neal referred to the chine on the boat was referred to as a "fading chine." The disadvantage of this type of chine is that if the boat went too fast, it would trip and begin to slide, then catch the chine and begin to trip all over again. This motion could cause a boat to fall apart. *Rebecca*'s boat hull could take speeds of up to 22 mile/hour (35 km/hour) (Mark Roberts, 2014, pers. comm.). The bilge pump currently on the boat is a Lovett 1200 brand pump and is located under the floorboards around mid-ships.

Figure 3. Mercury 50hp outboard motor with single propeller (Photo by Jeremy Borrelli, 2013).

In regards to cosmetic modifications, this vessel received alterations to the console. Mark Roberts reported that the original design had the dashboard and steering wheel was at the bow of the boat. Oscar Roberts later removed it and erected the console in the center of the boat. He later removed the console from the center of the boat and moved it to the center starboard side (where it is now). The chairs were designed and built by Oscar Roberts. According to Mark Roberts, Oscar Roberts was a small man and this is the reason why the chairs are somewhat small and also the reason why the console does not provide much leg room. The chairs were designed with a backrest that can be positioned forward or aft depending on the direction a person would like to face while seated (Figure 4). The chairs were not permanently fixed on the boat and could be removed if desired (Mark Roberts, 2014, pers. comm.). The interior of the boat is painted gray-blue.

Figure 4. Final Position of the console and chair. (Photograph by Jeremy Borrelli, 2013)

Rebecca is a wooden boat with a fiberglass coating on its exterior. The exterior of the boat appears to have undergone several restorative paint jobs which may indicate that the boat was kept in the water and not pulled up to shore during non-operation. The boat is painted white on the exterior from the rub rail down to the waterline. The waterline and bottom portion of the boat is painted blue, possibly with a lead-based paint to prevent marine growth. Beneath the blue paint, evidence of red paint remains which indicates that the paint from the waterline to the bottom of the boat may have once been was red in color before the decision was made to change it to blue. Another possibility could be that the waterline was purposefully painted red and the paint has since faded. Located on the portside exterior of the transom is an area of non-uniformity in both texture and paint layers indicative of damage to the area that underwent repair (Figure 5). During the interview with Mark Roberts, he confirmed the area has been damaged in an accident and was repaired (Mark Roberts, 2014, pers. comm.).

Figure 5. Repaired damage on the portside exterior of the transom (Photograph by Jeremy Borrelli, 2013).

This one-of-a-kind boat remained in the possession of the Roberts family up until Mark Roberts donated it to the Whalehead Club in Corolla, North Carolina, where it can be preserved and displayed as a symbol of North Carolina's boatbuilding tradition and coastal heritage.

Methodology

A variety of methods were available to be used in the documentation of the boat. Due to time constraints, the team chose the most productive and efficient methods in order to ensure that all the vital components of the boat would be recorded. The methods chosen were the use of measured drawings, a total station (an electronic theodolite with an electronic distance meter), and photography. All measurements were made in metric units.

Measured Drawings

Measured drawings were an important tool because they allowed the team to document areas in the boat where the total station could not reach. The points on the boat that were recorded by the total station were also recorded on the measured drawings which were used to fill in the gaps in the 3D reconstruction of the boat (see Figure 6). In this way, the measured drawings also acted as a point catalogue for the total station points. All drawings were organized consecutively by frame set and compiled in a binder to allow for future reference during total station recording and analysis.

Each drawing was numbered and labelled in order to prevent confusion. The drawings included a plan view of the boat, several profile views as well as section drawings divided by frame set. For every frame set, the team recorded the fore view, aft view, and a profile view of the space following the frame set. The team manufactured additional drawings for unique features on the boat, such as the steering console. Fasteners were not included in all drawings but do appear in some. This inconsistency should be taken into account when analyzing the fasteners of the boat.

Total Station

The team chose to use a total station for the documentation of *Rebecca* because a total station allows for rapid, accurate data collection. Since the full documentation of the boat had to be completed in only ten days, the speed of data acquisition provided by the total station was very advantageous. Documentation using the total station began on the starboard exterior side of the boat. The team chose this starting point because they were inexperienced in using a total station for boat recording. The starboard exterior side was easily accessible and did not offer many challenges such as hidden faces (surfaces). As the team became more experienced, they began to record the more advanced areas of the boat.

Prior to using the total station, each component of the boat was labelled and given a total station code. This allowed the team to mentally organize the boat into sections and also allowed the team to cut down on work that would have been disrupting while using the total station.

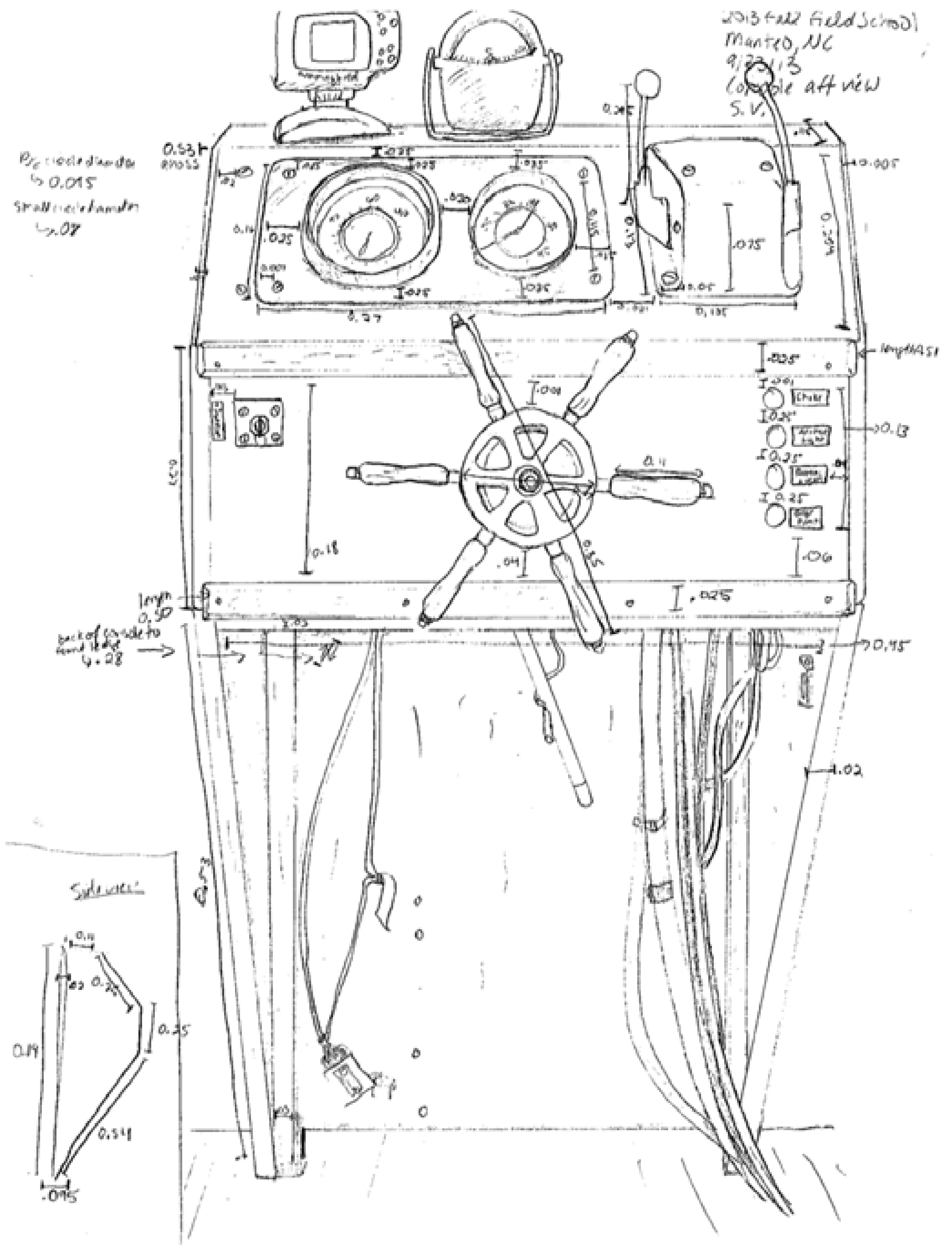

Figure 6. Example hand measurement drawing of *Rebecca's* console (Drawing by Sonia Valencia).

The next step in the process was the establishment of datum points. The datum points allowed the total station to calculate its spatial position in relation to the boat even if the station had been moved or repositioned. The datum points were marked using white tape with a cross hair drawn on it. The tape was then labelled and was not moved throughout the duration of the recording process. The rule of thumb used on the project was to shoot at least three datum points at each position, therefore a total of eight datum points were created. The datum points varied in height as well as proximity to the boat. It was important for the datum points to be in a range of easily visible areas so that they would be useful to the total station in a variety of positions.

The total station was then setup and an occupy point (TS01) was established. The occupy point was located on the starboard side of the boat. On initial set up, the total station also required a backsight; therefore a backsight (ZZ01) was established. The total station was set on the non-prism mode so that the team would be able to shoot the total station's laser directly onto the boat. Once the occupy point was established, the team was able to conduct the section shooting. Section shooting involves shooting in the eight datum points, or as many as the team could see from the primary position.

After the team concluded the section shooting, they marked points that would be documented by the total station. These points followed lines that ran vertically down the side of the ship. These lines were spaced at every second bolt of the boat's rub rail. The marks were made with chalk so that they could be easily removed once documentation had been completed. Markings were also made along the rub rails and transom. Once the markings were made, the team documented the starboard side of the boat, the starboard rub rails and part of the transom. A three-person team accomplished this task. One person recorded the location and code for each marking. The second person backstopped the marking to be shot in order to ensure the correct position was recorded. The third person operated the total station, which included aligning the sight of total station to the marking as well as shooting the total station's laser in order to record the marking.

When all the markings visible from the current position were shot, the team resectioned the total station. Resectioning is the act of repositioning the total station. Before moving the total station, it is imperative to choose a new position for which at least three datum points are visible. The team chose a location on the starboard side of the bow of the boat for the total station's new position. Once the total station was moved to the new location, three of the eight existing datum points were shot in in order to allow the total station to calculate its new position relative spatially to the boat. The team added markings to the boat's exterior hull, rub rails and keel. A three-person team recorded all of the markings using the total station.

After the starboard side of the boat was completed, the total station was resectioned to the port side of the boat. Markings were made using the vertical line method previously mentioned. Once the markings were recorded, the total station was resectioned again to a location on the port side of the bow of the boat. From this position, the team was able to mark and record the remaining hull, stem, and rub rails. The next total station position was very low to the ground at the stern of the boat. The team was able to mark and record the transom and keel of the boat. The total station was then resectioned again to a higher position at the stern of the boat in order to allow the boat recorders to complete the documentation of the transom and rub rails. The team recorded the coaming of the boat as well as the first three frame sets on the interior of the boat.

On the following day of recording, the team resectioned the total station near the starboard side of the stern of the boat. From this vantage point, they were able to mark and record the interior port side of the boat including, framing, floors, deck beams and coaming and fittings. The total station was then resectioned near the starboard side of the bow, which allowed the team to complete the marking and documenting of the port side interior frame set, coaming and fittings. The final day of recording, the total station was resectioned to port side stern of the boat to allow the team to mark and record the starboard interior frame sets, coaming and fittings. The total station was resectioned again near the port side bow of the boat in order to complete the marking and recording of the interior starboard frame sets, floors and fittings. A second total station team was positioned on the starboard side of the boat and the team marked and recorded the interior of the boat's transom. Overall, the two teams were able to record over 2,000 points in the short time frame they were given to record the boat.

At the end of each day's work, data was downloaded from the total station datalogger onto a backup computer. The data was saved both on the datalogger as well as the computer so that there was always a backup of the team's information. This data was then used to produce a three dimensional reconstruction of the boat using the CAD program *Rhinoceros* (Figure 7).

According to the team's research, the boat has been rebuilt several times throughout its life. Therefore, it should be stated that the reconstruction produced only provides a view of the boat in its last stage of life, although, it was possible to discern several of the alterations that have been made to the boat throughout its life. These modifications will be presented later in the chapter.

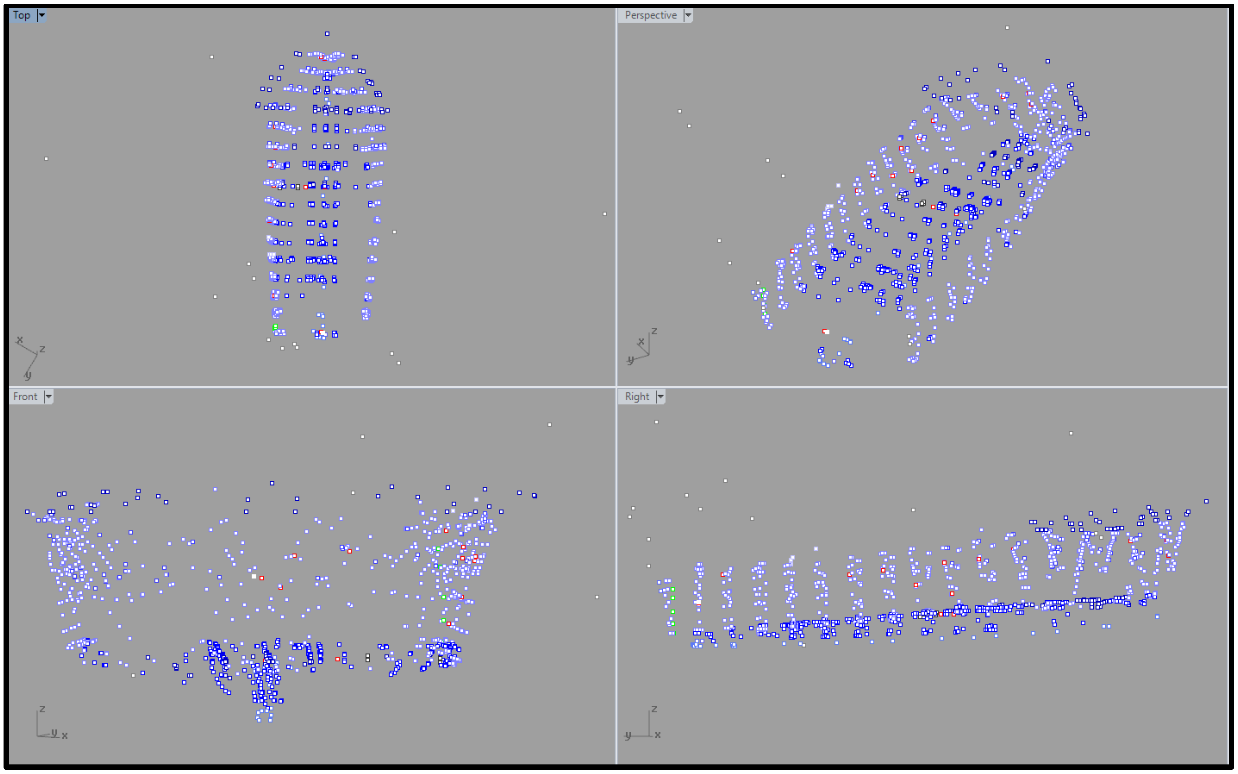

Figure 7. Point data of *Rebecca* displayed in *Rhinoceros*, with features organized by color, with viewports from top, perspective, front, and right (L to R) (Image by Nathan Richards)

Photographs

Digital photography was used to further document the boat. The photographs were taken using a Sony Cyber-shot 16.1 megapixel digital camera as well as a Canon Powershot Elph 115 16 megapixel camera. These photographs were used for reference in later analysis.

Construction Analysis

Following data collection the research team began analysis of the boat's contruction. This entailed writing descriptions of various components of *Rebecca*, including exterior features and surfaces, and construction features (stem, keel, keel shoe, transom, upper deck, coaming, rub rails, frames, ceiling planking, and strakes). Each attribute of the vessel is discussed in detail below.

Exterior surfaces

The exterior of the boat is made of wood coated in fiberglass. On top of the fiberglass the vessel was painted white with a red waterline. The exterior has several distinguishing features including tumblehome at the stern and a rising v or fading chine bow. As implied by the name, the bow has a hard flare that rises up and flares out in a v-form. This makes it ideal for the rough sound and ocean conditions in northeastern North Carolina. The v-form of the bow prevents waves from breaking over and into the vessel, acting as a shield. Rather than maintaining the flare throughout the vessel, the midship becomes straighter vertically and wider, then progresses into a tumblehome at the stern. The tumblehome allows for the ease of fishing activities that the vessel is intended for (Figure 8). A portion of the hull, where the keel meets the hull on the forward portion of the starboard side, is approximately one foot long and was patched with concrete. Other areas have been patched with additional fiberglass. It is unclear how this damage was created or when the repairs were made. The exterior clearly exhibits the imperfections of a home-built vessel, albeit by a talented builder. The imperfections also indicate many years of use, renewed coats of fiberglass and paint, and possible remodeling. When shooting the exterior lines of the vessel with the total station there was a fine line to walk between over shooting points and correctly capturing its numerous curves. Too many points of the exterior of the vessel were taken which led to a creation in *Rhinoceros's* point cloud of a curve that was much more pronounced than it really was (Figure 9).

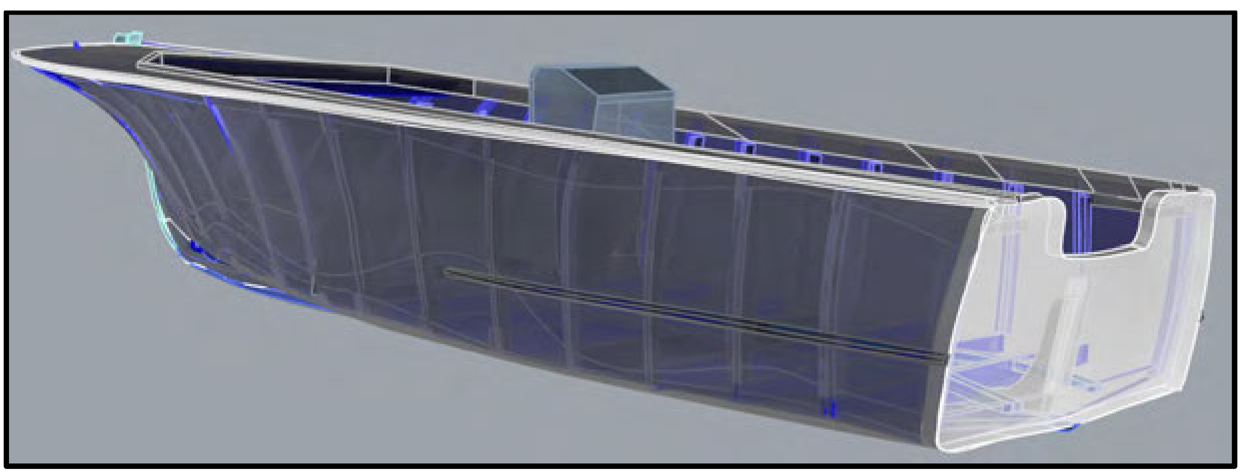

Figure 8. X-ray view of *Rebecca Rhinoceros* model showing an overview of the hull's exterior and showing the v-form at the bow, and tumblehome at the stern (Image by Nathan Richards).

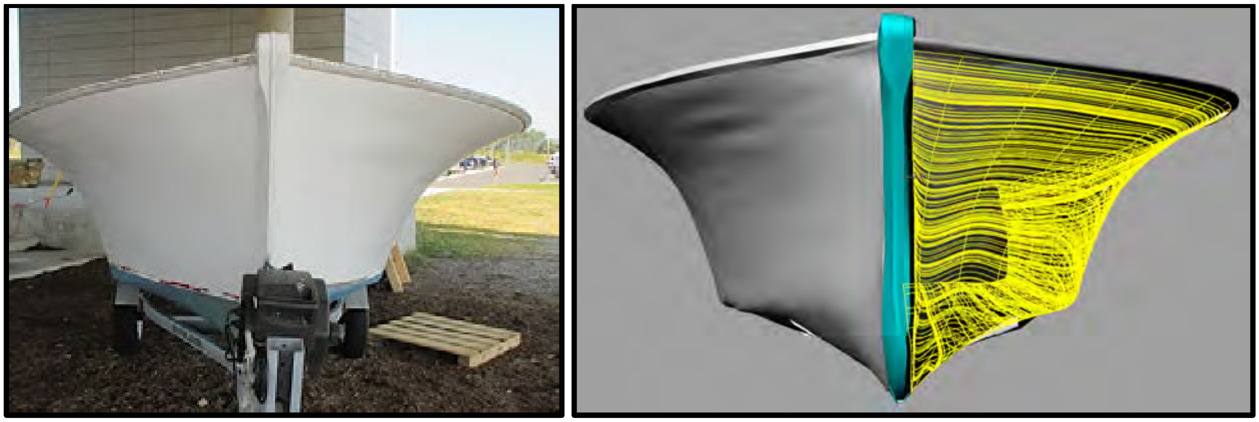

Figure 9. Exterior views of *Rebecca's* bow, showing a photograph on the left (photo by Jeremy Borrelli, 2013), and a rendered view of the bow with superimposed mesh contours on the right (Image by Nathan Richards).

Stem

Documenting the stem of the vessel was one of the more difficult aspects of the exterior. The stem faded into the hull and keel so seamlessly that it was unclear where one began and the other ended. The stem was likely a solid piece of wood. The top of the stem had a bluff square top that was shaped into a slender, curved piece of wood closer to the keel. A curved wooden block fastened to the bottom of the stem made it difficult to assess if it was made of two or more pieces of wood. The stem was dramatically curved, and measured roughly 8 cm (3.15") sided by 6 cm (2.36") molded. The top portion was formed in a square hook-like manner rising over the top deck and securing flushed to it. When this information was brought into *Rhinoceros*, it proved difficult to discern where the stem met the keel on the exterior and hence some of the results are speculative. However, given the large amount of data, the final interpretation is most likely very close to the actual measurements (Figure 10).

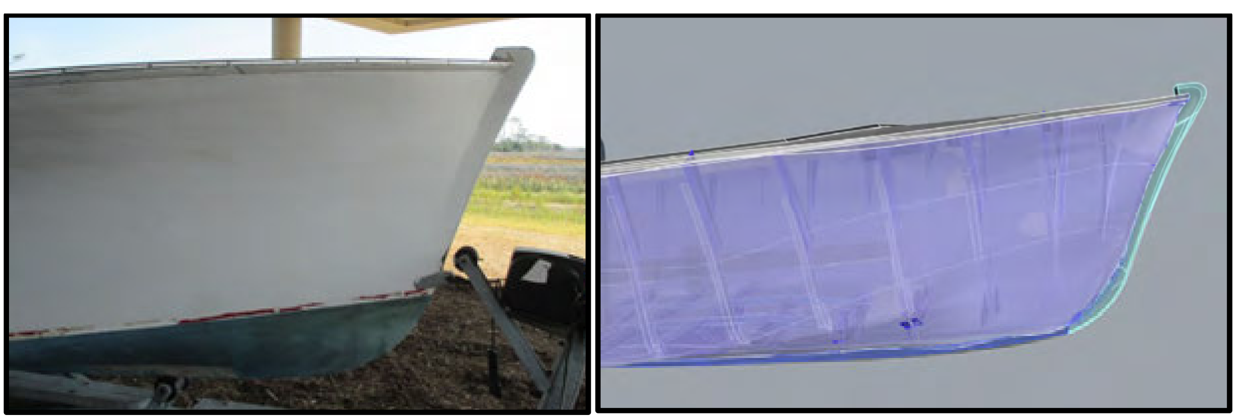

Figure 10. Exterior views of *Rebecca's* starboard site stem, showing a photograph on the left (photo by Jeremy Borrelli, 2013), and an x-ray view of the same area on the right (Image by Nathan Richards).

Keel and Keel Shoe

The keel measured 431 cm (169.69") long by 6 cm (2.36") sided by 9 cm (3.54") molded. Along the exterior and interior of the keel it could be seen that in various places the wood was joined to make a solid keel. However, due to the fiberglass and paint on the hull it is unclear in what manner the keel pieces were joined together to make a solid structure. The interior part of the keel is block-like. Once it reaches the exterior of the hull it begins to taper in a v-fashion to a thinner dimension. The front of the keel curved up to meet the rise of the bow and the stem (Figure 10). Its molded dimension also decreased as it reached the stern for less drag. It was, however, unclear where the keel ended and the stem began. The stern of the keel had a most interesting feature; 36 cm (14.17") before reaching the transom, the keel was notched, losing the large majority of its depth past the keel. For the last 36 cm (14.17") of the keel it was only 1.3 cm (0.51") deep rather than 9 cm. (3.54"). It does not appear that this portion was lost during an incident--rather it was purpose-built this way, most likely to increase the flow of water over the outboard engine. The keel shoe was quite small, measuring only 2.5 cm (0.98") wide by 0.5 cm (0.2") deep. It was also made of several pieces and attached to the keel with screws. Rather than running to the very stern of the vessel, it ended at the notch near the aft end of the keel (Figure 11 and 12).

Figure 11. Keel and keel shoe, starboard side (Photo by Jeremy Borrelli, 2013).

Figure 12. Stern portion of keel (Photo by Jeremy Borrelli, 2013).

Transom

The transom of the vessel followed the curve of the exterior. At the top corners it tapered in along the tumblehome and at the bottom corners it curved with the smooth chine. The base also curved in just before the keel. The transom was 4.6 cm (1.8") thick and fitted with a metal plate for the engine mount. It was clearly made of three pieces of wood joined horizontally, then coated in fiberglass and painted. The transom is joined to the port and starboard exterior using some form of bolt or screw that can be detected under the fiberglass but not accurately identified. This is assisted by a standing knee at the base of the interior and to lodging knees where the interior transom meets the upper deck and coaming. Capturing the transom seemed easy until the data was brought into *Rhinoceros*. It then became clear that how the transom interacted with the coaming and rub rails was different than originally documented (Figure 11).


Figure 13. Upper deck and transom of *Rebecca* (Photo by Jeremy Borrelli, 2013).

Upper Deck

The upper deck lies flush over the hull planking and extends into the interior of the vessel. At the stern it measures 10 cm (3.94") wide and is supported by a lodging knee on each side. Two-thirds of the way up the vessel it begins to broaden, quickly becoming a solid piece from side to side. From the stem, where it is a full piece, it extends 118 cm (46.5") towards the stern ending, allowing for the open area of the interior. Under the upper deck it is further supported by top timbers which join to the frame sets, small triangular hanging knees that join to the forward face of the top timbers, and a deck beam which joins to the forward face of the hanging knee running perpendicular to the hull. A batten then joins to the forward face of the deck beam and aft face of the next top timber. It appears that the deck is made of three pieces of wood. Each long side is a single piece and the board bow section is also a single piece. The upper deck is also fiberglassed and painted white (Figure 13).

Coaming

In outlining the interior of the upper deck coaming, the coaming is clearly made of five separate sections. The port and starboard each have a piece running the length of the interior, 340 cm (134") long, which end as it makes a 45° turn. The next few pieces continue 36 cm (14.17") on each side before ending in another 45° turn. The last piece, 116 cm (45.67") long, connects the two last pieces. They all measure 2 cm (0.79") above the upper deck. This provides an additional barrier for any water that comes over the bow, creating a run off system down the upper deck and off the side (Figure 14).

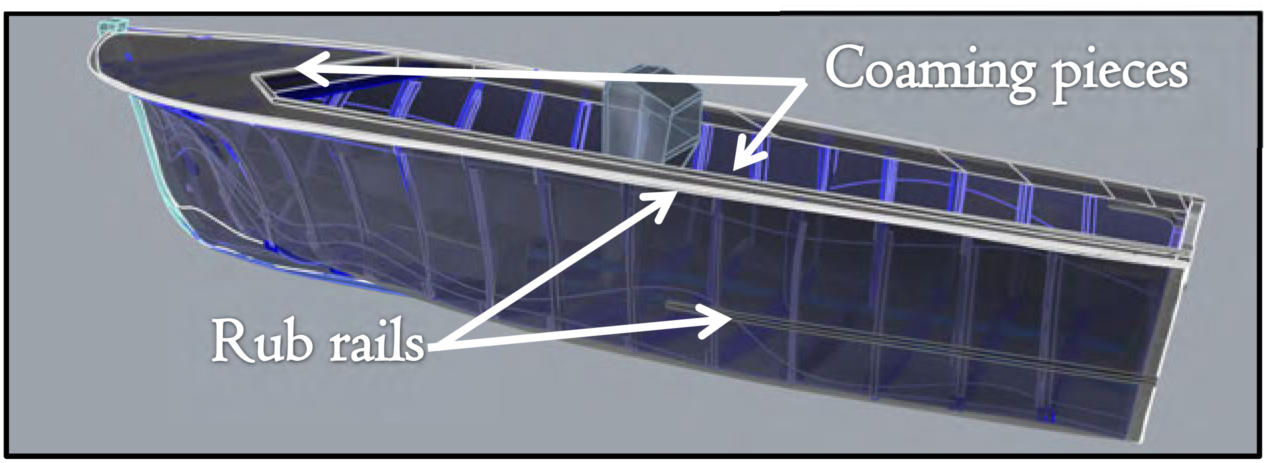

Figure 14. Port side stern exterior: coaming and rub rails (Photo by Jeremy Borrelli).

Rub Rails

The upper deck is outlined on the exterior by rub rails. Each side has a rub rail that runs the length of the exterior from stem to stern. Each consists of a triangular piece of wood that sits atop the hull planking and runs flush with the upper deck. Both sides are made of several pieces of wood cut to fit the curve of the hull. On top of the wood rub rail is a metal guard screwed onto the wooden piece, also constructed from several pieces of different length. At the stern, there is an additional rub rail on each side, which begins at the transom and extends 182 cm (71.65”) horizontally up the hull just above the waterline. The purpose of both rub rails is to protect the exterior of the hull if there is contact or collision with another vessel or structure. It also protects the vessel during fishing from the constant pulling of lines and nets up over the side of the structure as they rub and dig into the structure. This is bolstered by two small lengths of metal rub rails along a small portion of both stern pieces of coaming, where nets and lines were most frequently brought in (Figure 14).

Frames

The skeleton of the boat consists of sixteen sets of frames, each consisting of various components depending on their particular location on the boat. During examination, the frame sets were numbered beginning with the first at the bow and increasing in number aft. All further references to frame sets and their corresponding timbers will follow this numbering system. Each frame set generally consists of an alternating pattern of a floor (some with riders), futtocks, and top timbers. For most, the floors sit immediately atop of the keel with a limber hole running directly down the center of the boat. The first futtocks are placed immediately forward of their corresponding floors and extend approximately to the chine. At the chine they are bolted to the bottom of the second futtock, which runs up along the curve of the hull. The top timber is fastened to the second futtock and continues the frame up to the upper deck planking at the gunwale. The primary means of fastening the frames was by large carriage bolts measuring a little more than a centimeter in width. Some timbers forward of frame set four were fastened using nails, but in no recognizable pattern. The bolts were typically facing opposing directions, which would have added strength and stability to the fastened wood. While each frame set follows this general pattern, each displayed minor differences that lend insight into the construction and past modification of the boat (Figure 15).

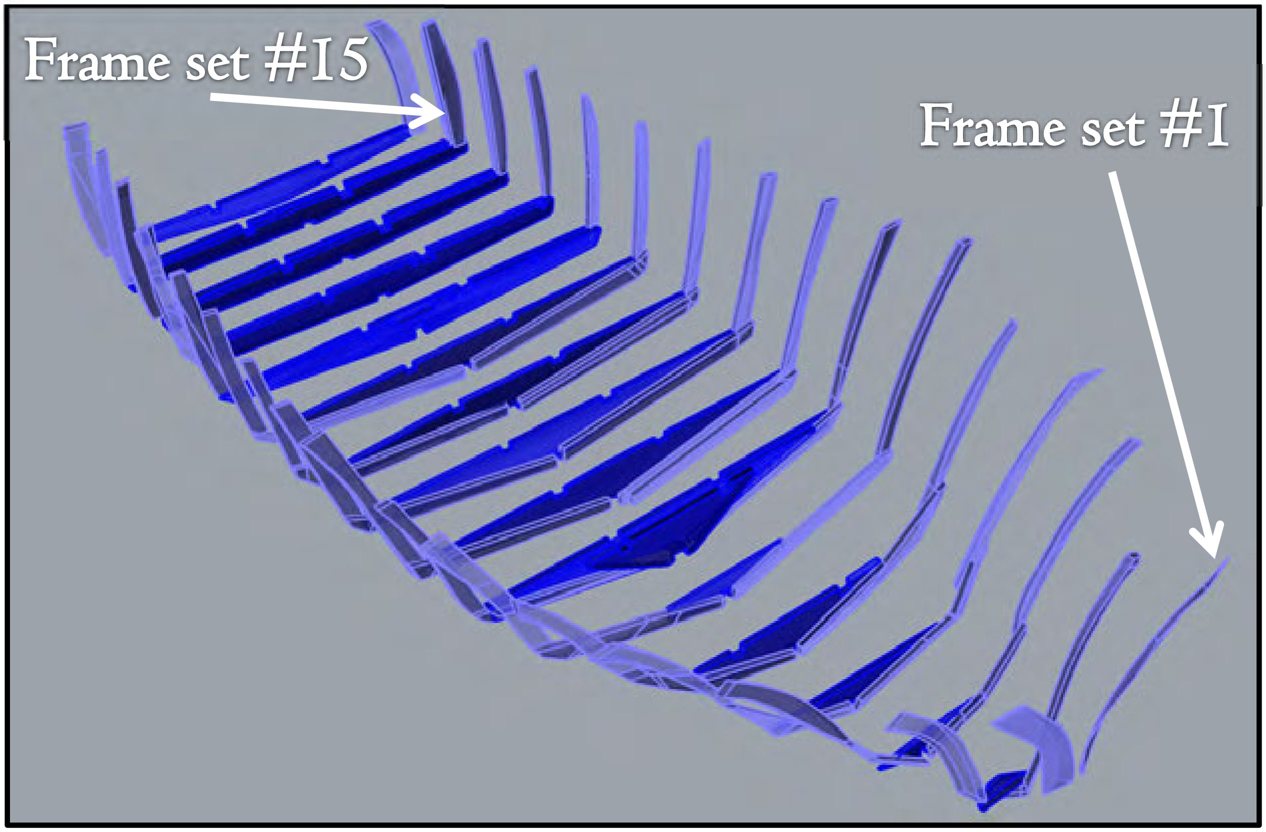

Figure 15. *Rebecca*'s frames, showing floors (dark blue) and futtocks (light blue) (Image by Nathan Richards).

Frame Set 1

The first frame set consists of a pair of futtocks that run along the sharp curve of the hull. The tops of the futtocks are screwed into the forward face of a deck beam supporting the upper deck at the bow. These futtocks have three sides with a molded (i.e., athwartship) dimension of 3.88 cm (1.528") on the port, and 5.65 cm (2.22") for the starboard. The sided (i.e. fore and aft) measurements for each are about 2.6 cm (1.02"). Frame Set 1 has the only frames not to be somehow connected to the keel or backbone of the boat. To reinforce the hull at this point, an additional timber was nailed to the forward face of the futtocks, opposite the deck beam, which serves to brace the hull and hold the frames in place. There is a hole in the middle of the added timber to allow for access to bolts fastening the stem apron a few centimeters forward.

Frame Set 2

This frame set marks the beginning of what is commonly found throughout the rest of the boat (Figure 16). Due to its location at the bow of the ship, the floor is reduced in size with a max length of 19 cm at the top and 8.49 cm (3.34") at the bottom. The molded dimension is 8.8 cm (3.46"), and the sided is about 2 cm (0.79"). This sided dimension remains consistent for all floors in the boat. Attached to the forward face of the floor on either side of the keel and stem apron are the first futtocks, which rise at a near vertical angle due to the shape of the hull. Each first futtock has an average molded dimension of approximately 5 cm (1.97") and sided measurement of 2.1 cm (0.83"). Where the futtocks differ is relative to their position on the boat, where varying lengths of the timber reflect the widening of the hull. At this frame the length of the first futtocks is about 4 cm (1.57").

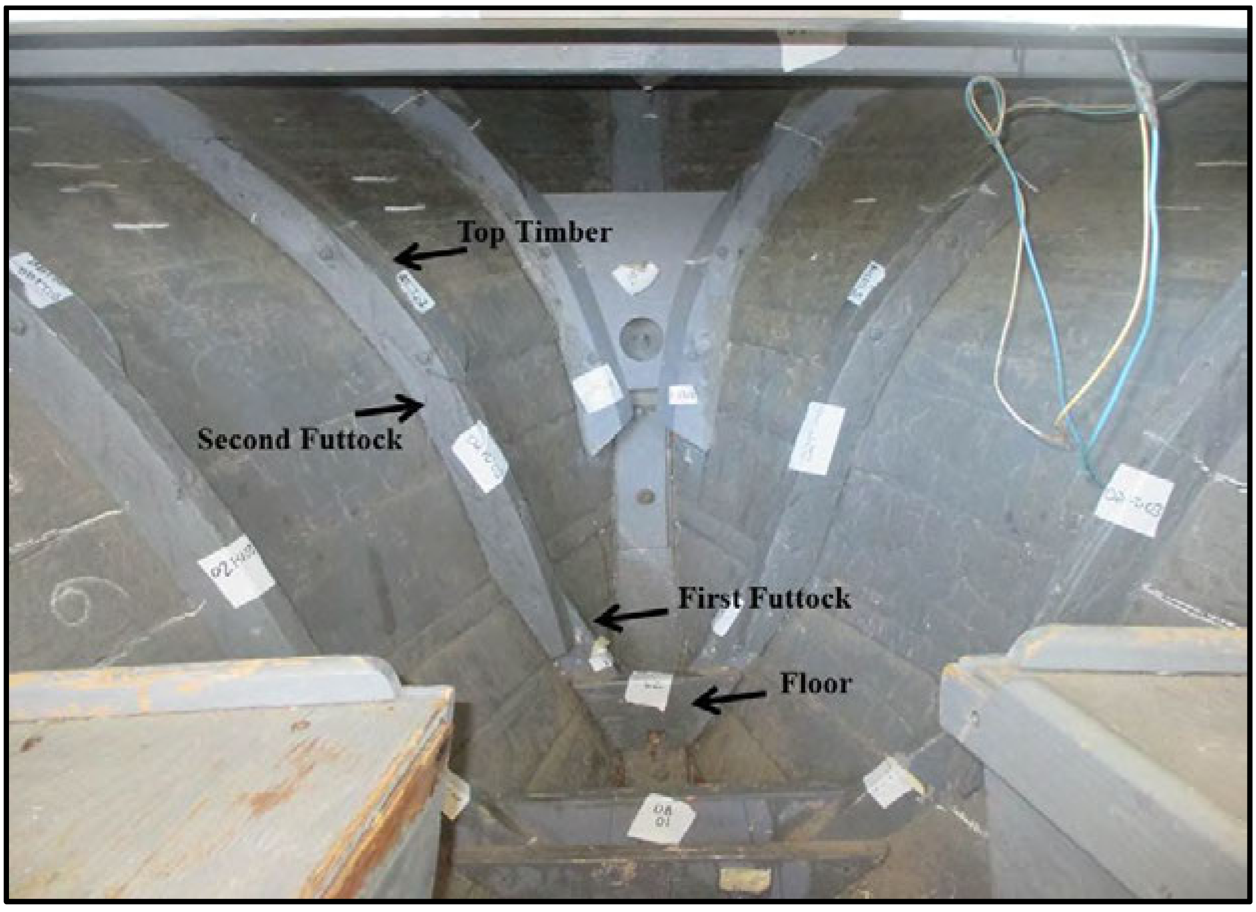

Figure 16. Image depicting the general configuration of Frame Set 2, located at the bow of the vessel. This is illustrative of the arrangement of frames in the rest of the vessel. Also in the photo are the first frame set, portions of the third frame set, the unidentified timber, and stem apron (Photo by Jeremy Borrelli, 2013).

The second futtock is nailed abaft the first, in line with the floor, and continues along the hull another 52.2 cm (20.55"). This futtock measures 4 cm (1.57") sided and 2.5 cm (0.98") molded. In general, these dimensions for the futtocks are also similar throughout the boat. The end of the second futtock is beveled, however, a feature which is not present in the other frames. This is indicative of a change in the shape of the hull outlined below (Figure 17). A little more than halfway up the second futtock, a top timber is bolted to its forward face. The top timbers have a sloping edge on their lower end and extend upward another 60 cm (23.6") to the deck, where they are bolted to a deck beam. These have a sloped edge on the lower side of the timber and are in the same general location frame to frame.

Figure 17. Image showing the beveled end of the second futtock in the second frame set (Photo by Jeremy Borrelli, 2013).

Frame Set 3

The third frame set consists of a floor measuring 38.8 cm (15.28") in total length and with a molded dimension of 10.4 cm (4.09"). Like all other floors, the sides of the timber follow the curvature of the hull, with the timber flattening back out a couple centimeters prior to the keel. The floor sits abaft the first futtocks, whose total lengths average 30.8 cm (12.13"). Fastened to the forward face of the futtocks is another floor with a sided dimension of 2.1 cm (0.83") and molded dimension of 5.9 cm (2.32"). This extra floor was probably added to the bow to provide additional strength for the hull as it moves through the water. Attached abaft the first futtock is the second, which measures 55.6 cm (21.89") in total length. The top timber nailed to this futtock is about 34.6 cm (13.62") long and is bolted to the deck beam.

Frame Set 4

The fourth frame set is composed of a single floor, two deck beams, a pair of first and second futtocks, and top timbers. The floor measures 13.8 cm (5.43") molded and 64.8 cm (25.51") in length, with a rider resting directly atop of it with the same length and sided dimensions. The molded dimension for the rider is 6.3 cm (2.48"). Forward of the floor are the first futtocks, which measure 48 cm (18.89") long. These sit abaft an extra floor whose molded measurement is 10.1 cm (3.98"). The second futtocks are bolted to the first futtocks and measure 82.9 cm (32.64") in length. The top timbers measure 41.9 cm (16.49") long and extend to the upper end of the hull.

Two longitudinal stringers begin at the fourth frame set and continue to the transom of the boat. These stringers are notched into the floors and riders aft of this frame set, explaining why additional riders were used at this point. The forward end of each stringer is located where the flat decking in the bottom of the boat ends. These stringers provided minimal longitudinal strength to the hull; their main purpose was to support the decking and the benches that were installed on either side of the boat near the bow.

Frame Set 5

This frame set contains an unidentified timber, floor, rider, futtocks, and top timbers. The rider sits forward of the unidentified timber and measures 69.2 cm (27.24") in length with the same molded and sided dimensions as the one in frame set four. The unidentified timber is shaped like the floor in the second frame set and has a similar length to the rider. It sits above the first futtock and limber hole. If gaps exist between the floor and the keel, they will cause the garboard seam to open or become loose. Timbers such as the unidentified timber in this frame set could have been used as a repair for reinforcing the garboard to the keel, floors, and frames (West System 2008:24). As shown in Figure 18, this blocking would be fastened to the keel using a large bolt. In this case, the first futtock on the port side extends slightly into the limber hole, allowing for this to be fastened together. Whether or not this is what the timber represents, it serves to add stability to the framing to support the benches on either side of the hull. The actual floor measures 14.3 cm (5.63") molded and 80.8 cm (31.81") in length. The lengths of the first futtocks are about 68 cm (26.77") and 81.9 cm (32.24") for the second, with the top timbers measuring about 53.8 cm (21.18") in length.

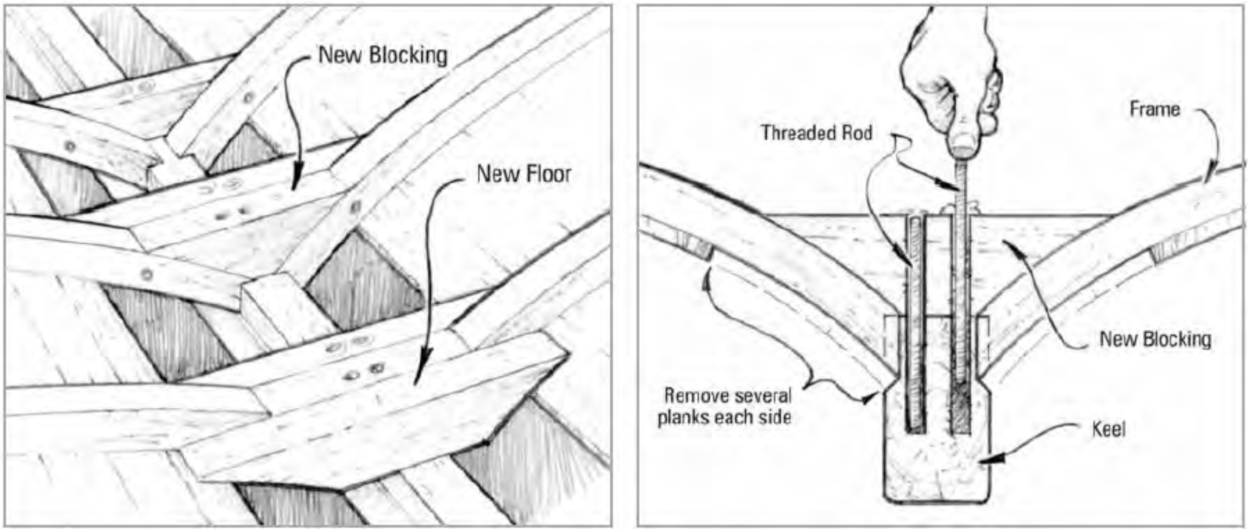

Figure 18. Images depicting the likely identity of the unidentified timber in Frame Set 5 and how it is typically fastened (West Systems 2008:24).

Frame Set 6

This frame set contains an unusual floor that only measures 45.8 cm (18.03") in length, with a molded dimension of only 10.2 cm (4.01"). It is topped by a rider measuring 119.5 cm (47.04") long. Originally this rider was categorized as part of the floor because the seam separating the two had been mostly covered by paint. Further analysis revealed that the floor ended and the rider continued to either side. It is possible that the original floor was broken and the rider represents an addition to the floor to restore it to its original size.

Forward of this rider is another which measures about 100 cm (39.37") in length and sits flush with the first futtocks. The first futtocks measure 68 cm (26.77") long and the second are 88.6 cm (34.88") long. They are also bolted to one another, with the second futtock further bolted to top timbers measuring 34.8 cm (13.7") in length.

Frame Set 7

This frame set is composed of three floor timbers, one up against the other, increasing in length aft. The first floor is 51.3 cm (20.2") long, the second 128.8 cm (50.7"), and the third 138.4 cm (54.49"). They are arranged similarly to the floors and blocking timber in Frame Set 2, where the middle floor could potentially represent a block timber to stabilize the garboard amidships. This middle floor is nailed onto the first futtocks, which extend beyond it an additional 12.9 cm (5.08") to the hull. Here they are bolted to the second futtocks, which run along the hull 68.4 cm (25.5"). The top timbers are bolted on the forward face of the second futtock and measure 33 cm (13") in total length. The aftermost floor is 19 cm (7.48") molded, in conjunction with the other two, and stretches 138.4 cm (54.49") in length.

Frame Set 8

This frame set is unique in that it contains the only set of double first futtocks on the boat. These are located on the port side of the frame set with the forwardmost futtock measuring 83.3 cm (32.8") long, while its companion abaft reaches another 2.8 cm (1.1") over the keel. The starboard side only contains this second futtock, even though there is a place for the additional futtock present. Further examination of this space revealed no fastener holes, and therefore it is believed that there was always only a single first futtock on this side. A possible reason for this configuration could be due to the bench that ends at this frame on the port side. On the starboard side, a console containing the steering wheel and associated machinery is located at this point and the additional room may have been put in place to accommodate this feature.

A rider measuring 139.2 cm (54.8") long sits atop the after first futtock, and forward of the floor, which is the same length. The second futtocks are bolted to the first at the chine and extend 66.8 cm (26.3") along the hull, which by this point has begun to flatten out, creating a more square shape to the boat. The top timbers measure about 32.8 cm (12.91") long.

Frame Sets 9-11

These frame sets are located where the run of the hull becomes straight, allowing the frame sets to become more consistent. Each are composed of the original framing pattern outlined in Frame Set 2. The average length of the floors measure 149.5 cm (58.86"), and the molded dimension is 16.5 cm (6.5"). The first futtocks average 80.2 cm (31.57") in length. Due to the relatively straight curve of the hull in this section, the second futtocks rise about 64.8 cm (25.5"), and the top timbers extend this height to the gunwale about another 6.8 cm (2.68"). On frame 11, the top timber is fastened lower on the second futtock by 11.4 cm (4.45"), and this position continues to the transom.

Frame Sets 12-13

At this point, the frame sets maintain the pattern of framing with one exception: the first futtocks are replaced by a second floor timber (Figure 19). The additional floor on the forward side of the traditional floor in each frame set is notched in key places that indicate the location of the console when the vessel had been navigated using a center-console (Figure 13). The average length for both floors is about 152.1 cm (59.88"), and the molded dimension of each is approximately 12.9 cm (5.08"). Furthermore, the forward floor extends another few centimeters to the side of the hull and is fastened with a bolt to the first futtock for these frames. The first futtock in these frame sets, located at the position of the second futtock for the previous frames, begins to curve inwards to support the tumblehome of the vessel at the stern and average a length of about 61 cm (24"). The top timbers on these futtocks have a length of 39.1 cm (15.39") for the twelfth frame set, and 32.8 cm (12.91") for the thirteenth.

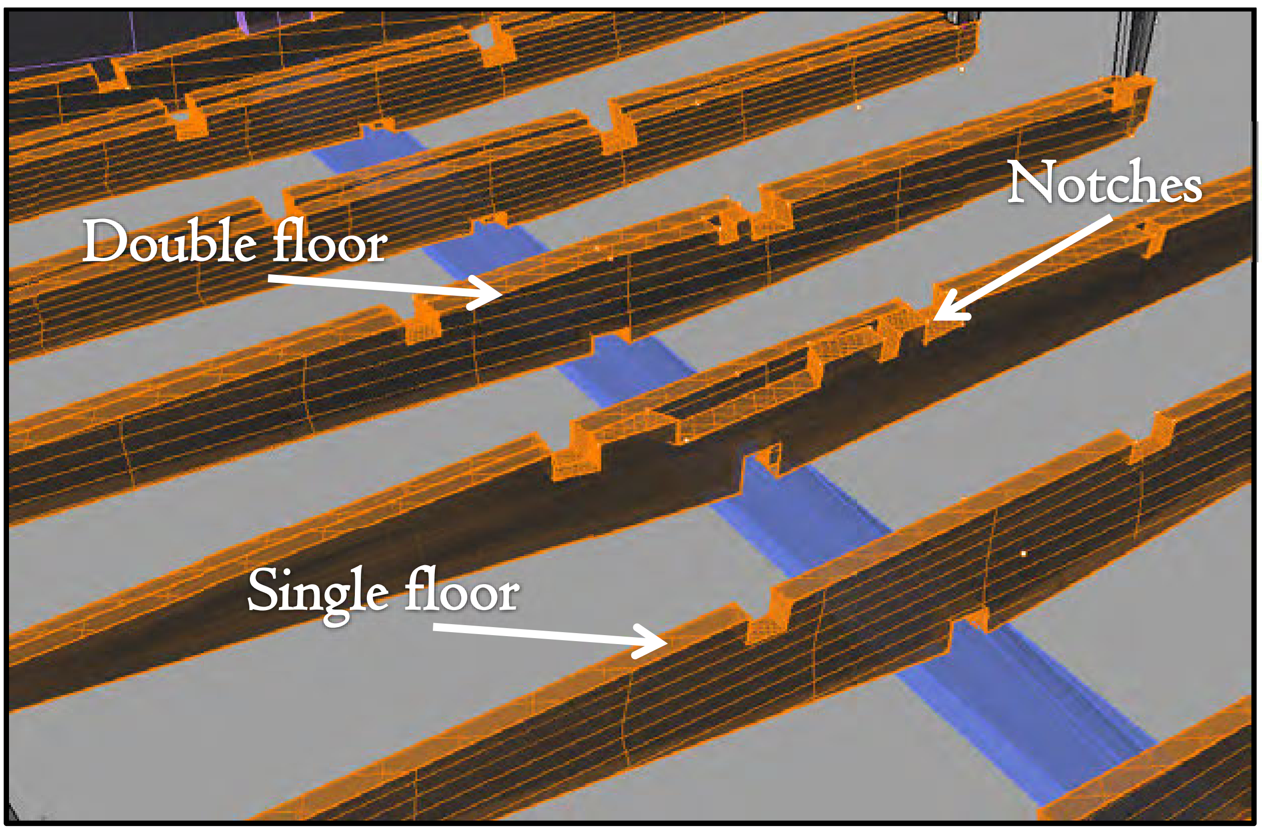

Figure 19. *Rhinoceros* image showing the transition to double floors and the notches that indicate the position of the console when the console was mounted in the center of the boat (Image by the authors).

Frame Sets 14-15

These frames depart from the original pattern and consist solely of two floors and two futtocks. The floors rise about 10.1 cm (3.98") from the keel and stretch laterally 150.1 cm (59.09") to either side of the hull. The futtocks in these two frame sets sit on top of the floors. The forwardmost futtock averages 58.6 cm (23.07") in length and replaces the top timbers by extending above the futtocks immediately following them by 4.4-8.8 cm (1.73-3.46"). The futtocks abaft these measure approximately 53.2 cm (20.94") in length. This configuration could have served several purposes. The added strength the additional floor brought to the stern of the boat would have aided in bracing the hull from the vibrations of the outboard motor attached to the transom of the vessel. Additionally, the extra timber would have supported the stern of the vessel with the additional weight associated with the center console located forward of the stern.

Frame Set 16

The final set of frames were located directly along the transom of the boat. This set consisted of a single floor, and a pair of first futtocks, which formed the shape of the transom tumblehome. The floor stretched from futtock to futtock and had one support beam and transom knee adjacent to it along the keel in order to support the outboard motor and transom. The total length of the floor measured 131.4 cm (51.73"), with a molded dimension of 9 cm (3.54"). The first futtocks were significantly curved to support the tumblehome of the stern and ran 50.8 cm (20") in length on the port side and 52.7 cm (20.75") on the starboard side. It is important to note that this frame set would have been the major support system for the stern of the boat and would have been used to shape the transom of the vessel.

Hull Planking

There are twelve identified strakes that together comprise the hull of the boat. The widths for each plank were measured in the room between each frame set. The planking begins with the inner side of the keel, which runs longitudinally along the center of the boat just below the midline of the floors. The sided dimension of the upper face of the keel is approximately 10.1 cm (3.98"). Straddling either side of the keel is the garboard, which measures 12.2 cm (4.8") in width. Based on reconstruction measurements taken between the interior and exterior hull sections in *Rhinoceros*, the average thickness of each plank can be estimated at about 4 cm (1.57"). The thickness of the planking can vary depending on the requirements of the individual location along the hull, and therefore the thickness measured above may not necessarily reflect the total thickness of all strakes along the hull (Estep 1918:64-68). Three more strakes form the bottom of the boat. Strakes 2 and 3 measure an average of 18.5 cm (7.23") wide, while the fourth strake increases in width to 20.4 cm (8.03"). The fourth strake butts against the chine of the boat, which is represented by another plank measuring 3 cm (1.18") in width.

The fifth through the seventh strakes on the port side, beginning directly above the chine, measure 12 cm (4.72") in width. The starboard equivalents of these planks measure an average of 14 cm (5.51") amidships. The eighth strake is composed of five small planks that are about 25 cm (9.84") wide. During construction, many shipbuilders will use a different number of strakes to satisfy the individual characteristics of the hull. Given the distinct flare of *Rebecca*, this was certainly the case. The increased number of planks associated with the eighth strake and above corresponds with the level of the hull where the curve is at its greatest. The smaller number of planks would have been easier to bend to create this sharp flare. The ninth strake measures about 11.8 cm (4.65") wide and the tenth 8.5 cm (3.35").

Strake Widths at Three Different Sections of the Boat

When constructing a hull, the widths of the planks tend to taper or widen closer to the bow and stern to accommodate the curvature of the hull, which in the present case is more pronounced closer to the bow. The differences between the measurements taken at the stern, amidships, and at the bow are listed in Table 1 and demonstrate the changing widths of the strakes as they curve to create the shape of the hull.

Table 1. Changes in width of the planks from the bow to the stern of the vessel. N/A indicates that no measurements were taken and a dash represents points where the plank was either not present or could not be measured. All measurements in centimeters.

	G	2	3	4	5	6	7	8	9	10	11	12
Bow	-	3	6.5	8.4	15	8.5	10	9.7	4.5	3.5	6.5	12
Mid	12.2	17.5	17.5	20.4	12.1	12	11.5	9.5	2.5	2.5	5.5	5.9
Stern	18.6	N/A	N/A	N/A	6	10.4	12.1	9	7.5	7.5	-	5.6

There are several features of the planks highlighted in Table 1. First, the planking on the lower hull of the boat show a distinct change from the bow to amidships where the planks get markedly wider fore to aft. This is due to the fact that the bow features a narrow v-shape. As the planks approach the bow, they must narrow. Second, widths of the planking on the sides of the boat close to the chine, strakes 5-8, remain relatively constant. These planks are where the curve of the hull is the most consistent. Therefore, there is a slight decrease in width close to the bow, followed by an increase amidships, and subsequent decrease at the stern. The planks above this reflect a change in hull shape with the distinct flare of the bow as well as potential modifications to the hull whereby the eleventh and twelfth strakes were likely added after initial construction.

Interpretation

In depth analysis of *Rebecca*'s hull construction revealed important insights into the life history of this vessel, and indicated a pattern that corresponds to a major renovation of the hull. In every frame set, each of the second futtocks lined up with one another along the hull planking. Frame Set 1, located in the bow, was the only exception and will be discussed below. Additionally, the tenth strakes on both starboard and port sides, also lined up with the top of the second futtocks as they progressed towards the bow. Aft of the tenth frame, the tenth plank on either side of the vessel curved inwards to create the tumblehome at the stern. This construction pattern indicates that at one point during the boat's life history, the hull of the vessel only had a floor, first futtock and second futtock to frame the boat, while the hull planking only consisted of ten strakes. This demonstrates the manner in which the boat was originally constructed, and later modified to its present condition.

Based on these observations made during fieldwork it was apparent that the bow of Rebecca was raised and the flare extended outwards. This is evident by the presence of an added top timber to the frame sets and additional hull planking, particularly at the bow. In order to raise the hull structure at the bow, top timbers were added to the existing frames at the second futtocks from Frame Set 2 to Frame Set 14. Following the pattern of alternating the attachment point of the first futtock to the second futtock, the top timbers were attached to the forward face of the second futtock and shaped to the necessary height modification. The top timbers not only the extended flare of the bow, but also provided further support to the modified outer hull. These timbers were also attached to smaller deck beams to support the gunwale and upper deck of the boat. This pattern continued to Frame Set 14, where there are no observable top timbers. Instead, there are two second futtocks that are joined flush to one another along the hull planking. Therefore, the original height of the stern remained constant during the refit of the bow. Since Frame Set 1 was located in the bow, it was likely inserted during the renovation to support the forward-most section of the raised hull.

Furthermore, on the port side of the vessel, beginning just aft of Frame Set 9, the eleventh hull strake began and eventually reached a maximum of 11 cm (4.33") in width as it moved forward. On the starboard side, this plank was visible forward of the ninth frame set, but appeared to begin aft of Frame Set 9, behind an additional batten straddling the tenth and twelfth strakes (Figure 20 and 21). These two planks raised the upper deck of the boat and allowed the builder to extend the flare of the bow. Each additional hull plank above the tenth strake would have been added to the hull and primarily attached to the top timbers to complete the extension of the bow. For example, at the flare of the bow, multiple additional hull planks were noted to accommodate the necessary curvature of the hull. These added hull planks also explain the beveled first futtock in Frame Set 2, shown in Figure 17, which indicates how the original hull would have been shaped. On the original hull, the tenth strake would have sat flush with this curve in the first futtock to form the shape of the bow. During the refit where the bow was raised and widened, this tenth plank was likely bent outward and up to enlarge the flare in the bow, which resulted in the top of the futtock remaining off of the hull planking. This would have given the vessel added stability and seaworthiness the ocean, and allowed it to easily cut through waves. The whole procedure, however, would have been a major refitting operation for the vessel involving the reconstruction of the stem, gunwale and upper decking. This vital part of *Rebecca*'s life history was uncovered through meticulous examination of the construction patterns evident in this historic craft

Figure 20. Image showing the port planking above the chine, with the beginning of the eleventh strake in line with the tops of the second futtock indicating the original height of the hull (Photograph by Jeremy Borrelli, 2013).

Figure 21. Image of the beginning of the eleventh strake on the starboard side of the hull. The additional batten on the tenth and eleventh planks is indicated by the arrow (Photograph by Jeremy Borrelli, 2013).

Conclusion

The above methods and analysis of features illustrate the boat builder's techniques, construction technology, and modifications performed on the vessels over the span of nearly half a century. The use of the total station allowed the team to record the dimensions and details of the vessel with good accuracy. The use of *Rhinoceros* produced a 3D digital model that can be studied and admired by many from the comfort of home in a virtual realm where it can be preserved for many years to come. Analysis of the data revealed creative troubleshooting on behalf of the boat builder to address desired modifications. For example, Oscar Roberts must have desired to improve the seaworthiness, speed, and stability of the craft in open water conditions for purposes such as deep water fishing, so he made the decision to raise the hull and extend the curve of the bow. To do this, he built in top timbers to extend to the heightened gunwale and flushed them against the futtocks for added support. Doing so improved *Rebecca*'s ability to withstand rough weather. This history is tangible in the construction of the boat and is why in depth analysis of these locally built watercraft are so vitally crucial. In cases where boat builders seldom leave behind records of work performed, such as boat plans, a careful study of the boat's features and construction may yield insights as to why the boat was built, the boat builder's methods and techniques, and perhaps reasons for building the boat or feature one way as opposed to an alternative way.

A NORTH CAROLINA SAILING SKIFF
(WPT Vessel #2013.09.04)

Kara Davis, Phil Hartmeyer, Alyssa Reisner, and Caitlin Zant

Introduction

Examining and recording information about small boats not only provides technical data in the form of measurements, but the construction style and purpose of the vessel can reveal wider implications concerning the boat builder and the culture from which the boat came. These records are also significant as they provide future researchers with detailed documents. The specific case of a sailboat, boat number 2013.09.04 (Figure 22), built by Oscar Roberts in the 1980s, is illustrative of these points. The examination of this North Carolina-built sailboat can reveal information concerning the purpose for which the builder created the boat, and this can lend insight into his socioeconomic status, environmental surroundings, and the culture in which he lived. This chapter outlines the methodology utilized by the authors to record a North Carolina Sailing Skiff (WPT Vessel #2013.09.04) before analyzing the history of the vessel via an interpretation of its construction.

Figure 22. Vessel Number 2013.09.04 in its position to be measured (Photograph by Alyssa Reisner, 2013).

Various methods may be used to record small craft. As technology advances, so do the means of taking measurements. Total station recording methods are a digital alternative to taking all of the boat's measurements with rulers and tape measures. The results of this data can then be imported into 3D modeling software to make a digital reproduction of the boat. The following section reviews the methods used to record the sailboat's measurements along with the vessel's function, hull form, dimensions, structural components, and construction.

Methodology

In the fall of 2013, students enrolled in the Maritime Studies course *HIST 6850 Fall Field Research in Maritime History* were engaged in the complete documentation of four North Carolina built small boats from the Whalehead Preservation Trust in Currituck County. The goal of this project was to accurately capture enough detail and accuracy to be able to reconstruct each assigned boat in the future. This section will outline the methodology selected by the authors for use on boat 2013.09.04.

Each recording team was given the opportunity to choose a specific recording process for the complete documentation of a North Carolina-built boat. Available recording methods included using traditional baseline-and-offset measuring systems or total station surveying and measuring equipment. The authors opted to conduct complete documentation of their assigned boat with the total station equipment because of its ability to accurately and quickly record large amounts of data. Recording techniques involved a combination of Topcon total stations, hand drafting, annotated measurements, photography, and McNeel's *Rhinoceros* 4 3D modeling program. The following section discusses the methodology used which culminated in enough data for a comprehensive analysis and interpretation of the hull structure and boat construction.

Point Catalog and Hand Drafting

The first step of the recording process entailed creating a recording system that would ensure all areas of the boat were accurately recorded. Standardized forms were developed to form the core of a comprehensive recording catalog; the forms included the name of the project, vessel number, drawing view and type, date, and the recorder's name. Using the standardized catalog forms, the boat was divided into small sections for the recording group to draw each feature (Figure 23).

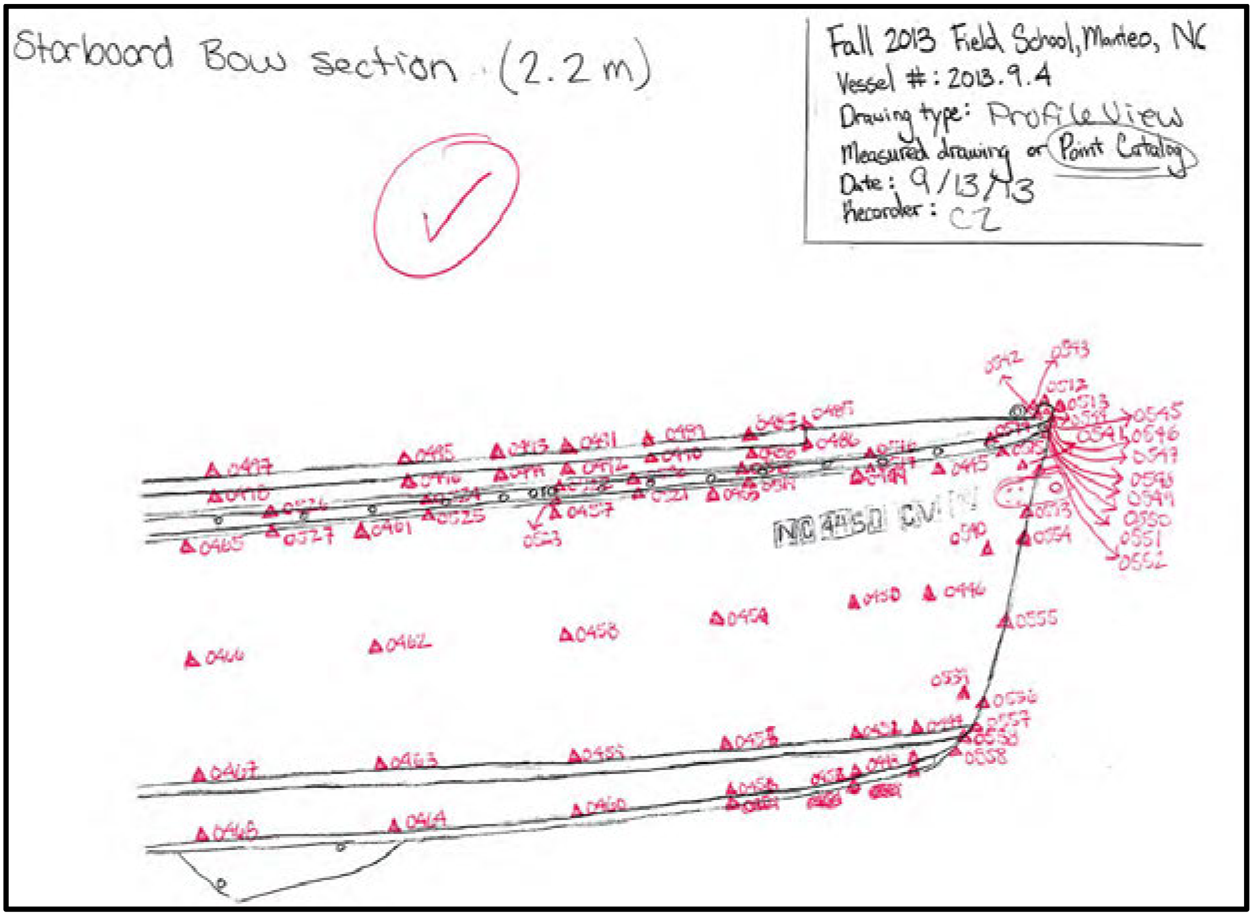

Figure 23. Finished drawing of starboard bow section with individually marked and numbered points recorded by the total station (Image courtesy of Caitlin Zant).

The catalog drawings included details regarding the faces, sides, and angles of timbers. This step in the boat recording process is crucial for digital model creation, as it provides dimensional data needed for determining the recorded locations of total station points. During total station recording, the captured points were individually marked and numbered on the catalog sheets to ensure organization and corroboration for 3D modeling purposes (Figure 24). The completed drawings also captured necessary details including warping, tool marks, and construction techniques that would be difficult to recognize through total station recording (Stewart 2012:3-4).

Often times, features intended to be mapped with the total station were obstructed or hidden by other structural features. When the total station was incapable of capturing these points, the feature was accurately measured by hand. Annotated drawings also ensured comparability of data to total station points. All measurements were taken in metric units. Upon the completion of each drawing, catalog forms were collected and organized by feature in a timber catalog (Figure 25).

Total Station Point Catalog					
Project:	Fall 2013 Field School				
Location:	Manteo, NC				
Site Number:	2013.9.4				
Dates:	9/13/2013				
Recorder(s):	Phil Hartmeyer, Kara Fox, Caitlin Zant, Allysa Reisner				
From Point:	To Point:	Point Type:	Face/Side:	Notes:	Completed?
1	5	XE01	BB	0001 DD for lower edge rub rail / 0005 DD for keel rabbet	Yes
6	10	XE02	BB	0006 " / 0010 "	Yes
11	15	XE03	BB	0011 " / 0015 "	Yes
16	20	XE04	BB	0016 " / 0020 "	Yes
21	24	XE05	BB	0021 " "	Yes
25	28	XE06	BB	0025 DD for lower edge rub rail	Yes
29	32	XE07	BB	0029 " "	Yes
33	36	XE08	BB	0033 " "	Yes
37	40	TM	BB	0037 " "	Yes
41	69	SM	BB	0049 DD for lower edge of rub rail / 0050 DD for upper edge of rub rail	Yes
70	91	RR01	BB		Yes
92	107	CM01	BB	outside port	Yes
108	122	KL			Yes
123	126	FD			Yes
127	134	CM02		front coaming	Yes
135	144	AP		0137-0140 DD for ST1 & ST8 (ST1: 0137,0139) (ST8: 0138,0140)	Yes
145	176	SL			Yes
177	182	MC		one in TS, to be copied in rhino, other 3 some shape? Confirm note	Yes
183	187	ST10	SB		Yes
188	215	ST08	SB		Yes
216	223	TH01	SB & BB		Yes
224	238	SC02	SB		Yes
239	261	SC01	BB		Yes
262	280	ST01	BB	0264-0269 DD for F7-F5 Aft Face / 0279-0280 DD for F1 Aft Face / 0273-(	Yes
281	283	ST09	BB		Yes

Figure 24. Example total station point catalog form (Image by the authors).

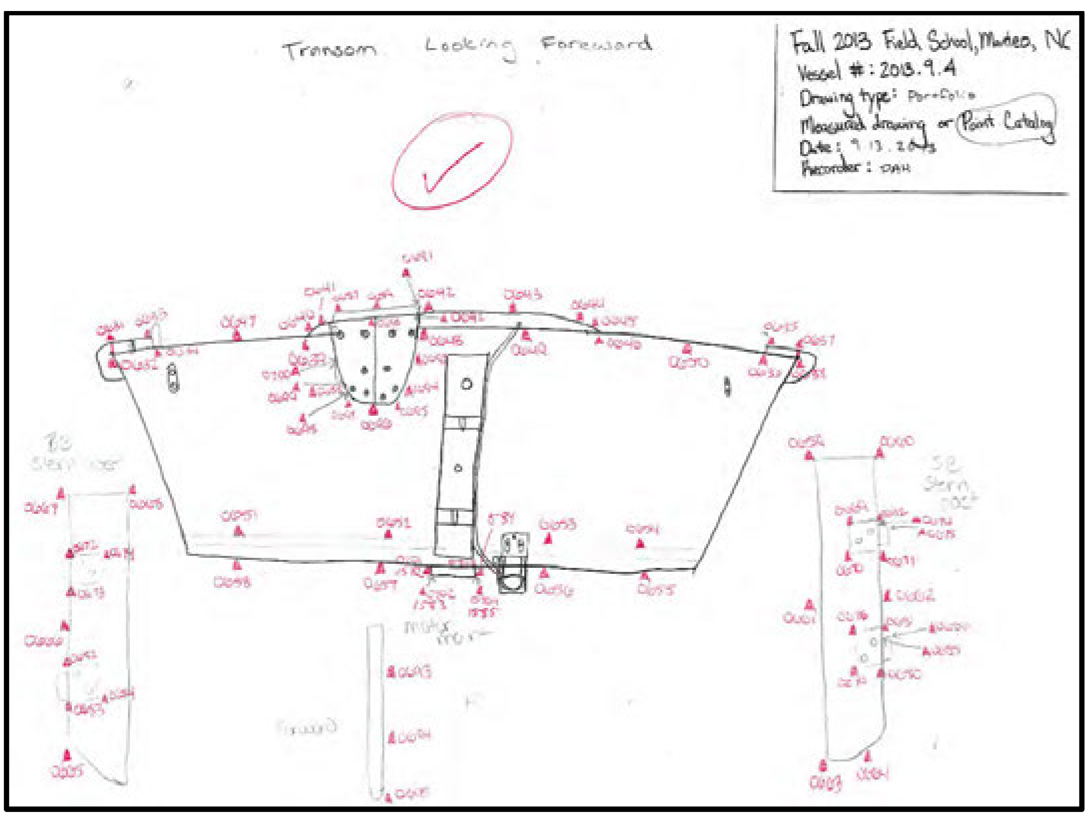

Figure 25. Example timber (transom) recording drawing (Drawing by Phil Hartmeyer)

Total Station

Total station recording combines traditional methods (measured drawings done by hand) and more recent technologies (total station distance measuring equipment). The total station captures the orientation and distance of points located on surfaces, edges, curves, and features located on the object or site. The total station measures these points and records precise three-dimensional coordinates relative to one another. These points are then transferred into modeling software. Once the point data has been compiled and interpreted, a digital model can be assembled. This type of technology has been used widely in land surveying and terrestrial archaeology. The technique is best suited for maritime sites on land, that are floating, or are partially submerged (Campbell 2009:2; Green 2011:42; Stewart 2012:2).

The authors primarily recorded the boat with a Topcon ES-102 reflectorless total station and a Topcon FC-2500 datalogger. An attempt was made to deploy a secondary recording team which would simultaneously capture points with an additional reflector-dependent total station. Although some points were successfully recorded, this process proved ineffective. However, the reflectorless total station provided accurate results in a short amount of time, requiring no prism or reflective target. Although modern reflectorless systems are more accurate than older total stations, they can pose a potential drawback. With no target or prism in use, an incorrectly sighted point can record anything in its line of sight—producing false, inaccurate points.

Prior to the boat recording process, the total station required a series of datum points to be established around the site. Measurements were taken from these datums, which were then measured directly to recorded points on the boat. This process is called resectioning. Each time the total station was moved to a new location for data collection, resectioning had to be repeated. This process allows the total station to capture points in different locations, relative to the existing points and the ring of datum points. When measuring the datums at a new location, the program indicated if the recorded datum point had been measured within a specific range of tolerances. If unsuccessful, the point was re-measured until a successful percentage of tolerance was achieved (Stewart 2009:10). Errors in resectioning sometimes produced inaccurate point data. After all the data points for a particular area were successfully recorded the total station was moved and resectioned into a new location.

With the boat supported by a trailer, boat recorders opted to arrange the boat in the most accessible position for the total station to allow for maximum data collection. The boat was positioned with the two bottom wheels on the ground, and the top wheel resting on a concrete step. This provided the best recording position—allowing the total station to record on an elevated level looking down into and around the boat. Similarly, it allowed the total station to be lowered to the ground with access to the bottom of the boat. The boat's location also provided more innovative recording techniques using the assistance of a truck—capturing points through the elevated deployment of the total station in the bed of the truck and on a stool (Figure 26).

Figure 26. The authors at work shooting total station points (Photograph by Caitlin Zant, 2013).

The recording team was divided into four roles: the shooter, the pointer, the archivist, and the organizer. Members of the recording team rotated through these roles to obtain maximum exposure to all aspects of total station recording. The shooter managed the total station, locating and shooting points. The pointer assisted the shooter with finding the location of each point, also acting as a "backstop," ensuring the total station captured the correct location of the point. The archivist kept account of the boat catalog, recording the actual points taken in the point catalog. The organizer assisted the cataloguer and shooter with maintaining catalogue sheets and labeling layers within the Topcon field recorder.

While shooting, it was important to remember which points would give the maximum amount of information about the position, angle, and size of the timbers—as well as capturing the shape of the hull. The team chose to begin recording at the bow, and they proceeded aft down the boat's port side. Once the exterior lines were recorded on the port and starboard sides, the authors chose to move towards the stern section of the boat to record the transom and interior features. Shooting continued until all required points that could be captured from any given location were recorded. The point data was saved within the datalogger unit, and, at the end of each day, the data was transferred from the unit into a computer and stored in folders for each day. Once the fieldwork was finished, the raw point cloud data was imported into computer-aided design software (McNeel *Rhinoceros* 4) where it would be worked into a digital model.

Three-Dimensional Modeling

Following the recording process, total station data was entered into *Rhinoceros* 4. *Rhinoceros* enables the creation of three-dimensional models derived from the total station point data. Data based on evidence from archaeological, historical, or iconographical contexts is integrated and entered into *Rhinoceros* to create lines and curves. Connecting coordinate data creates an extremely accurate 3D model.

The final recorded point cloud resulted in over 1,700 points (Figure 27). Once the total station data had been compiled and transferred into *Rhinoceros*—the total station points were further organized into layers representing structural components, features, and timbers. These layers were each labeled and assigned a corresponding color. The individualized layers provided the ability to selectively view and build individual features such as the futtocks or floors. The option to color-code specific features or shift viewing angles also enhanced the modeling process and value of the final data products.

The authors ordered the organized layers sequentially according to basic shipbuilding techniques, starting with the "backbone" of the boat including the keel, stem, and transom. Next, the exterior and interior line layers of the boat were constructed. This provided the basic hull shape for the interior features. After this, the futtocks, floors, stringers, centerboard, and storage locker were assembled. These features provided the major interior structural components of the boat. Lastly, miscellaneous features including the brackets, coaming, rub rail, thwarts, thwart risers, and fittings were composed and added to the model. Once the model was finished (Figure 28), contextual colors and surfaces were applied to improve realistic appearances.

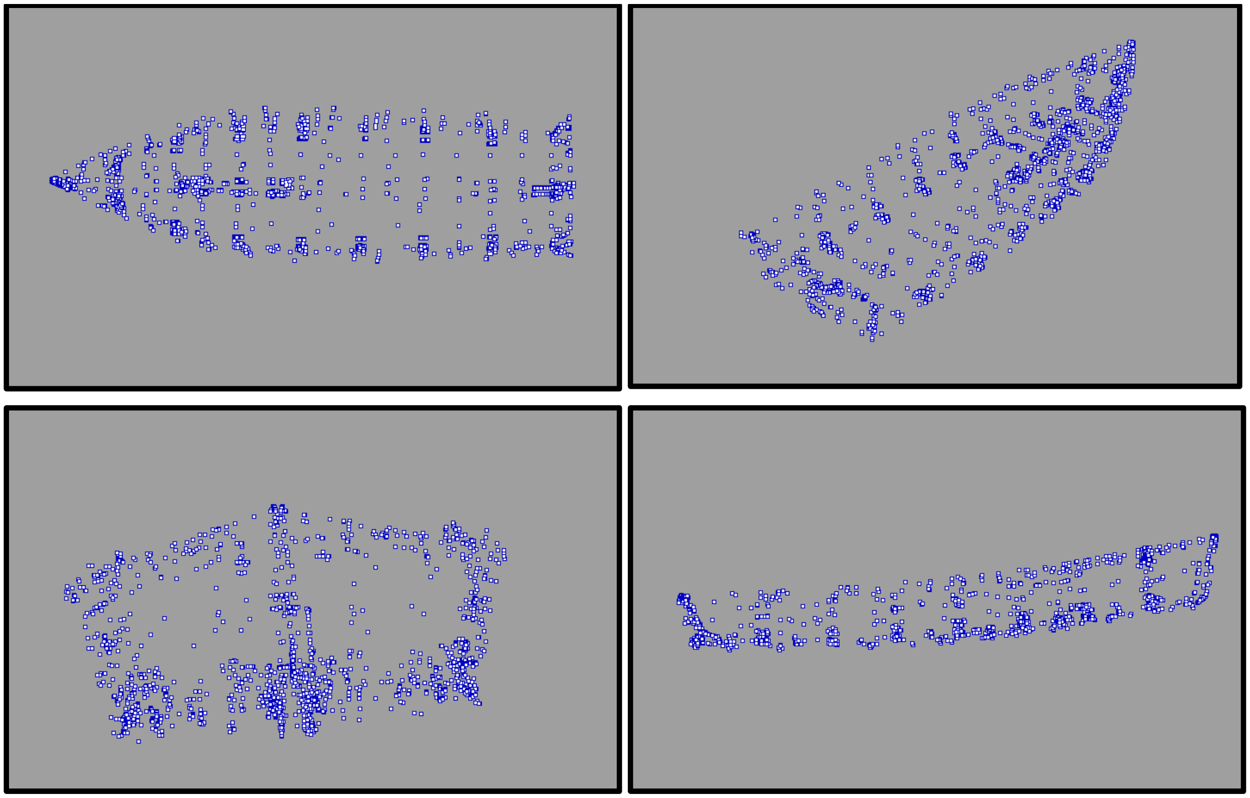

Figure 27. View of 1,700 recorded points from top, perspective, right, and front perspectives (clockwise from top left) (Image by Nathan Richards).

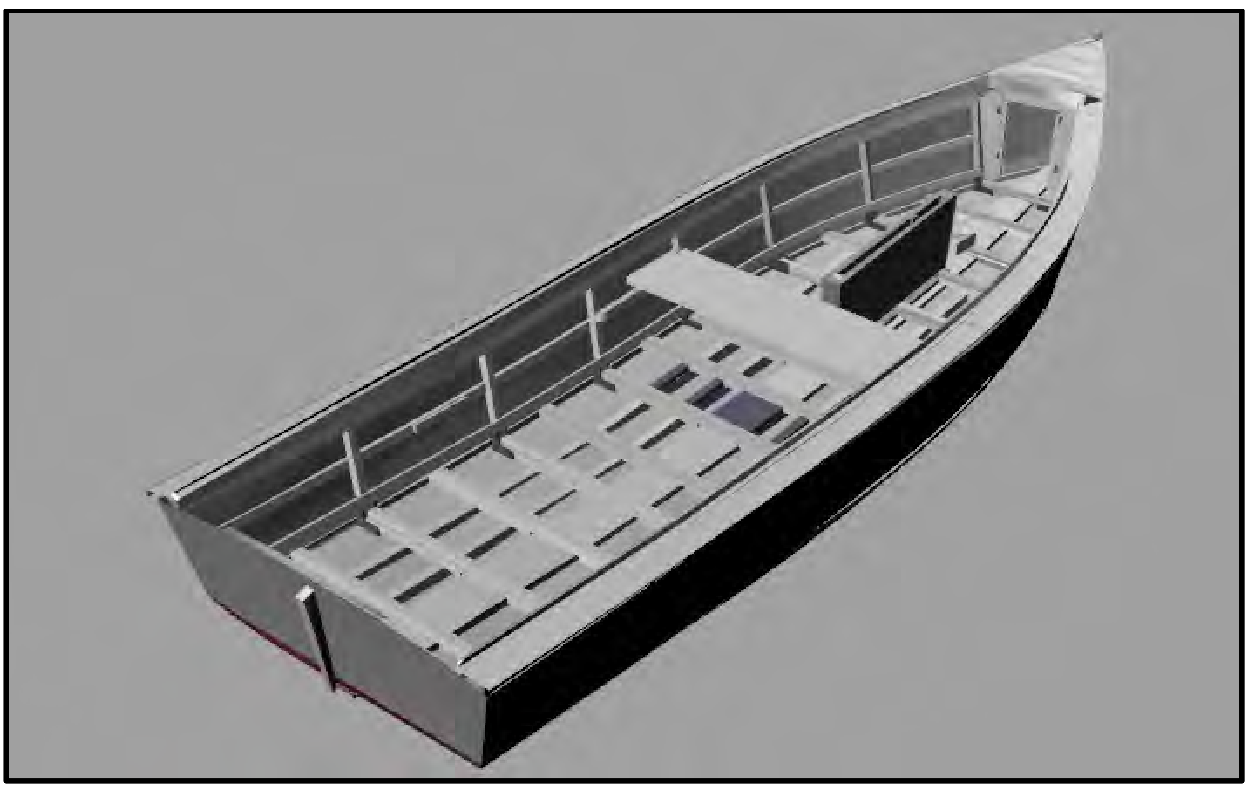

Figure 28. View of final rendered digital model from *Rhinoceros* (Image by Nathan Richards).

Photography

Digital photographs were taken of the entire boat and of individual features and timbers. This imagery provided additional documentation and supplemental references that assisted with digital modeling efforts. All photographs were taken with a Canon T2i SLR digital camera.

Interpretation and Analysis

Following recording and reconstruction, the boat's structure could be subjected to interpretation and analysis. This section outlines a discussion of the boat's function, hull form, dimensions, structural components, and construction.

Function

The shape, size, and design of this vessel strongly suggest that it was utilized in the shallow sounds of North Carolina, and that it rarely ventured into open waters. The presence of seven features supports this conclusion: centerboard, short keel, flat bottom, digital fish finder, oarlocks, and small transom motor mount.

These features are of particular importance in determining 2013.09.04 as a vessel that mostly sailed in shallow water. Further, the two-part mast, centerboard, and 17' overall length allowed the vessel to be easily trailered and launched at even the smallest boat ramps. Based on these characterizations, it is likely the boat's owner and builder, Oscar Roberts probably used the boat primarily for recreational fishing and boating.

Discussions with Oscar Roberts's eldest son, Glen, further contributed to knowledge about 2013.09.04's function. According to Glen, 2013.09.04 was the last boat that Oscar built, and it was designed to be operated by one person, as exemplified by the scarfed mast. The scarfed mast allowed Oscar to step the mast and sail the small craft alone..

Oscar finished 2013.09.04 in the early 1980s when most of his children had already left home. When his children were young, Oscar included them in boat building, and boating was a staple family hobby. 2013.09.04 was Oscar's last hull and reflects this transitional period in his life. Boating and building were activities that Oscar was forced to enjoy alone in the early 1980s. Glen confides that he only knew of his father launching the boat "on two or three occasions" after it was built. Coupled with 2013.09.04's features that allowed it to be sailed by one person, the Roberts family history illustrated by Glen confirms the vessel was bound to the shallow sounds of North Carolina (Glen Roberts 2013, pers. comm.).

Hull Form

From a view from bow to stern, the flat bottom, low deadrise, and hard/sharp chine of the boat's hull are readily apparent. There is little rocker to the bottom, and little corresponding sheer at the upper edge of the hull and coaming. The plywood hull boards join the bottom at the nearly-square chine. The keelplank is flat, square, and offers little tacking assistance to the flat bottom (Figure 29).

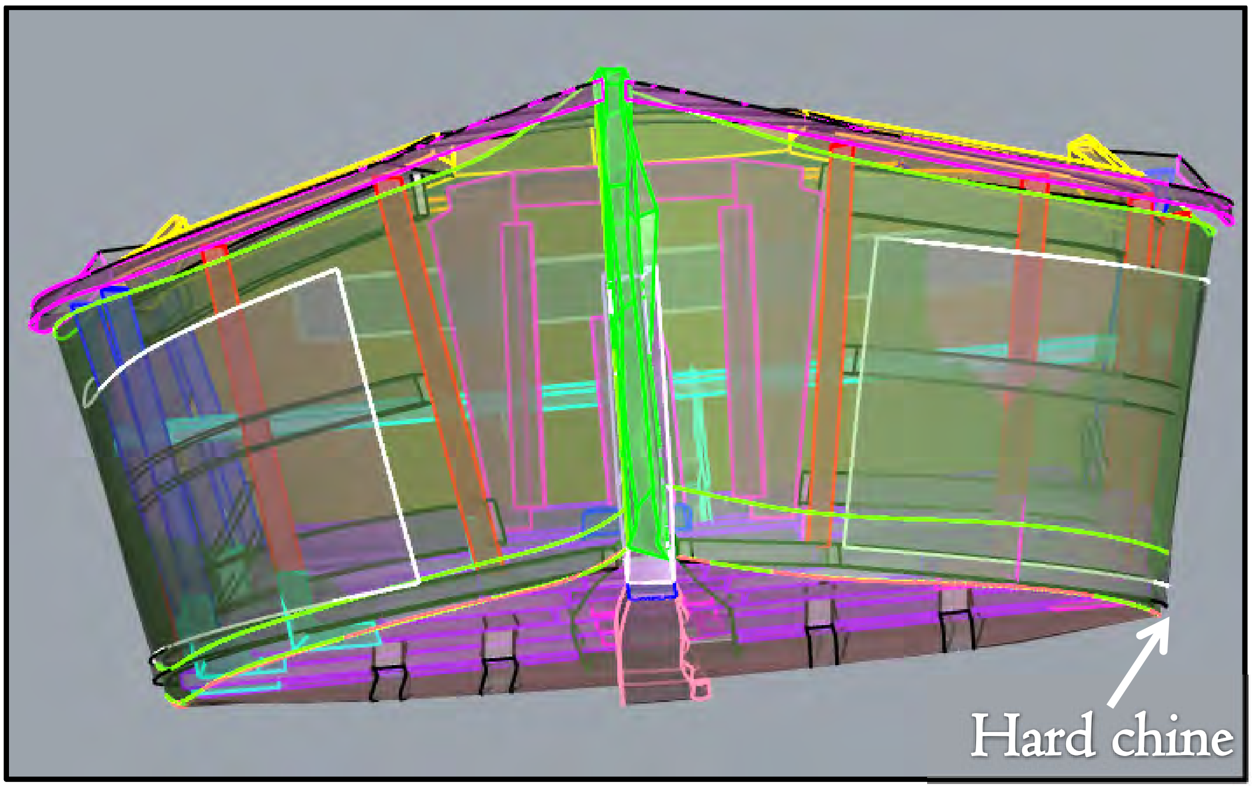

Figure 29. Ghosted view of boat from front (Image by Nathan Richards)

The beam is found just forward of midships, six feet aft of the stem. The stem is raked to about 120°, but the transom is raked much less, giving the hull much more shape and curvature foreword. The sheer begins at the centerboard and rises to the stem, which is slightly elevated over the top of the transom (Figure 30).

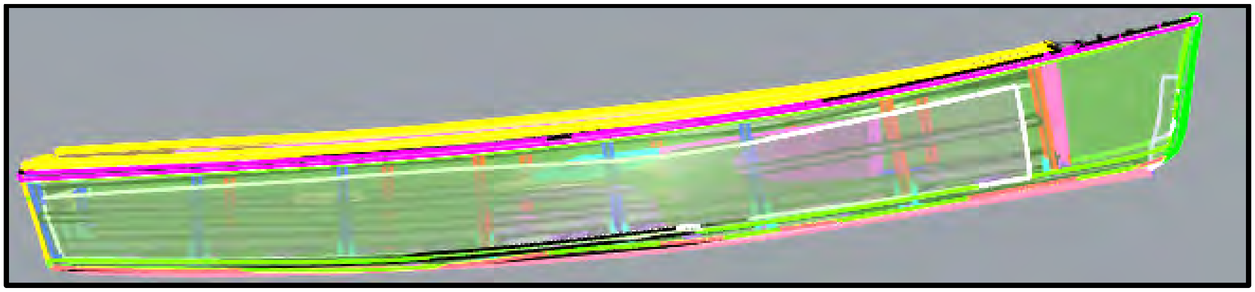

Figure 30. Ghosted view of starboard profile (Image by Nathan Richards).

Aft of the centerboard, the hull runs straight to the transom with little sheer, and no tumblehome. As a whole, there is little plywood distortion or warping, and the hull's shape is close to what it was when built. The small sheer and minor curvatures are due to the few large pieces of rigid plywood that were used for the hull, bottom, and transom. As a result, the hull is rigid in shape itself, with little definition, except at the bow section to the centerboard (Figure 31).

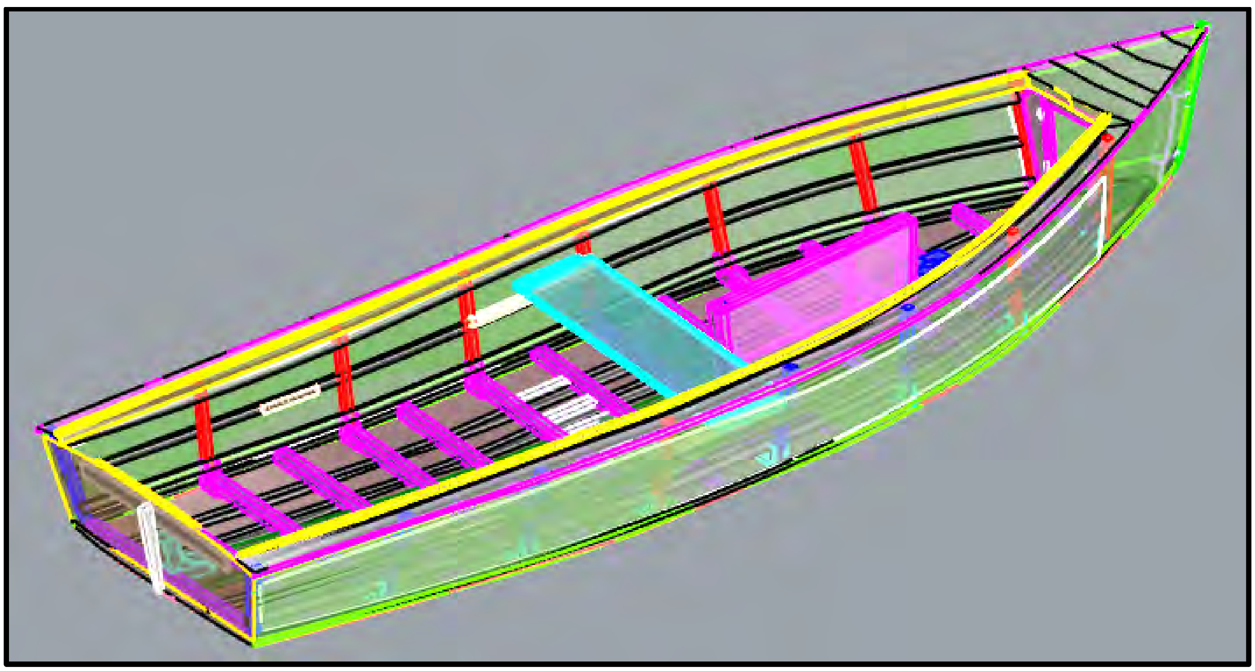

Figure 31. Ghosted perspective view of boat showing details of transom (Image by Nathan Richards).

Dimensions

From the aft edge of the transom to the stem, 2013.09.04's length is 515 cm (202.76") with a 148 cm (58.27") beam. Maximum beam is located 2.34 m aft of the stem. These dimensions give the sailing vessel a length to beam ratio of 3.5:1. The distance from the top of the rub rail to the chine is 50 cm (19.69"). The draft is unknown, but it is most likely between 15 cm and 25 cm. With these figures, 2013.09.04's saltwater displacement is between 2,621 lbs and 4,369 lbs, or 1.18 metric tons and 1.98 metric tons. The likely draft range between 15 cm and 25 cm is the range in vessel draft between unloaded and fully loaded.

Structural Components

The construction of this boat clearly fits in to the North Carolina small work boat tradition, with all diagnostic elements present (see Alford 1990:1-10). As a sailboat with a centerboard, this vessel was well equipped to work in the shallow waters of the sounds and rivers of the Outer Banks. The backbone of the boat is formed by the stem, transom, and hull planking. Because of the nature of the work carried out by these types of shallow water boats, the keel offers no longitudinal support to the rest of the vessel, as it was added after the construction of the structural supports. It is unclear how the hull planking is attached to the stem due to the fiberglass coating on the outer surface of the vessel's hull. It is also unclear how the transom is attached to the hull planking, although it seems to have been attached with wood glue, caulk, and nails.

All structural timbers are made of an unknown species of soft wood, while the hull planking is made of at least three pieces of plywood, roughly 1 cm (0.39") thick. The vessel's stem is made of a hard wood and measures 151 cm (59.45") tall, rising almost vertically from the keel rabbet. An apron is attached just aft of the stem, into which the chine stringers and the stringers midway up the side of the hull are fastened. Due to the tight quarters in the bow, it was not possible to discern how these had been fastened. It is unlikely they are fastened by a rabbet joint, so a combination of nails, screws, and wood glue were likely used. Since the entire vessel was covered by a layer of fiberglass to make it watertight, it is difficult to discern how the hull planking is attached to the stem. Despite this, it is possible to find small raised areas beneath the layers of paint which likely correspond to nails that extend through the plywood hull planking and into the stem. The entire bow of the vessel is complete with a small storage locker that likely housed the boat's anchor. This anchor locker measures 52 cm (20.47") deep from the stem to the locker's plywood face, and 62 cm (24.41") from port to starboard (Figure 32).

The other main structural component of the vessel is the transom (Figure 33). Though the boat does include a sternpost, the transom is the main structural support in the stern. The transom itself measures 116 cm (45.67") from port to starboard, and 50 cm (19.69") in height, with a depth of 1.5 cm (0.59"). The aftermost frame set is flush with the transom, attached with a combination of wood glue and caulk, as is the vessel's stern knee which offers the vessel additional structural support. A transom frame is also located on the transom for added support. It measures 7 cm (2.76") molded and 2 cm (0.79") sided, with a length of 92 cm (36.22"). It is unclear how the hull planking is attached to the transom, but it is likely fastened in a manner similar to the stem. A coaming is located on the upper edge of the transom, measuring 1 cm (0.39") molded and 1.5 cm (0.59") sided. A motor mount is also attached to the outboard side of the transom, measuring 15 cm (5.9") by 23 cm (0.91"). This indicates that a motor was used to power the vessel, in addition to the use of its sail.

Figure 32.Bow of the vessel, including the floors, centerboard, and storage locker (Image courtesy of Caitlin Zant, 2013).

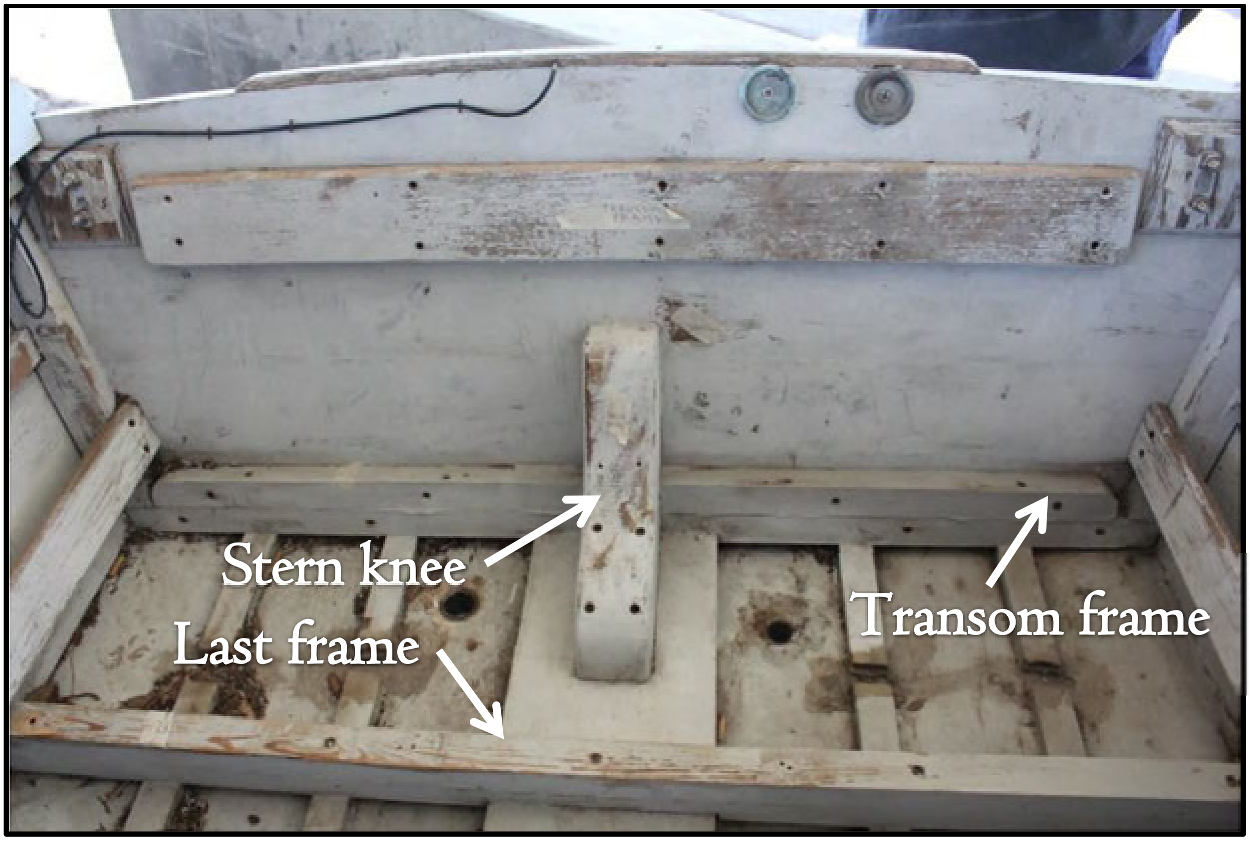

Figure 33. Photograph of the vessel's transom, including the transom frame, stern knee and the last frame set (Image courtesy of Caitlin Zant, 2013).

The vessel's sternpost measures 4 cm (1.57") by 3 cm (1.18"), with a height of 42 cm (16.54"), extending from just above the keel to nearly the upper edge of the transom. Although they are not a major structural component for longitudinal strength, two gunwales are attached to the sternpost into which pintles on the detachable rudder are inserted. The rudder itself measures 110 cm (43.31") in height and 20 cm (7.87") at its widest point. The tiller is made up of two components and can be extended in length for ease of steering.

Eight stringers run longitudinally along the inner surface of the plywood across the bottom of the hull and midway up the side of the hull on both the port and starboard sides of the vessel. These stringers vary between 1.4 cm (0.55") and 1.8 cm (0.71") molded and 3.2 cm (1.26") and 3.6 cm (1.42") sided. The variation in the sided dimensions of the stringers is due to the non-uniform construction technique of small boats in North Carolina. Stringers 1-8 were labeled, beginning with the portside stringer running midway between the deck and the chine of the vessel, and ending with the starboard side stringer of the same type. Stringers 9 and 10 were labeled later, and they consist of the stringers located just outboard of the coaming, beginning with stringer nine on the portside and stringer 10 starboard. Stringers 2 and 7 are chine stringers, and they serve as the anchor into which the hull planks are attached. Two additional stringers are located just outboard of the coaming. These stringers are about 1.5 cm (0.59") molded and 6 cm (2.36") sided, and they extend nearly to the underside of the vessel's deck. They are attached to the inboard side of the vessel's frames by nails which are only visible in a few areas, as they have mostly been painted over.

Although the stringers run the length of the boat, each is made up of at least two separate pieces of wood. On the sides of the vessel, this is due to the curvature of the vessel's bow, while the separate pieces of the bilge stringers are not flush, acting as limber holes through which bilge water could drain. Five limber boards are located on the stringers and keelson, creating the limber holes. The limber boards on the stringers measure the same sided dimensions, but measure 2.5 cm (0.98") molded, extending the entire space between Floors 8 and 9. The board on the keelson also has the same sided dimension of the keelson itself, but it is 2.5 cm (0.98") molded, also spanning from Floors 8 and 9. The stringers do not appear to be fastened using nails or screws, but seem to be attached using a combination of wood glue and caulk. The vessel's keelson measures 4 cm (1.57") molded and 19 cm (7.48") sided aft of Floor 3. Halfway between Floors 2 and 3, the keelson begins to taper to the apron, where its sided dimension is 7 cm (2.76"). It is not clear how the keelson is attached to the bottom of the hull, but it is likely attached with nails through the bottom of the hull (Figure 34).

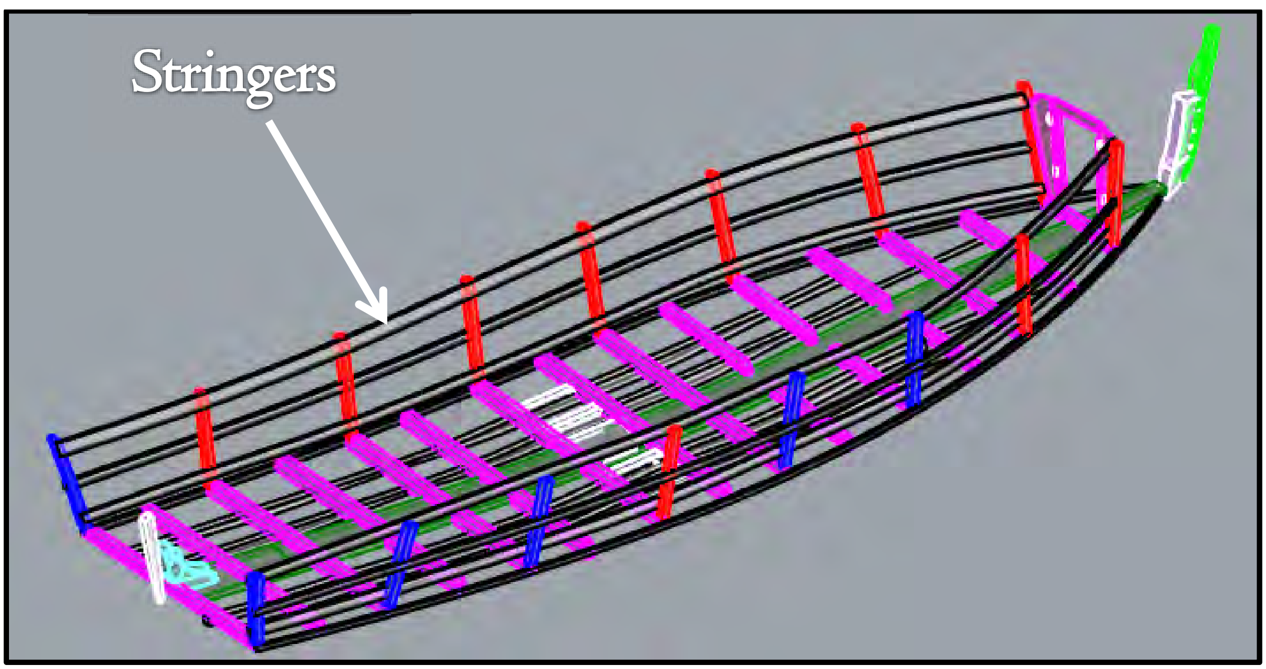

Figure 34. *Rhinoceros* view of boat construction showing the location of stringers (Image by Nathan Richards).

One other longitudinal structure is the shelf clamp. Made up of two timbers, each measures 1 cm (0.39") molded and 4 cm (1.57") sided. The shelf clamp runs along the inboard side of the futtocks on both the port and starboard sides, and it is fastened to the futtocks with screws. The shelf clamp sits just above the plywood floorboards when they are in place in the boat.

The vessel has 15 floors, each at approximately 29.2 cm (11.5") down the length of the boat. These floors are made up of two pieces of wood, each 3.3 cm (1.3") molded and 3.3 cm sided, adding up to a molded dimension of 6.6 cm (2.6") (Figure 35). The first floor component has a curve at each end, tapering town to the second floor piece, and it is notched to fit over the keelson. The second floor piece extends almost the entire width of the boat, ending at the chine stringer, with the exception of Floors 4 through 6. These three floors have port and starboard sections due to the centerboard trunk. Each of these floors extends from the chine stringer to the garboard strake on the port and starboard sides. The two floor pieces are fastened to one another using screws, evenly spaced along each floor. A pair of futtocks is attached to every other floor, beginning with floor one. The futtocks are attached to the second floor piece by a set of brackets on the forward and aft faces of the timbers. These brackets are attached using three to four screws on each face. It is likely that wood glue and caulk were used to further secure these pieces to one another. The floors rest on the bilge stringers. It is unclear how these are fastened, but it is likely through a combination of wood glue and caulk.

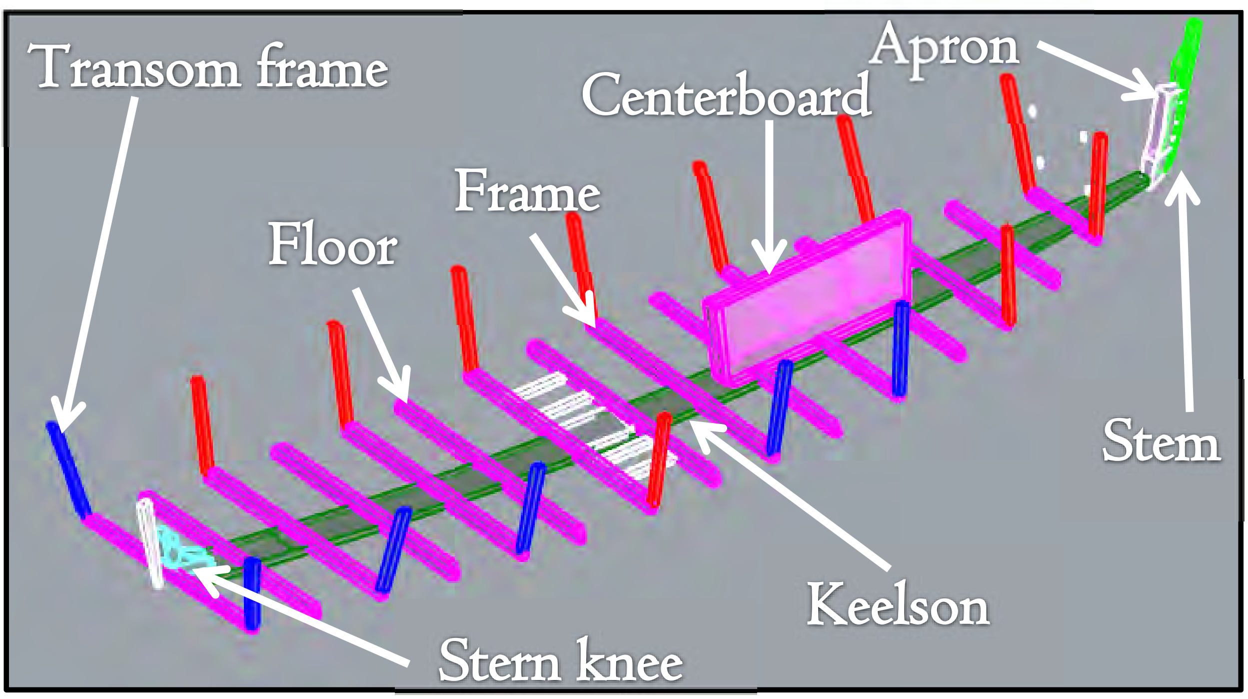

Figure 35. *Rhinoceros* model of floors, frames, stern knee, centerboard, keelson, transom frame, apron, stem (Image by Nathan Richards).

The vessel has eight sets of futtocks, each regular in shape and spacing. These extend from the underside of the deck to the top of the second floor piece. Each frame measures 3.3 cm (1.3") molded and 3.3 cm sided, and they extend the distance from the floors to the deck. Instead of running flush with the curvature of the hull, the futtocks remain straight and uniform throughout the length of the vessel (Figure 36). The futtocks are attached to the floors using wooden brackets that were screwed into both the futtocks and the floors. It is unclear how the futtocks are attached to the deck due to the fiberglass covering its surface, but it is likely that the deck was nailed into the floors.

Figure 36. Image of the vessel's interior (Image courtesy of Caitlin Zant, 2013).

Futtock 8 is flush with the transom on its aft side. It is also unique in that two additional pieces of wood were added to the set's outboard sides, filling the gap between the futtock and the hull planking. The top piece is 1 cm (0.39") molded and 3.3 cm (1.3") sided, extending from the coaming to the top of stringers 1 and 8. The bottom piece also measures 1 cm molded and 3.3 cm sided, and it begins just beneath stringers 1 and 8.

The vessel also has a stern knee that is connected to the transom and the keelson by screws. Measuring 20 cm (7.87") in height and 7 cm (2.76") in width, the knee is notched to fit over Floor 15, and it offers additional support to the transom structure. The knee has beveled edges along its upper face. This beveling offers no functional purpose and was likely added for purely aesthetic reasons. While many of the other components of the vessel are made with a soft wood, the stern knee is made of a hardwood (unknown species), and is the strongest part of the entire vessel. This small sailboat has a fully functional centerboard. The centerboard trunk measures 9.6 cm (3.78") in width by 36 cm (14.17") in height and was constructed out of five boards, each measuring 3.1 cm (1.22") thick. Located in the forward section of the vessel, just aft of Floor 3, the centerboard trunk is attached to the keelson by two garboard strakes located on the port and starboard side of the trunk. These strakes are notched for Floors 4 through 6, and are secured to the keelson with screws. The centerboard was raised and lowered through the use of a rope that extended through a small hole in the top of the trunk. Just forward of the centerboard trunk is the vessel's mast step. This is constructed out of two pieces of wood measuring 13 cm (5.12") by 17 cm (6.69"). The top piece of wood has a thickness of 3.3 cm (1.3"), as does the bottom piece. The top mast step piece has an opening into which the mast was secured, measuring 5 cm (1.97") by 6 cm (2.36"), and measuring only 3.3 cm (1.3") deep, as it does not extend through the second piece of wood. The hole is square shaped with rounded corners to match the shape of the removable mast. The entire structure spans the gap between Floor 3 and the centerboard trunk. It rests on Floor 3 and an unnamed member, made up of two pieces of wood, likely left over from the construction of the floors. The mast step is attached to the floor and the support with six screws.

The deck structure of the vessel is made up of the coaming, deck planking, and rub rail (Figure 37). The deck planking is made of plywood and coated in fiberglass. The port and starboard side deck measures 6.2 cm (2.44") wide and extends from the outboard side of the coaming to the rub rail. The foredeck is made of a separate piece of plywood, and it extends the distance from the forward coaming to the stem. The foredeck is supported by additional pieces of wood attached to the underside of the deck. These are arranged as planks made of a stronger wood, and they are attached to the stem. The foredeck measures 65 cm (25.59") wide just in front of the forward coaming and tapers to the stem, 6.7 cm (2.64") forward. The deck itself is attached to the futtocks using nails, though they are difficult to see, as they are covered in paint and fiberglass. The coaming is made up of three different sections, measuring 1.5 cm (0.59") sided. The outboard face of the port and starboard coaming measures 2 cm (0.79") molded, while the inboard face measures 5 cm (1.97") molded. The inboard face of the forward coaming also measures 7 cm (2.76") molded, while the outboard face measures 2 cm (0.79") sided. This difference in the molded dimension of the forward coaming is due to the slight curvature of the foredeck. A soft metal rub rail was attached all along the port and starboard sides of the vessel. Located on the outer edge of the deck, these rub rails measure 3 cm (1.18") wide and are attached to the deck with screws evenly spaced along the boat's length.

Two thwarts are still located in the boat though there are risers for a third thwart between futtocks 6 and 7. The forwardmost thwart is located between futtocks 1 and 2 and is 2.5 cm (0.98") thick, 26.9 cm (10.59") wide and 106.2 cm (41.81") long, and is held up by a small, unidentified member. This forward thwart has a small hole cut out of its center that measures the same dimensions as the hole in the mast step through which the mast had been inserted when in use. The midship thwart is located between futtocks 4 and 5, and it is 3 cm (1.18") thick, 35 cm (17.78") wide and 135 cm (53.14") long. This thwart rests on thwart risers fastened to Futtocks 4 and 5 by screws, although the thwart itself does not span the entire distance between these two futtocks. The aft thwart risers measure 2 cm (0.79") molded and 3 cm (1.18") sided. It seems as though an additional thwart was located there at one point, though the boom of the sail extends directly above this location, making sitting on this thwart difficult. Although its location provides a perfect spot for handling the rudder, the sail is likely why this thwart was ultimately removed.

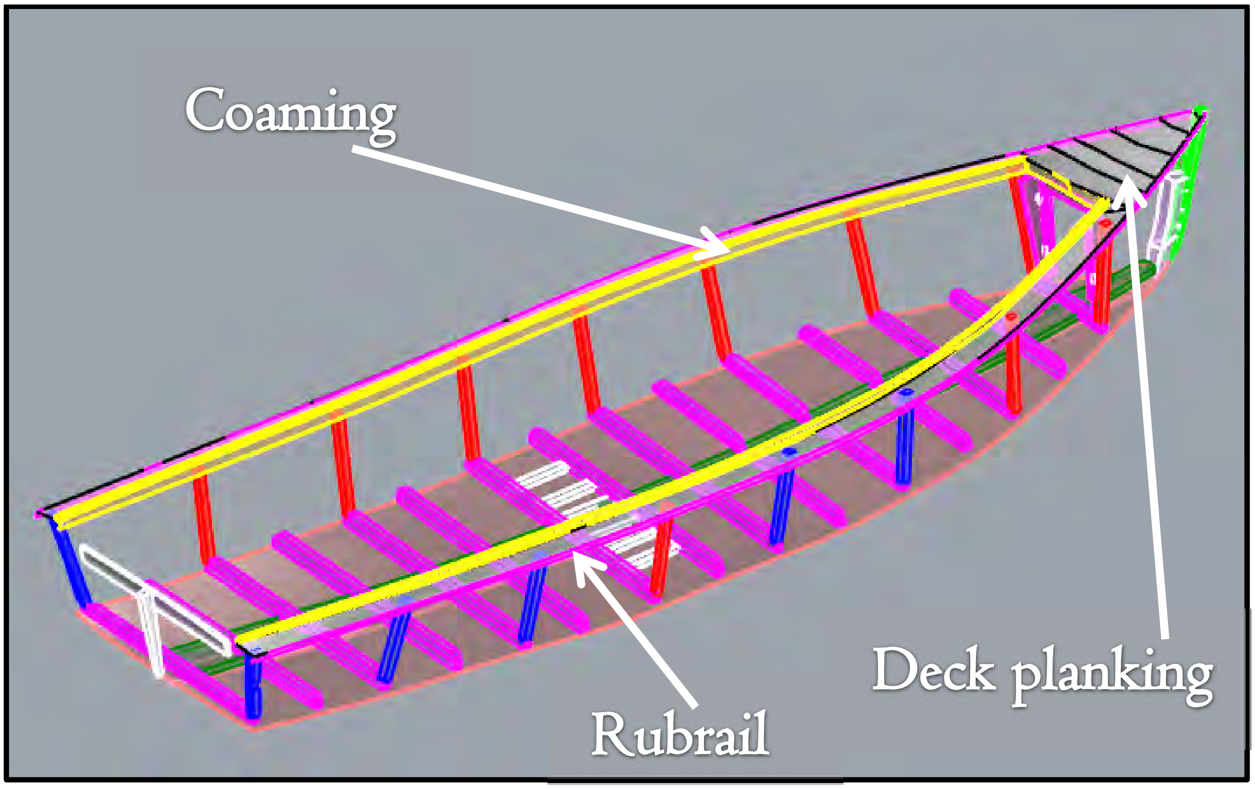

Figure 37. The vessel's coaming, deck planking, and rub rails (Image by Nathan Richards).

Discussion of Construction

Vessel 2013.09.04 seems to be a traditional workboat of North Carolina, and it was built in a similar manner as other vessels that had been constructed using North Carolinian flat-bottomed building techniques. It appears that the boat builder could have used his knowledge concerning skiff building and applied this basic idea to the construction of vessel 2013.09.04. Though more than one interpretation of the construction method is possible, certain interpretations seem more plausible.

Flat bottom boat construction is a particular style of boat building. There are many boats with seemingly flat bottoms, however, not all are considered to be flat bottom boats. There are two main ways to construct a flat bottom boat; one method involves building the bottom first and then adding the sides, and the other method is to construct the sides first and then add the bottom (Figure 10). Both construction methods have an end result of a boat with a sharp chine between the sides and bottom. In the case of vessel 2013.09.04, it seems that the sides would have been built first and then the bottom would have been attached. It has been noted that most indigenous boats of North Carolina seem to have been built using this construction method. With this type of construction, the bottom planks often run side to side. This type of construction method is possible for builders who possess a general carpentry skill set and intend to build a skiff within a few days while only investing in a small amount of materials (Alford 2004:2). Though the builder of this particular vessel seems to have had much experience and skill, this method of construction would likely have been good for a vessel he had intended for recreational use, or it is possible that he was building the vessel as a hobby or simply as a project for enjoyment.

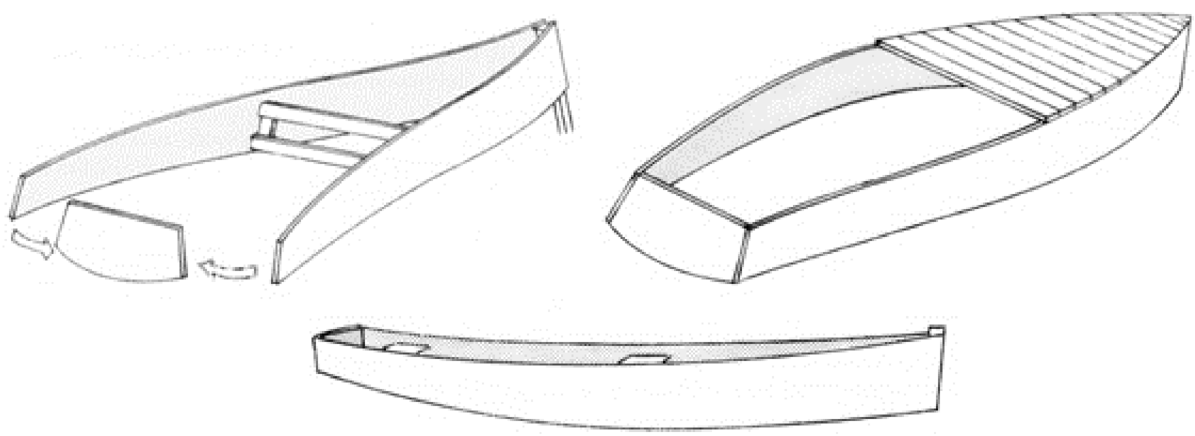

Figure 38. Flat bottom boat construction technique with the sides of the vessel constructed before the bottom (Adapted from Alford 2004:3).

This vessel has similarities to sail skiffs, which were common in North Carolina and often had a length of 14 to 20 feet. They allowed for the vessel to have mobility, and the sail made it easier for them to travel long distances. The wide sides and flat bottoms of the skiffs made them simple and quick to construct. The pivoting centerboard, which can also be seen in vessel 2013.09.04, allowed a sail skiff to sail to windward, but it could also be retracted when a pole was employed to move the skiff across shoals. Residents of the Outer Banks would often sail to the mainland in order to run errands in little skiffs such as these (Alford 2004:4-5).

Plywood sides were utilized to build vessel 2013.09.04, and caulk and glue were both employed to construct the boat. It appears to be a fairly simple boat that was able to serve its purpose. Caulking, it is noted, serves another function in addition to keeping out water; the many tucks or loops of caulking, when set down hard into the sides, act as a wedge that provides pressure and solidifies and stiffens the hull (Gardner 1996:240). Boat builders did not benefit from a strong, durable, and totally waterproof glue until World War II when the needs of war spurred research in thermoplastics, and boatyards began employing plastic glue (Gardner 1996:241). Vessel 2013.09.04 was built for specific purposes, which were most likely recreational in nature. The vessel shows evidence of having been a racing sailboat; racing cleats are attached on either side of the boat. It also has features, such as a depth finder, that suggest that it was used for fishing.

The plywood sides and stringers were probably set early in the construction, and, though there is currently no evidence left on the vessel, a series of molds were likely used. Two, or possibly three, molds would likely have been used to set the shape of the vessel, as the frames of the vessel do not give it its shape. Initial construction in an upside-down position, like the boat shown in Figure 38, would make sense. The plywood hull and transom would have been constructed first, followed by the chine stringers and then the bottom of the vessel and keel. The floors were installed before the futtocks. The stringers appear to have been attached to the vessel using glue or caulk. It also appears that the brackets may have been fastened and then wood glued. Fasteners, if used on the floors, could possibly have been on the bottom sections of the floors, though the floors could also have mainly been held on by the brackets. Although it cannot be known for sure when the centerboard and centerboard trunk were built into the vessel, they were part of the original vessel's structure. They were most likely added to the vessel just before or just after the floors were attached. The centerboard area could have been cut into the keel while the boat was upside-down. Though one cannot see fasteners on the stringers, they could have been fastened underneath or glued. The floors could have been fastened into the stringers. The strongest part of the vessel seems to be the stern knee, which reinforces the transom. There are three forms of propulsion that the boat displays evidence for -- sails, oars, or a motor. The vessel includes sail rigging, oars and oarlocks, and a motor mount on the transom.

Though there is no way to know for sure, there is a logical order that boat builders usually use in order to construct such a vessel. It appears that the builder would have started with the boat in an upside-down position and first set up a series of molds along with the stem and transom. He then likely added the chine stringers and sides around the molds and connected them to the stem and transom. The keel would then have been added. The boat would have been flipped over to allow the rest of the bilge stringers along with the stringers midway up the side of the hull to be attached. The last set of frames, Floor 15 and

Futtock 8, were then most likely added (with the floor being put in before the futtock), along with the keelson. The stern knee, which was notched around the last set of floors, was likely then put in the vessel. After the stern knee, the floors, centerboard and centerboard trunk, and then futtocks were likely attached into the boat. Stringers 9 and 10 and the shelf clamp were then probably added, followed by the deck, brackets, coaming, rub rail, thwart risers, and thwarts.

Conclusion

Information concerning the methods used to record vessel 2013.09.04 along with the boat's function, hull form, dimensions, structural components, and the construction of vessel may be used to shed light on different aspects regarding the boat and its builder. Vessel 2013.09.04 has a sturdy stern knee that is similar to other boats built by Oscar Roberts. This vessel, however, seems to have been built in a somewhat simpler manner employing the use of caulking and/or wood glue. It has a relatively flat bottom with a hull featuring a somewhat simple curvature. The flat bottom suggests that the environment for which the boat was intended was fairly shallow, and it was most likely not an ocean-going vessel. This sort of shape serves its purpose in the shallower waters of North Carolina.

Vessel 2013.09.04 was built in the 1980s, and it was most likely the last boat that its builder constructed (Glen Roberts 2013, pers. comm.). As previously mentioned, it seems to have been built primarily for recreational purposes. The depth finder on the boat suggests that the vessel could have been used for fishing, and the racing cleats on either side of the boat suggest that it may have been a racing sailboat.

This information suggests that vessel 2013.09.04 would have been used in shallower waters where a depth finder and a boat with a flat bottom would have been useful to avoid grounding. It also indicates that the builder valued recreational activities such as racing and fishing, and he would likely have lived in a culture that also appreciated these maritime pastimes. This vessel suggests that its builder held the socioeconomic status to enjoy such recreational activities. As many of these locally-built small craft are disappearing, digital documentation projects such as this are important endeavors in preserving the construction techniques, culture, lifestyle, and identity of local shipbuilders like Oscar Roberts.

MOJO BONES: A NORTH CAROLINA SKIFF (WPT Vessel #2013.09.06)

Ryan Bradley, Sara Kerfoot, Adam Parker, Julie Powell, and Emily Steedman

Introduction

In the fall of 2013, *MoJo Bones* was the focus of a boat documentation project as part of East Carolina University's Maritime Studies Fall Field School. The skiff is owned by the Whalehead Preservation Trust located in Corolla, North Carolina. The Coastal Studies Institute, located on Roanoke Island provided the documentation location for the project. Supervised by Dr. David J. Stewart, graduate students Ryan Bradley, Sara Kerfoot, Adam Parker, Julie Powell and Emily Steedman spent five days documenting the boat at the field location before returning to the lab to analyze the data. Prior to this documentation the only known information about the boat was compiled by Currituck County local Travis Morris. This information included ownership and usage details, but no documentation of the structure had been conducted.

This report consists of five sections. First, a brief history of the vessel type is given, then a discussion of methodology is provided. This includes total station, measured drawings, and photography usage. After methodology, there follows a brief review of noted interpretations about the paint and fiberglass process. Third, an overview of the construction is provided. Detailed sections on the keel, frames, thwart, chine bars, stringers, weather deck structure, hull planking, stem and stern are included in this portion of the report. Finally, a list of recommendations for future research is provided.

History of Skiffs in Currituck County, North Carolina

MoJo Bones, a skiff from Maple, North Carolina, was likely used in the area as a tool for waterfowl hunting. This was typical for this type of boat. A gas-powered boat ferried sport hunters and a skiff out to the hunting blinds. Usually two hunters were placed in each blind and a guide remained in the skiff. The skiff was typically hidden by the blind in addition to its own camouflage. The motor boats and skiffs needed a shallow draft to navigate the waters of Currituck Sound; both variants of boat were specifically constructed to meet this need. Once the hunters were situated in the blinds, the men would shoot the game, and the guide would pole out in the skiff to pick them up. Being engine-less, poling allowed guides to pick up the catch silently and avoid scaring any game that was still around (Morris 2011:95-6). As time progressed, this method of hand-propelling skiffs gave way to outboard motors (Walsh 2008:101). *MoJo Bones*' transom has impressions where an outboard motor would have been attached. This indicates that its construction is more recent. It also means *MoJo Bones* would not have needed to be towed to the hunting location. At the end of the day, the hunters were picked up and returned to their respective hunt clubs while the guides dressed and iced down the day's catch for its trip home with the hunters (Morris 2011:95-6). Skiffs, therefore, played a significant role in the development of Currituck County's maritime heritage, a heritage that remains present today through the operation of the Outer Banks Wildlife Education Center and Whalehead Club. Both organizations raise awareness of this heritage through multiple exhibits, programs and special events.

Methodology

The goal of this project was to record *MoJo Bones* in as much detail as possible in the allotted time; there were five working days to record the 467 cm (183.86") flat bottom boat (Figure 39). The final project entailed the creation of a three-dimensional model through the use of the computer program *Rhinoceros*. To transfer data from the field to the program required the use of a total station and hand-drawn recordings.

Figure 39. *MoJo Bones* setup for recording (Photo by Ryan Bradley, 2013).

Total Station

MoJo Bones is a small flat bottom boat with an open hull, so recording occurred with a Topcon ES-102 reflectorless total station and a Topcon FC2500 datalogger. Before recording was underway, the authors were able to move the boat in a manner that would allow recorders to get data from all sides of the boat as well as underneath the boat. The team was able to do this by maneuvering *MoJo Bones* on top of cinderblocks and by putting it diagonally across the stairs. Four cinderblocks were used to support the boat.

Since *Rhinoceros* would be utilized to create a three-dimensional model, the boat recorders were interested in getting the bulk of points with the total station. It is easy to transfer points shot from the total station to *Rhinoceros,* and a total station has the potential to be more accurate than measured drawings. The goal was to work from a macro to micro scale. Hull design and fasteners are both important; however, if there was a time crunch, the team wanted to establish the shape of the boat before they worked on the smaller features and details.

The boat was in a sheltered area under a roofed enclosure. This allowed for a maximum amount of working days since rain was not a deterrent. Regardless of the precautions the team took, such as utilizing vehicles to block wind, the area acted to intensify the wind (creating a wind tunnel). The inconsistent wind occasionally affected the recording process by shaking the total station enough that it was difficult to line the cross-hairs up with the point intended for recording. When the wind was particularly intense, someone would stand in front of the total station to block the wind, though it was generally better practice to wait for the wind to die down.

Prior to using the total station to record the boat, recorders had to establish specific datums that would act as a way to reorient the total station within the context of the hull whenever the instrument was moved. It is not difficult to add more datums, so not all datum points were established with the initial data collection. Unlike many terrestrial archaeological sites, there was not a main datum that needed to be referred to. The location of the vessel was not relevant because it had already been removed from its original context. The team was only interested in the construction of the vessel for this project. By the end of the project, there would be multiple datums used in order to realign the total station to match the context of the first shots taken. Datums were setup in places that could easily be seen and marked with a piece of duct tape labeled with a specific number that would identify the datum in the Topcon datalogger. The recording team drew cross-hairs on the tape in order to relocate the exact spot in which we first shot the total station. The team thought it would be easiest to have the point catalog coincide with the measured drawings. This allowed ease in seeing which timbers had been recorded and which ones still needed work. While datums were being established, group members drew the first aspects of the vessel that needed to be recorded, such as the exterior hull.

The use of the total station requires a minimum of two people while engaged in recording. One person is the "shooter," the other person is the "pointer." Either shooter or pointer may be in charge of keeping a log of the points recorded. The pointer is integral in the shooting process because it can be very hard for the shooter to see what they are shooting at, especially if it is in a poorly lit area. The pointer can more clearly define where the data should be recorded; the pointer is also in charge of backstopping. This means that in less defined areas, such as edges, the pointer can limit where the laser can go. To streamline the process, points to be recorded were discussed ahead of time. Some points would act as "double" points, indicating multiple aspects of the vessel, such as the end of the transom and the beginning of the rub rail.

The numbering system associated with the points was labeled with a specific code that identified the exact part of the vessel it was from. Codes were a combination of numbers and letters. The first letters indicated if the point was from the port (BB) or starboard (SB) side of the vessel. The next sets of letters indicated what part of the vessel the point is coming from, such as a futtock (FU) or a transom (TM). The next number combination varied depending on what part of the vessel it was shot. If there was only one construction piece, then the number started at 001 and increased until the timber was complete. If there was a series of similar timber pieces, then the first number combination indicated which piece it was and the second number combination indicated what point it was on the specific, already indicated, timber. Example: BBFU04008, this code indicates that the point represents the eighth point taken on the fourth futtock on the port side of the vessel. All points were labeled in this manner, excluding points that did not need a port or starboard indication. Once the coding system was established, the authors made a comprehensive list of what measured drawings what total station measurements were needed. The whole vessel needed to be drawn; as some team members were shooting, others were drawing the vessel.

The people making the measured drawings worked around the people that were operating the total station. Since every aspect of the boat needed to be drawn, people could easily switch drawings tasks; whereas, if the total station operators had to wait for a measured drawing to be complete, they would lose time having to properly align and set up a new total station location.

Each night the data recorded was put into the three-dimensional modeling program *Rhinoceros*. The data was backed up after each day of operation. By loading the points onto *Rhinoceros*, the team was able to slowly see their point cloud grow after each download. Recorders worked with the "less is more theory." Rather than shoot as many points as possible to get an accurate depiction of the vessel, they tried to only take necessary points that would indicate more than one aspect of the vessel. While this did not make they point total go up, it did ease the confusion of the point cloud once back at the computer lab. The point cloud slowly grew and the team was able to gauge what had been accomplished and what still needed work. Each part of the vessel was marked in a different layer. The layers were color coded, and recorders had the ability to turn each layer on and off. This helped decipher the shape of the vessel while in the field (Figure 40).

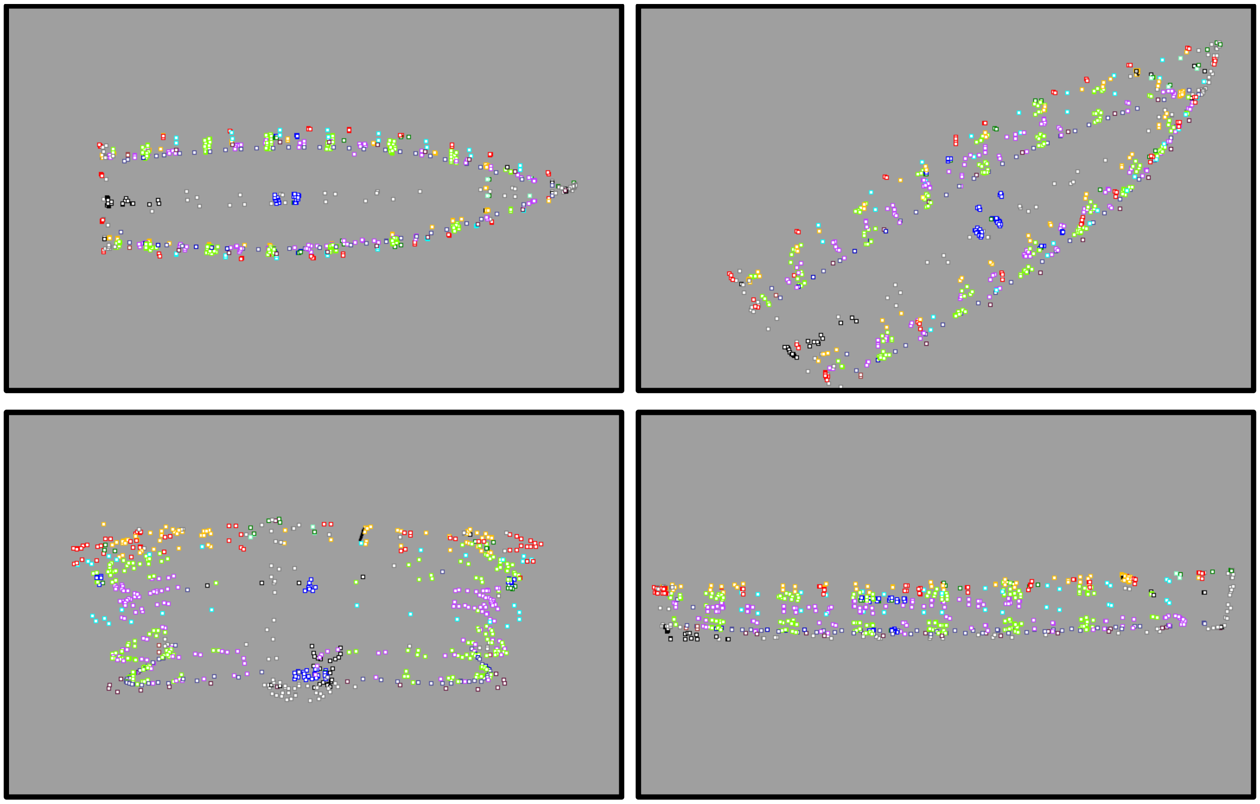

Figure 40. Point cloud of *MoJo Bones* model, showing views from top, perspective, right, and front (clockwise from top left) (Image by Nathan Richards).

Another advantage of looking at the computer after each day of work was that it allowed recorders to catch mistakes. For example, close to the end of a recording day, a mistake was made that disassociated two parts of the spatial data. In this case, the total station was moved and the datums were not re-shot. This meant that newly acquired points were accurate relative to each other -- though not relative to previously recorded spatial data. In order to fix this error, the next day the recording team found three points from the misaligned section, re-shot them with the correct datums, and then matched all of the data in *Rhinoceros* at the end of the day. The matched-up data aligned with an error of less than 0.2 cm (0.079"). The final point cloud can be seen in Figure 40.

During the project, a binder held the point catalog, the measured drawings, the list of things yet to do, and the table of scantlings. A sketch was completed for every aspect of the vessel. Every sketch was copied twice so that it could be further augmented with measurements, and so it could also form the basis of a point catalog. As the flat bottomed boat was being recorded, the recording team began to think about the construction process of the vessel. Thinking about the construction helped work through the recording process by demanding recorders to actively think about which parts of the vessel were important in the construction process. A basic understanding of the vessel indicates that it was created using molds (which set the shape). Subsequently, side planking would have been nailed to the stem, followed by the addition of the transom. Next, twenty-seven pieces of planking were nailed to the bottom of the boat. While the boat was upside down, the builders would have then nailed in a keel. After the boat was righted, a chine stringer was added, followed by the futtocks. The futtocks added very little structural integrity to the vessel. Stringers were then nailed on the inside of the futtocks. The thwart was built, deck planking was added, the coaming was installed, and lastly the rub rail was fixed to *MoJo Bones*, completing is simple but highly efficient construction

Measured Drawings

Measured drawings were made as extensively as time allowed. The areas first measured were those inaccessible to the total station. Then measured drawings were done of intricate aspects of the vessel that would be impossible to record using the total station. When those drawings were done, and because time allowed the team to do so, those doing the measured drawings continued their work in the vessel. Doing both measured drawings and total station points provided a backup of data in case the total station data became corrupted. *Rhinoceros* allows its users to create points and lines within the already created three-dimensional model. So long that there is recorded data, whether in the total station or hand drawn, it is possible to compile it together in the same finishing program. All measurements were recorded in metric.

Photographs

The boat was extensively photo-documented on the last day of recording. These photographs would be used in later analysis of construction and hull interpretation.

Construction

This section will look at the construction of the flat-bottomed skiff *MoJo Bones*. There are generally two methods of constructing flat bottom boats. There is the bottom first method and the side first method.

The authors believe *MoJo Bones* was constructed with the "side first method" – a rudimentary method that is the most prevalent construction process found in North Carolina boat building. The skill needed to create a craft of this variety is that of a common carpenter (Chapelle 1941:34). It is thought that the skiff was built using a method of construction where the use of a mold is employed. The mold method of construction, illustrated in Figure 41, utilizes an object the size of the desired width of the skiff to mold side planks around (Alford 1990:3).

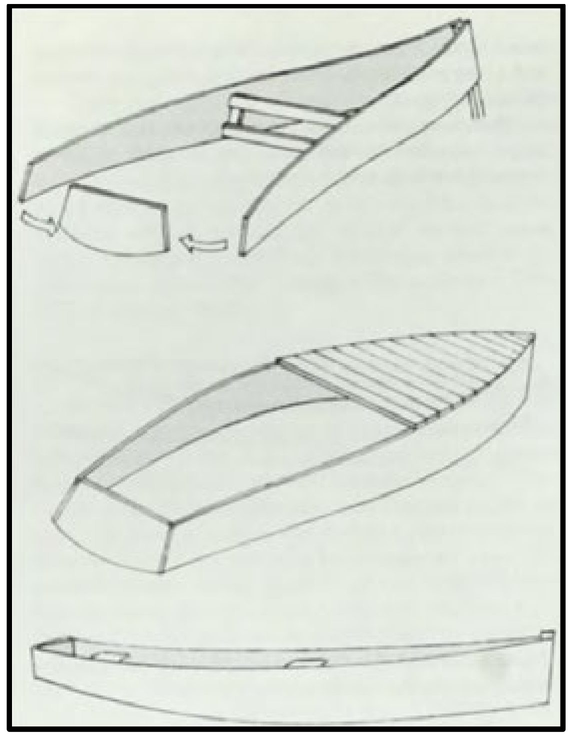

Figure 41. The side first construction technique (Alford 1990:3).

Structural Base

In *MoJo Bones* it appears that two single planks (strakes) were bent around a mold, and then attached to the stem and stern on both sides of the vessel. Chine stringers were then added to both sides. With the chine stringers in place, bottom planks were then laid horizontally, running the entire length of the vessel, and fastened to the chine stringers. After the hull planks were attached a keel was laid. Structurally, the keel on *MoJo Bones* is not the same as one on a ship designed with a keel laid first. For one thing, it was not the first piece to be laid. It is also no more attached to the stem and stern than it is the rest of the hull planking. It is hard to tell how it is fastened. There are no visible fasteners on the keel or in the hull planking. The authors hypothesize it is attached with wood screws or nails as characterized by the common and inexpensive materials used throughout its construction. The keel has been covered in a fiberglass and resin coating obscuring signs of fasteners.

It is believed that the keel is comprised of two pieces at the stern of the boat. The hull slopes up to meet the transom as seen in Figure 41. A single keel piece runs the entire length of the boat. It appears that a second piece, a skeg, is attached at the stern where the slope or rocker begins to meet the transom. In this manner, the keel represents a horizontal line despite the rocker in the stern.

Flat bottom boats, such as skiffs, were often made without a keel (Chappelle 1941:31). *MoJo*

Bones has one and a few theories can be suggested about its usefulness. The keel in this vessel is multi-purpose. It may provide a small amount of longitudinal strength to the vessel. It also may serve as a buffer to protect the hull planking during launching and in the event of grounding. The presence of the skeg prevents the boat from drifting to leeward and may contribute to stability while in the water.

Chine Stringers

The interior structure of the *MoJo Bones* has a starboard and port chine stringer. Each chine begins slightly forward of the futtock closest to the bow (Futtock 1), and runs the length of the boat. The forward edge of both stringers curves down to meet the hull planking. The sided dimension of both chine stringers is approximately 7 cm (2.76") and the molded dimension is approximately 2.4 cm (0.94"). These measurements fluctuate slightly throughout the length of the stringers due to deterioration of the wood. The starboard chine stringer is completely deteriorated at the aftermost futtock (Futtock 8) (Figure 42).

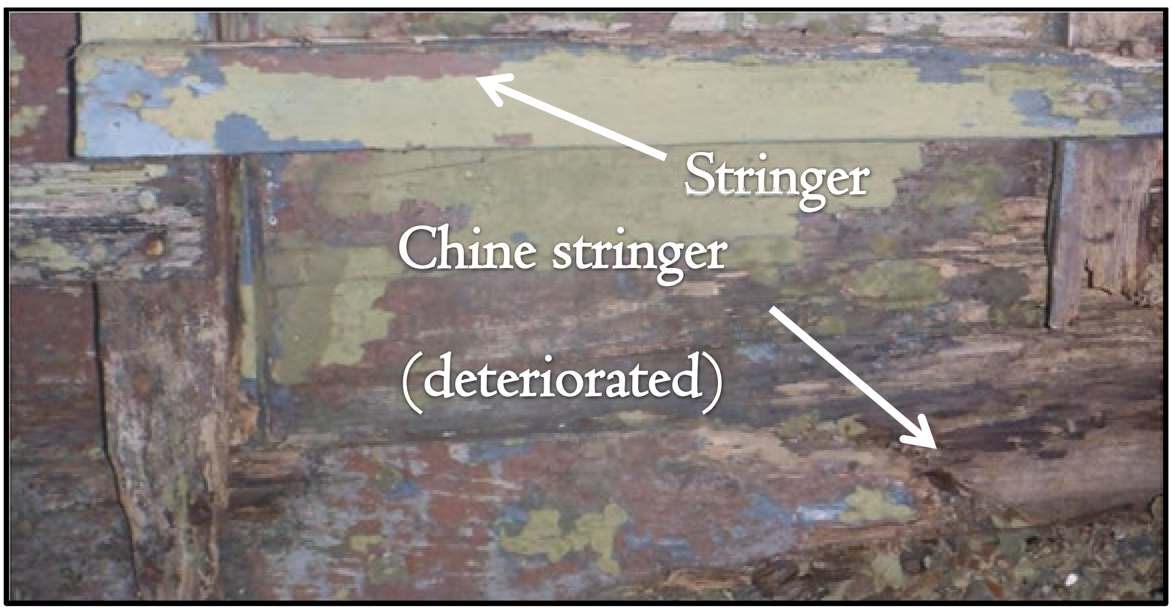

Figure 42. Aft section of the starboard chine stringer. (Photo by Ryan Bradley, 2013).

Each stringer is made of a single piece of wood. The chine stringers sit on top of the hull planking (Figure 43). There are no visible signs of fasteners on either of the stringers. This indicated that the side planking and bottom planking are fastened to the stringers from the outside of the hull. The fiberglass on the outside of the boat makes it impossible to discern any fastening patterns and thus definitively determine how these particular chine stringers were attached.

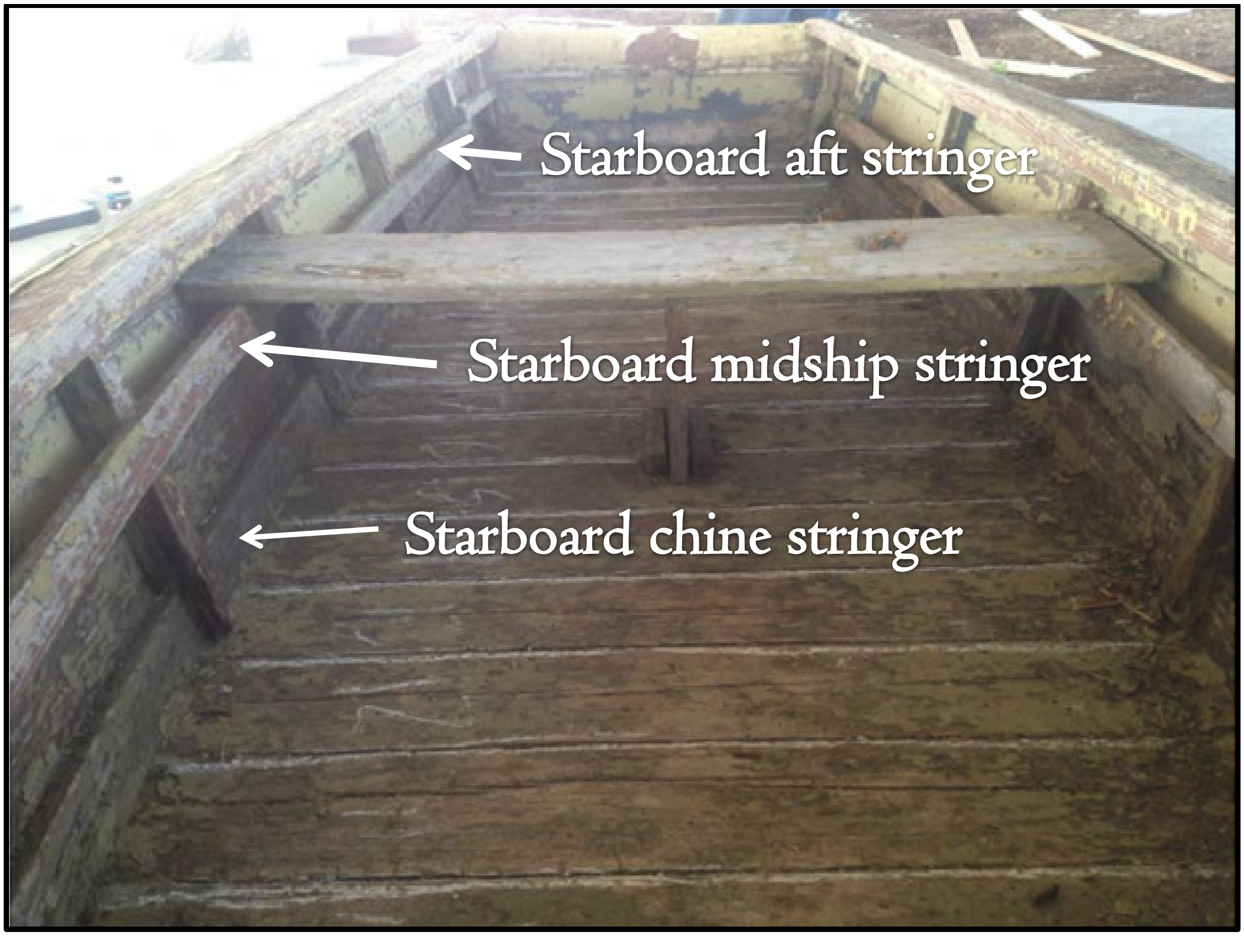

Figure 43. Perspective of stringers. (Photo by Ryan Bradley, 2013).

Stem

The stem of the vessel is an area that generated a lot of discussion amongst the team members. The most important question was whether or not the stem is made of two or three pieces of wood. A boat builder has the option of rabbeting the stem, carving notches which would allow the meeting of the strakes to the stem. This is a very difficult process. A simpler method is to create a secondary or "false" stem behind the main stem. This false stem is then fastened to the back of the main stem and used to guide the strakes to the stem and create a platform for the strakes to be received. Both methods perform the same duty, but the second is much simpler and more economical for a less experienced boat builder (Figure 44).

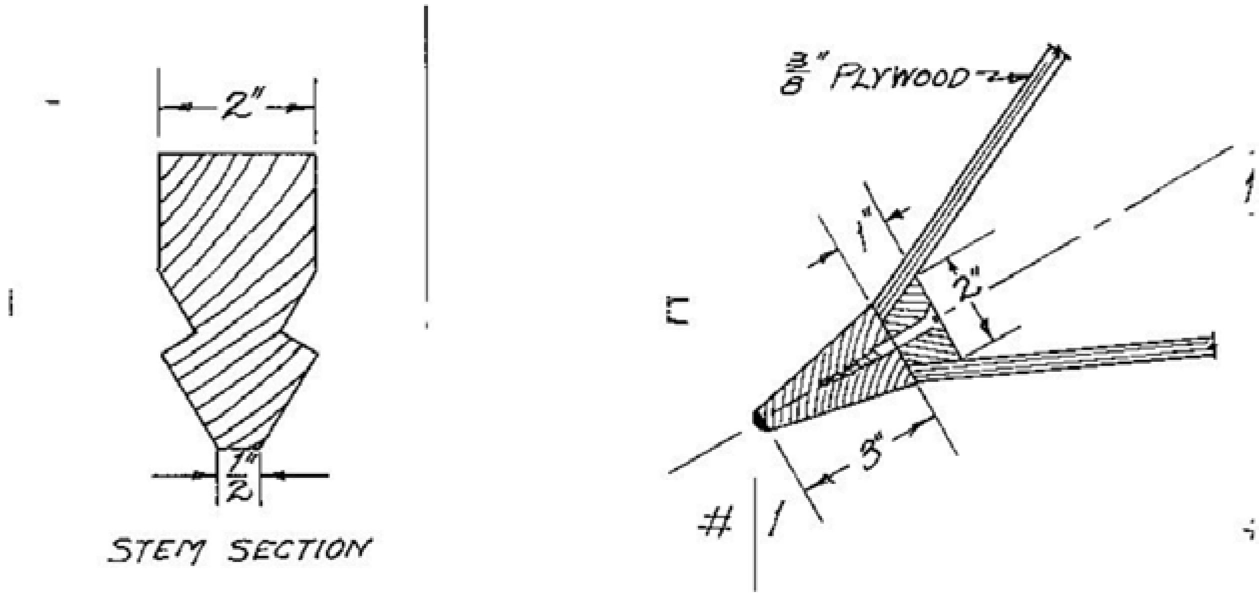

Figure 44. Comparison of One and Two-Piece Stem Construction (Gardner 1997:40,135).

The fiberglass coating on the outside of the hull made analysis of stem construction difficult, but not impossible. By probing heavily, it was determined that the stem is likely the simpler, two-piece construction. There are several reasons why the boat builder may have constructed the stem this way: either the builder was content with building the boat as simply and economically as possible or, as the outer hull planks may suggest, the available materials would not allow for single stem piece construction. In both stem construction methods, bottom plank 1 would have been fastened to the stem, with the fasteners going up from the bottom of plank 1 up through to the stem (see Gardner 1997:342). The team was not able to verify this, due to the fiberglass on the outer hull; however, common sense dictates there must be a method of fastening to ensure the articulation of timbers.

Stern

The transom of the vessel represents the largest single scantling on the vessel. It has a sided dimension of 4.5 cm (1.77"). At the top of the transom, the molded dimension is 107 cm (42.13") and at the bottom it is 89.6 cm (35.28"). The transom is a single piece of wood, giving it a lot of structural strength. The height of the transom at its midpoint is 31.4 cm (12.36"). This measurement does not include the height of the keel where it meets the transom. Several layers of paint can be seen on the transom. One line running along the molded dimension shows where an aft thwart may have been, with nail holes in Plank 26 showing evidence of the thwart's stanchion guards. Indentations of an outboard motor previously mounted on the transom can also be seen. Once again, it is difficult to see how the transom is fastened to the rest of the vessel – but the articulation of elements assumes that the strakes are fastened to the edges of the transom. The bottom outer hull planks are flush with the bottom of the transom, meaning it was cut specifically to meet the planks, instead of resting above them like the stem.

Hull Planking

The hull planking of the vessel consists of two strakes on either side of the hull and the flat bottom. There were some different interpretations of the strakes to begin with. At first it looked as through three strakes made up each side of the vessel. Closer examination, however, showed that what appeared to be a seam between two strakes is actually a generally uniform large crack running nearly the length of the vessel.

The top strake on each side has a width of 12.5-14 cm (4.92-5.5"). The strake is wider at the bow with the width tapering off the farther aft it went. The lower strake has a much greater width. At the bow, the strake is 31.6 cm (12.44") wide and at the stern, 24.9 cm (9.8"). This lower strake provides the majority of each of the vessel's sides. The thickness of each strake is 2.8 cm (1.1"), determined by probing in the seams. Due to the outside covering of fiberglass,

Table 2. Molded dimensions of planks.

Plank #	Width
1	11.0 cm at stem; 25.5 cm at Plank 2
2	40.0 cm
3	48.0 cm
4	57.0 cm
5	64.5 cm
6	72.5 cm
7	79.0 cm
8	84.0 cm
9	89.0 cm
10	92.5 cm
11	96.0 cm
12	98.0 cm
13	99.5 cm
14	99.5 cm
15	101.0 cm
16	100.5 cm
17	101.0 cm
18	100.5 cm
19	99.0 cm
20	97.5 cm
21	95.5 cm
22	94.3 cm
23	91.5 cm
24	89.5 cm
25	88.0 cm
26	86.0 cm
27	85.0 cm

it could not be determined how the strakes are fastened to the transom, stem, or other outer hull planks. An assumption is that they are fastened to the other scantlings by use of metal nails or screws, of similar sizes found on the futtocks.

The bottom of the vessel is made of 27 hull planks (Table 2). The planks are fairly uniform in size, with the exception of the bow. For recording purposes, the planks were numbered sequentially; Plank 1 being the forwardmost plank and Plank 27 the aftermost plank. All of the planks have a thickness of 2.2 cm (0.87"). The vast majority of the planks have a width of 14.5-15 cm (5.71-5.91"), with two major exceptions. Plank 24 has a width of only 8.7 cm (3.43") and Plank 5 has one of 20.5 cm (8.07"). The team came to the conclusion that the boat builder was using whatever wood was available when constructing the boat, leading to the differences in the size of these two planks. Planking widths are given in the table below. Plank one has two width measurements: one where it meets with Plank 2 and one where it meets the stem's covering. Each measurement was taken at the midpoint of each plank

Twenty-five planks have large cracks running across their full widths. The general condition of all planks is not good and all have cracks of varying lengths. Planks 5 and 25, however, are the only two with cracks running the entire length of the plank. The cracks associated with these planks are also large. There are several possible reasons why these cracks have appeared. They might be from seasonal weathering or could indicate points on the vessel where stress from weight was localized. Once again, due to the fiberglass, it could not be determined how the bottom outer hull planks are fastened to the vessel.

Frames

MoJo Bones has eight sets of futtocks. Each futtock is comprised of two pieces of wood, except for the first futtocks which only have one. Their length varies depending upon their location on the vessel. The outboard piece on the second futtock measures more than 30 cm (12") in length. Futtock size, from forward to aft, diminishes until it reaches 23 cm (9.06") at the eighth futtock in conjunction with the tapering of the shear strakes. The width of each futtock face averages 4.5 cm (1.77"). The outboard piece sits directly on the chine stringer. The inboard piece overlays the chine stringer and is fastened to both the chine stringer and the outboard piece by housing nails. Both sections of the futtock extend up to meet the decking. They do not extend to the bottom planks. They serve the purpose of joining the sheer strakes and giving the vessel overall strength and integrity.

Stringers

The starboard side of the boat has three stringers: a forward stringer, a midship stringer, and an aft stringer (Figure 43). The forward stringer has a sided dimension of approximately 4.8 cm (1.89") and a molded dimension of 2.2 cm (0.87"). It is made of a single piece of wood and is fastened into futtocks three, four, and five on the starboard side. Two nails are used to fasten the stringer into each of the specified futtocks. The midship stringer has similar sided and molded dimensions, with an overall length of 125.8 cm (49.53"). Three nails are used to fasten the midship stringer at Futtocks 5, 6, and 7. The midship stringer attaches to Futtock 5 immediately below where the forward stringer attaches to it. The aft stringer has a sided dimension of 3.7 cm (1.46"), a molded dimension of 2.4 cm (0.95"), and an overall length of 39.2 cm (15.43"). One fastener is used to attach the aft stringer to futtock seven and two are used to attach it to futtock eight. It is attached immediately above the midship stringer at Futtock 7. There is some deterioration of the wood at the aft end of the aft stringer. All three stringers are rectangular in shape with straight edges on their forward and aft ends. They also all have paint deterioration, likely caused by weathering.

Like the starboard, the port side has three stringers located forward, midships, and aft. The forward stringer has a sided dimension of 4.6 cm (1.81") and a molded dimension of approximately 2 cm (0.79"). It is attached at Futtocks 3, 4 and 5 on the port side. It is fastened at each of these futtocks by two nails. The midship stringer has a sided dimension of 4.2 cm (1.65") and a molded dimension of 1.6 cm (0.63"), with an overall length of 125.8 cm (49.53"). It is attached at each of Futtocks 5, 6, and 7 by three fasteners. The aft stringer of the port side is almost completely disintegrated. All that remains is a piece of wood attached to port side futtock eight. Lack of information prevented this stringer from being documented in *Rhinoceros*.

The deterioration of both the starboard and port side aft stringers suggests that the stern of the vessel faced more stress or use than other sections of the boat. The portside stringers also show paint deterioration similar to their starboard counterparts (Figure 45). Overall, it appears that the stringers on the starboard and port sides are mirror images of one another, minus the deterioration.

Figure 45. Deteriorated condition of aft port stringer. (Photo by Ryan Bradley, 2013).

Thwart

A thwart is located amidships. It is comprised of a single plank that runs from starboard to port and rests on stringers. Its width measures 2 cm (0.79") and its length is 156 cm (61.42"). A thwart stanchion at its middle supports it. The stanchion shares the same width as the thwart and may be from the same original plank. It measures just fewer than 27 cm (10.63") high. The stanchion is attached to the thwart with fasteners at the top. The thwart stanchion is not attached to the hull planking; it is allowed to float. When weight is administered on the thwart, the stanchion makes contact with the hull planking. There are two pieces of wood attached to the hull planking on either side of the thwart stanchion to keep it perpendicular to the thwart. It appears a second thwart once existed at the stern of the craft. The absence of paint in a thin line, roughly the same thickness of the amidship thwart, was noted on the transom (Figure 46). This ghosting, along with the presence of fastener holes located on the hull planking in the manner of the stanchion braces located amidships, is a good indicator of a missing thwart (Figure 47).

Figure 46. Example of ghosting, indicating missing stern thwart. (Photo by Ryan Bradley, 2013).

Figure 47. Fastener holes in the hull planking (circled with chalk) associated with stanchion braces in the stern. (Photo by Ryan Bradley, 2013).

Weather Deck Structure

The weather deck structure includes the deck's planks, deck beams, coaming, and rub rail (Figure 48). There are three deck beams at the bow of the boat, used to support the forward and side deck planking. The first deck beam is located slightly aft of the stem and the third beam located slightly forward of the forward coaming. The fiberglassed hull and location of the deck beams provide no visible appearance of fasteners. Looking at the entire bow structure, it is likely that the deck beams are fastened to the outer hull planking.

There are three forward deck planks that are nailed to each of the deck beams. The nails are driven into each of the deck beams in a straight line that runs from the starboard to the port sides. There is also side deck planking on the starboard and port sides that begin at the bow and run the length of the boat. Both the starboard and port side decking consists of two planks each. The first plank begins at the bow and stops slightly forward of the thwart, where it is scarfed. The second plank, also scarfed, runs from this point to the transom. These two deck planks are joined together by fasteners. The wood, where the two planks are scarfed, has deteriorated some. It is unclear how the side planking is attached to the stem because of the fiberglass. It is attached to each of the deck beams like the forward deck planking. Past the deck beams the deck planks are nailed into the outer hull strakes as well as the transom piece. There is some corrosion on the deck planks near the transom. There is an open-style cleat fastened into each of the starboard and port aft deck planks near the transom with screws (Figure 49).

There is forward, starboard, and port side coaming present. The forward coaming is nailed into the forward deck planking. It stops where it meets the starboard and port side deck. The starboard and port coaming begin where the forward coaming and side deck meet and continue all the way to the transom. The starboard and port coaming are nailed into the side deck as well as the futtocks. The starboard coaming appears to be one piece, and so does the forward and port coaming. The port coaming has a crack in it near the side deck scarf. The port coaming also has writing located amidships near the thwart. It reads: "West Ambrose, Maple NC." This is possibly the name of an owner of the boat, as well as where the boat was used.

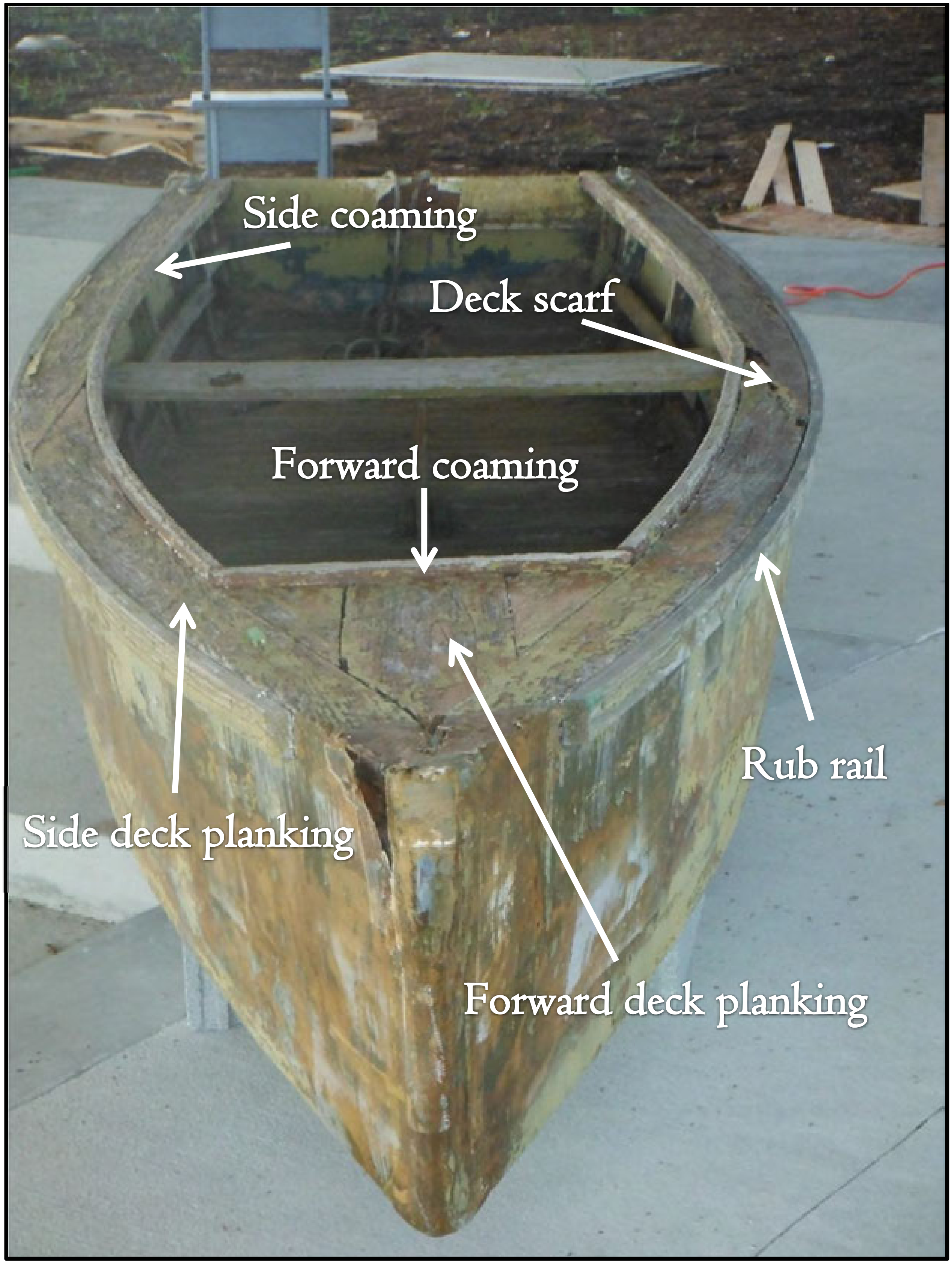

Figure 48. Forward deck, side deck, coaming, and rub rail (Photo by Ryan Bradley, 2013).

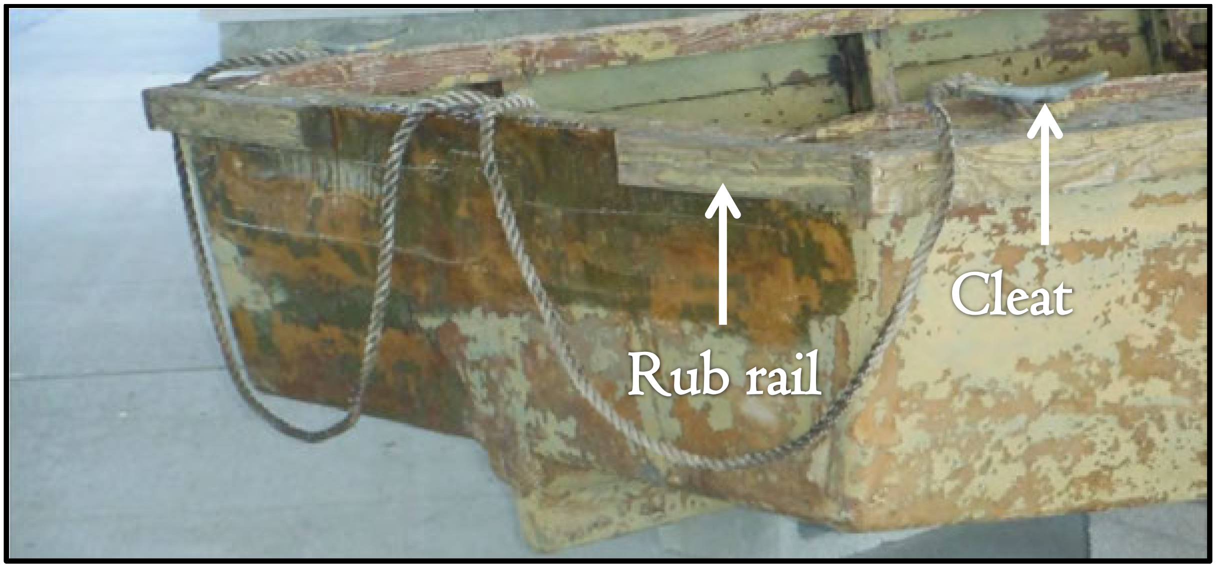

Figure 49. Stern of *MoJo Bones,* showing transom rub rail and cleat (Photo by Ryan Bradley, 2013).

The rub rail begins somewhat aft of the stem on the starboard and port sides. The starboard and port rub rail each consist of two pieces of wood. The forwardmost piece of wood is scarfed at both ends, and stops slightly forward of the thwart. The aftermost piece is scarfed where it meets the forward piece and ends at the transom, where it has a straight edge. The starboard rub rail has a sided dimension of 4.2 cm (1.65") and a molded dimension of 1.8 cm (0.71"). The port rub rail has a sided dimension of 4.2 cm (1.65") and a molded dimension of 1.9 cm (0.75"). There is also a transom rub rail that consists of two pieces of wood. The first piece begins where the starboard rub rail and transom meet and extends 28 cm (11.02") across the transom, with a sided dimension of 4.2 cm (1.65"). The second piece begins where the port rub rail and transom meet and extends 27.6 cm (10.87") across the transom, with a sided dimension of 4.1 cm (1.61"). Both transom rub rail pieces are straight-edge where they meet with the side rub rail and scarfed where they end on the transom. The starboard and port rub rails are fastened to the side deck. The rub rail does not appear as weathered as the rest of the boat. It is possible it was added some time after the boat was built.

Interpretation

To extend *MoJo Bones'* life, and to lessen the wear on the boat, the authors hypothesize that the boat was painted immediately after being constructed. The outer hull of the boat has been fiberglassed multiple times. Relevant to the interpretation of the boat is the question of whether the fiberglass was put on the boat to begin with, or if the fiberglass came after the boat needed repair work done. Understanding when the fiberglass was put on may also help with understanding the boat's age. Various common fiberglass patterns may have been more popular at certain times.

To assess the boat's condition, the authors analyzed paint layers. *MoJo Bones* has multiple paint layers on it. In order to discover whether the first fiberglass coat was original or not, the team had to look at whether or not the first layer of paint matched the paint on top of the first layer of fiberglass. This in itself was a challenge because *MoJo Bones* is not painted uniformly.

The first paint layer of dark chestnut brown is painted across the entirety of the boat except the thwart, the top half of the transom, and the second aft most stringers on both the port and starboard side of the vessel. The futtocks were all initially painted brown with a second paint coat of pastel blue. It was possible to identify these paint layers by chipping the paint, layer by layer. This blue layer could be seen on the second and last pair of aft stringers, as well as the bottom of the transom, and the thwart. The blue color may have been the first coat on some of the boat timbers, but the second coat on the other boat timbers. This may indicate that the boat was not painted fully when it was being built, or it indicates that certain parts of the boat have been replaced, and as the boat was being repaired, a new paint job was given to the boat.

The next color that is almost universally across the entirety of the boat is a pea-soup green paint layer. This array of colors seems to indicate that the boat underwent many paint and, potentially, repair jobs. This could mean that the boat got a lot of use which would explain the wear and tear on the small craft. The entirety of the vessel, below the rub rail, has fiberglass applications. The hull planking, directly above the keel, has been painted brown first and then has been painted over with pea-soup green.

It is also possible that after the boat was painted and before being fiberglassed, the boat went through a period of disuse. On the starboard side, close to where the transom and hull planking butt together, there is a hole where the wood has decayed and rotted away near the bottom. The wood around the hole has not been re-painted. The wood looks like it has had time to fall into disrepair. It does not look like anyone tried to repair the boat after the hole formed. It looks rotted out with no indications of intentional removal or patching.

The rope around the aftermost cleat on the port side has a rope cinched around it in a manner that prevents it from coming off. This is a permanent attachment to the boat. There is not brown or blue paint on the rope, but there is pea-soup green on the rope, as well as the cleat. This may show that the rope is newer; if the boat fell into a period of disuse, it is likely that the repaired boat would have received a new rope. It may also indicate that this boat was not professionally painted because a professional would do a much tidier paint job on a boat that a customer was paying to have painted.

When the boat was being fiberglassed, it was tipped over. It is possible to tell this because the drips from the resin run away from the bottom, toward the deck. The rub rail on the transom may be new or added since the original construction. There is no resin on the rub rail, even though the resin drips up between the two rub rails and the transom. Another indicator that the rub rail is newer is that it still has very sharp edges on it, whereas other parts of rub rails on the boat look more rounded from wear.

The layering on the outside of *MoJo Bones* goes as follows: fiberglass, brown paint, re-fiberglassed with light brown paint then the pea-soup green paint. The transom has been re-painted with the pastel blue then has been fiberglassed on the top of the transom. The paint closer to the bottom of the vessel is pea-soup green, the closer to the top of the transom is a darker shade of green, though this may be from less fading.

Conclusions

This project has provided a baseline for the documentation of *MoJo Bones*, a vessel that represents part of the North Carolina flat bottomed boatbuilding tradition. There are still areas that need to be further explored. The recording team can make recommendations for future work, including:

- Many features on the boat would benefit from more detailed recording. These features include the exterior stem, coaming and transom.
- The exact construction of the stem could not be documented due to extensive fiberglass on the exterior. In the future, if conservation or deconstruction is possible, the construction should be investigated.
- Due to time constraints, the fasteners, and any patterns of fastening were not documented.

MoJo Bones is part of the Whalehead Preservation Trust's small boat collection. The goal of this collection is to gather, preserve and share information about Currituck County's maritime heritage. The *MoJo Bones* documentation project fulfills these goals by providing digital references that can be used for illustrative and educational purposes. Skiffs were a common boat in the waters of Currituck County and this project provides insight for future research into the construction techniques used by local builders.

A NORTH CAROLINA SKIFF
(WPT Vessel #2013.09.09)

Chelsea Freeland, Allison Miller, William Sassorossi, and Jeneva Wright

Introduction

This small boat recording project was a collaboration between East Carolina University and the Whalehead Club Preservation Trust to fully document a small vernacular watercraft as a function of a field school. The project goals were to create a data set that could be used for examination of design philosophy and construction techniques in North Carolina small boats, as well as offer the potential for interpretation in public outreach and education.

East Carolina University had previously partnered with the Whalehead Club Preservation Trust to document some of their collection of duck hunting and shad boats, but this project presented an opportunity for a more thorough recording and structural analysis. This intensive recording was essential for the examination of a watercraft with little historical documentation or past archaeological review, but that presents an archetype of a local Carolina skiff utilized in duck hunting, fishing, and sound/river transportation (see Alford 1990).

Documentation of Vessel #2013.09.09 was supervised by East Carolina University (ECU) Professor David J. Stewart, and was completed by Chelsea Freeland, Allison Miller, William Sassorossi, and Jeneva Wright, all graduate students in ECU's Program in Maritime Studies. Recording was completed in ten working days from 9 September 2013 to 4 October 2013, totaling approximately 320 working hours. During that time, the students completed sectional drawings of all vessel construction elements, the collection of total station point data and supplemental hand measurements, and detailed photographic documentation. From 11 October to 4 December 2013, the students created a digital model of the vessel using *Rhinoceros* 4 computer aided design software, compiled a timber catalog, and completed this written report.

Figure 50. Photograph of North Carolina Skiff WPT#2013.09.09 (Photograph by William Sassorossi, 2013).

Methodology

Since this was the students' first time documenting a vessel of this nature, as well as using a total station and virtual modeling software *Rhinoceros*, efficient data-collection strategies were essential to balance the inherent delays of learning the project methodologies. The data was primarily collected using a total station, a much faster and more effective three-dimensional measuring tool than measuring by hand. Hand measurements were utilized in areas unreachable by total station (e.g., underneath deck planking). All measurements were taken in metric units.

Drawings

The students' first steps were to organize the vessel into sections, and then sketch each elevation of every construction element into unscaled drawings for annotated measurement and point catalogs. This resulted in detailed drawings of:

- Stem (exterior and interior)
- Outer hull (seven drawn sections each for port and starboard sides)
- Deck planking (two drawn sections for forward deck planking)
- Deck planking knees (two knees)
- Side deck planking, combing, and rub rails
- Thwarts (three thwarts)
- Thwart shelves
- Rooms and frames (eleven sets of frames)
- Hull and bilge stringers
- Bottom hull planking
- Bulkheads (forward and aft)
- Stern knees (three)
- Transom (exterior and interior)

Each of these drawings was labeled with project information, vessel number, date, whether the drawing was used with the point catalog or annotated hand measurements, and the initials of the student(s) working with the drawing. The students organized their process to complete a number of drawings within the first working day and then divided their efforts to have two students begin shooting points on completed drawings, while the other two finished the remaining elevations.

Total Station

Data collection was primarily achieved with a total station. The authors began by identifying and setting permanent datum points (spatial positions established with a high degree of accuracy) that would provide location context throughout the recording activities. Following any relocation of the total station, it was resectioned in relation to three datums (essentially offering x-, y-, and z-coordinates, with the total station placed in their center) for maximum accuracy. Before shooting began at each new resection, accuracy was tested. A maximum tolerance of 0.2 cm (0.08") was permitted for each resection.

Data points for each construction feature were shot on to separate feature layers to distinguish individual elements when reconstructing a digital model of the vessel. To maximize efficiency, however, the authors did not attempt to complete individual construction elements feature-by-feature; instead, they shot every point accessible from a given total station position, ensuring that the point was housed on the appropriate layer for the feature. This strategy allowed for as few resections as possible, while also supporting contextual accuracy. To further support this aim, no movement of the vessel was allowed, the recording team provided a backstop for every point shot, and they stressed the importance of good communication while shooting to minimize errors. Every point shot was entered into a catalog that identified the point number, feature layer, and any additional notes (such as use for multiple construction features).

After shooting all available points from multiple locations, the authors organized a strategy to identify which additional points were necessary to reconstruct a digital model and provide the most thorough data for construction analysis. They then organized the information into elevations from which they strategized points that could be reached, again maximizing efficiency. Wherever a desired point was deemed impossible to shoot, the students annotated their drawing with hand measurements. Through the course of the field project, a total of 1,207 points were accumulated on nineteen feature layers (Figure 51).

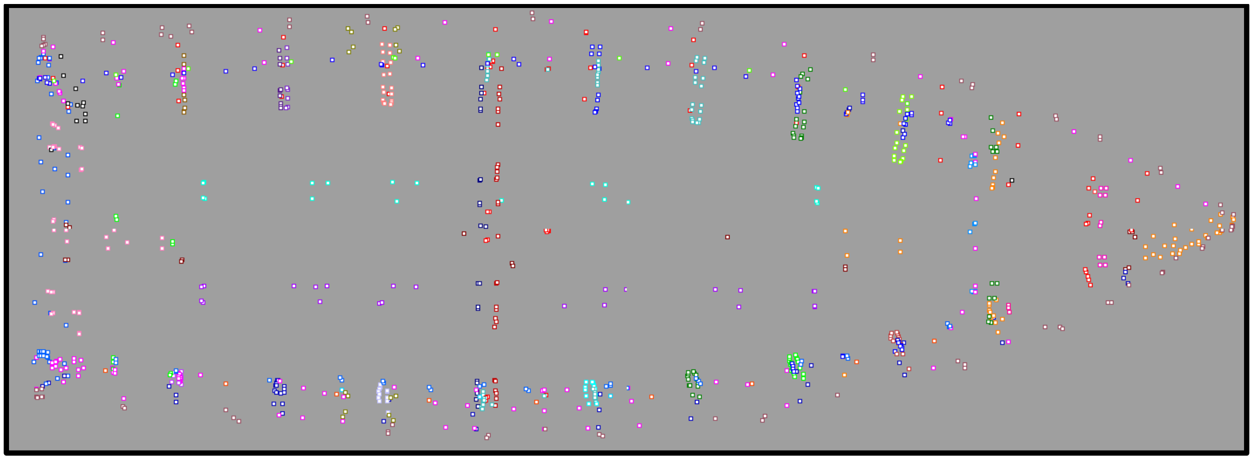

Figure 51. Point cloud of North Carolina Skiff WPT#2013.09.09 (Image by Nathan Richards).

Rhinoceros Modeling

From 11 October through 4 December, 2013, the team organized their point data, reviewed every point to ensure it was on the correct feature layer and imported the data set into *Rhinoceros* 4 software. The goal was to construct a three-dimensional model from the point cloud and hand measurements which could be used both for archival purposes and to assist in the examination of structural properties. The recorders divided the work by construction features, each working with separate layer groups. After features were thus individually constructed within the software, the vessel was virtually reassembled according to an hypothesized building sequence (Figure 52).

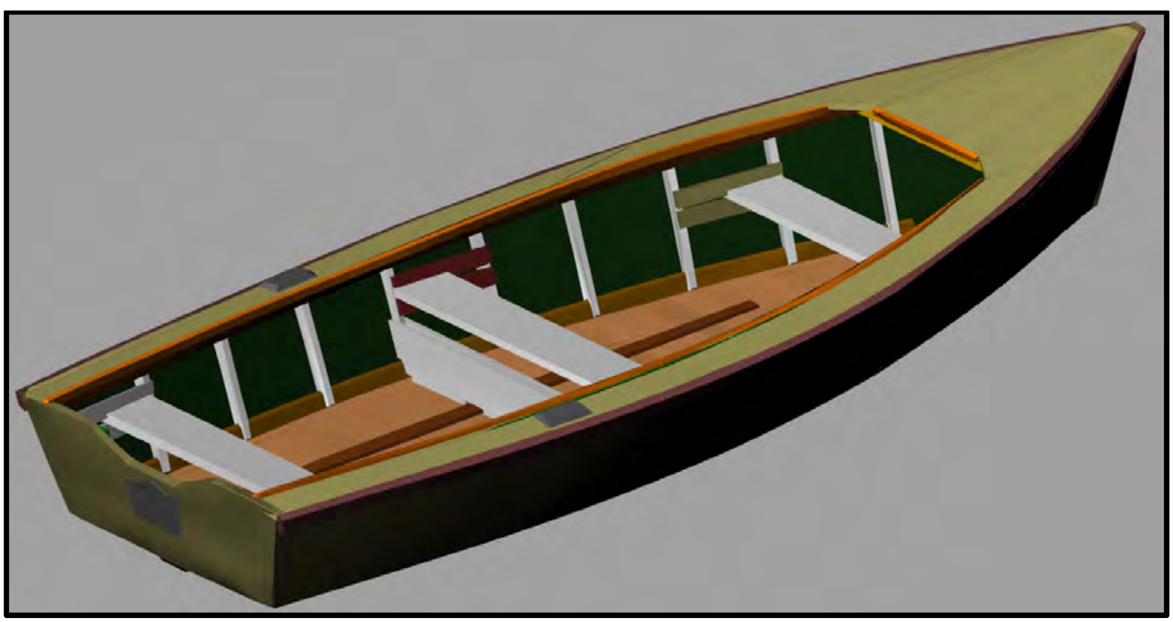

Figure 52. Perspective view of final rendered virtual model of North Carolina Skiff WPT#2013.09.09 (Image by Nathan Richards).

Results

This section outlines the results of the recording of WPT#2013.09.09. The subsections that follow outline an interpretation and analysis of the dimensions, hull form, structural components, construction, repairs, and function of the vessel.

Dimensions

Vessel #2013.09.09 is 470 cm (185.04") long from the top of the stem to the center of the transom, with an extreme beam of 160 cm (63"). From the top of the external hull planking at the stem to the keel, the boat's height is 70 cm (27.56"). This measurement applies to the bow, as the transom is significantly lower (to be discussed later). Maximum draft was calculated to be approximately 46.9 cm (18.46"). At this draft, displacement in freshwater and saltwater is 8,271 lbs and 8,469 lbs, respectively.

Hull Form

The hull structure shows an extremely flat-bottomed boat with a hard chine, and no tumblehome. The stem has a rake of 116.5°. The transom sits almost flat, at a 103.5°angle to the bottom hull planking, and flush with that and the side hull planking. In this boat, the keel is not a structural element of the hull form, as it was most likely added after the completion of the bottom hull planking, which gives the shape of the boat.

The structure of the boat follows the tradition of North Carolina flat-bottomed boats, which is characterized by the sharp-angled chine formed by the bottom and side hull planking (Alford 1990:2). The backbone of the boat is formed by the stem, transom, and bulkhead. As mentioned previously, the keel offers no structural support for the vessel; it is a false keel to prevent damage to the bottom of the hull if the boat were to run aground. Due to the presence of a fiberglass coating over the boat, it is unclear how the stem is attached to the hull planking. Wear in the fiberglass does make it possible to see that the bottom and side hull planking were nailed into the transom.

Structural Components

The bottom hull planking consists of roughly 33 strakes running athwartships. This is a rough estimate because some of the planks were cracked along parallel lines to the run of the planks, making it difficult to distinguish between seams and cracks from wear. These planks start at the stem joint and extend aft to the transom. The bottom of the hull from the forward face of Frame 1 to the stem is one piece of wood: Bottom Hull Plank 1. This has a trapezoidal shape and connects to the inside of the stem on the interior of the boat. The planks all have thicknesses of 2 cm (0.79"), but vary in their widths. The pattern for this variance is unclear.

The side hull planking is formed by three strakes on either side, though it is difficult to differentiate plank seams from cracking and paint chipping. It is possible that there are more or fewer strakes, but it seems most probable that there are three per side. They do not run parallel to the bottom of the boat, instead they come up towards the transom diagonally. The strakes vary in their widths and length; they are all 2 cm (0.79") thick. The bottom strake on the port side starts at 49 cm (19.29") wide where it joins the internal face of the stem. This joint is diagonal, not a true measurement of height. Just forward of Port Frame 1, the lowest strake is 32 cm (12.6") wide. This continues to decrease as the plank runs down the length of the boat, until midships (around Frame 7), where it begins to increase again. Table 4 shows the pattern of widths.

Table 3. Widths of the bottom port strake at the forward faces of each frame.

Frame Number	Dimension
1	32 cm
2	30 cm
3	28 cm
4	Unknown
5	25 cm
6	23 cm
7	Unknown
8	23 cm
9	24 cm
10	26 cm

Port Frame 4 is not included in Table 3 because measurements were prohibited by the placement of a set of thwart beams. Port Frame 7 is not included because the frame sits inside of the two bulkheads (Table 3 and Table 4). The middle port strake does not have as much variation in size as the other two. From the forward face of Frame 1 to the forward face of Frame 7, the strake is consistently 13.5 cm (5.32") wide. At Frame 8, it measures 13.2 cm (5.2"); at Frame 9 it measures 12.5 cm (4.92"), which is consistent until the strake ends at the transom. The top port strake also varies in width as it runs the length of the boat. Unlike the bottom strake, however, its widest point is at Frame 4, and there is a drastic decrease as the strake continues along the length of the boat. This variance is shown in Table 4.

The bottom strake on the starboard side starts at 39 cm (15.35”) wide where it joins the internal face of the stem. As on the port side, this joint is diagonal, so it does not provide a true measurement of height. Just forward of starboard Frame 1, the lowest strake is 33 cm (12.99”) wide. This continues to decrease as the plank runs down the length of the boat, until midship, (around Frame 7), where it begins to increase again. Table 5 shows the pattern of widths. Starboard Frame 7 is not included because the frame sits inside of the two bulkheads (Table 3 and Table 4). The middle starboard strake does not have as much variation in size as the other two. From the forward face of Frame 1 to the forward face of Frame 4, the strake is consistently 13.5 cm (5.32”) wide. At Frame 5, it measures 13.2 cm (5.2”); at Frame 8 it measures 12.5 cm (4.92”), which is consistent until the strake ends at the transom. The top starboard strake also varies in width as it runs the length of the boat. Unlike the bottom strake, however, its widest point is at Frame 4, and there

Table 4. Width of the upper port strake at the forward faces of each frame.

Frame Number	Dimension
1	9.2 cm
2	11 cm
3	13 cm
4	14 cm
5	13 cm
6	13 cm
7	Unknown
8	9.6 cm
9	7.1 cm
10	4.3 cm

Table 5. Widths of the lower starboard strake at the forward faces of each frame.

Frame Number	Dimension
1	33 cm
2	31 cm
3	28 cm
4	25 cm
5	24 cm
6	24 cm
7	Unknown
8	24 cm
9	25 cm
10	26 cm

is a drastic decrease as the strake continues along the length of the boat. This variance is shown in Table 6.

Table 6. Widths of the upper starboard strake at the forward faces of each frame.

Frame Number	Dimension
1	10 cm
2	12 cm
3	13 cm
4	14 cm
5	14 cm
6	13 cm
7	Unknown
8	10 cm
9	8 cm
10	6.2 cm

All hull planking is flush-laid. They are fastened to the frames with nails. Given the presence of fiberglass, there are no visual clues that nails cross the plank seams, and edge fastenings would be unlikely in this type of vessel. The top strakes are fastened to the deck with nails.

The boat has 11 sets of frames. None of the frames run across the bottom of the boat as floors. Instead, all are free futtocks attached to the side hull planking with nails, with typically at least one nail per strake, sometimes more. All frames are regular in spacing; they are 38 cm (14.96") apart. Frames 2-10 are regular in shape, as well. These nine frames are notched to fit over the bilge stringer. Frame 1 is simply rounded at the bottom, as the bilge stringer stops between Frames 1 and 2. Frame 11 is notched to fit over the bilge stringer, but sits flush against the bottom hull planking, rather than being rounded off. None of the frames are attached to the bottom hull planking in any way, with the exception of Frame 11, where it is unclear whether or not they are connected. The frames are connected to the hull by nails, with at least one for every plank as the frame extends vertically. They are not connected in any way to the bilge stringer, but are instead simply notched to fit over it. Each frame is 5 cm (1.97") sided and 3 cm (1.18") molded with variation for wear. The length of Frames 1-11 decreases from bow to transom, from 48 cm (18.9") (Frame 2) to 38 cm (14.96") (Frame 11) at the hull planking, until the frames meet the bilge stringer, and from 54 cm (21.26") (Frame 1) to 45 cm (17.72") (Frame 11) on the inside face. Frame 1 is not considered in the measurement along the hull planking because it does not fit over the bilge stringer, thus making its measurement along that face, 54 cm (21.26"), an outlier. Frame set 1 is 21 cm (8.27") from the internal face of the stem along the bottom hull planking, and 46 cm (18.11") from the stem line at the top of the internal hull planking, where it meets the deck. Frame 11 is connected to the transom with nails that enter the forward face of the frame and extend through to the transom.

There are bilge stringers extending from between Frames 1 and 2 to the transom, on both sides.

They are 2 cm (0.78”) molded (top) and 5 cm (1.97”) sided. The bottom edge of each is flush against the bottom hull planking while the top is angled down. Two deck stringers run along the sides of the boat just below deck level. They are 2 cm (0.78”) molded and 4 cm (1.58”) sided. They are nailed into the frames, with at least one nail per frame. They are not attached to the hull planking on the side in any way, however, as they sit on the inside face of the frames. The deck stringers do appear to be attached to the deck planking by nails driven vertically from the top. Additionally, there is another deck stringer on the starboard side that runs along the length of the boat, but does not extend as far as the main stringers. It is 2 cm (0.78”) molded and 6 cm (2.36”) sided. The stringer covers the area from just forward of Frame 6 to just aft of Frame 8; it is possible that it is nailed to Frames 6, 7, and 8, but it is definitely nailed to the main starboard deck stringer. This might be a repair stringer as it coincides with a crack in the deck planking at about the same area, again providing evidence that the stringers were nailed in through the top of the deck planking.

There are two hull stringers that run along the bottom of the boat, along the bottom interior hull planking. These stringers are 1.4 cm (0.55”) molded and 6 cm (2.36”) sided. They extend from Bottom Plank 7 to Bottom Plank 28 (about the distance from Frame 4 to Frame 10) for a total length of 240 cm (94.49”) each. They are 35 cm (13.78”) apart. These stringers are 20 cm (7.87”) from the side of the boat at the bow end, and 30 cm (11.81”) from the side at the transom end. Both stringers run through the bulkheads. They are nailed into the bottom hull planking at varying intervals.

There are two bulkheads, running athwartship, near the center of the boat. They are roughly trapezoidal in shape, with the longer edge (136 cm/53.54”) at the top, and the shorter edge (108 cm/42.52”) along the bottom of the boat. Both bulkheads have a thickness of 2 cm (0.79”). They are notched along the sides that connect to the hull planking, as well as along the bottom to allow the hull stringers and bilge stringers to pass through (Figure 53). The forward bulkhead also has two additional holes at the bottom, slightly outside of the spaces for the hull stringers. These may have originally been intended as limber holes, though they are irregular and could be from wear rather than intentional function (Figure 54).

The transom has a roughly trapezoidal shape. The length across the bottom, where it connects to the bottom hull planking, is 110 cm (43.7”). The length at the top (at the broadest point) is 150 cm (59”). Both sides are about 45 cm (17.72”) in length. The transom is 4 cm (1.57”) thick. As mentioned above, the transom is almost perpendicular to both the bottom and side hull planking. There is an angle of

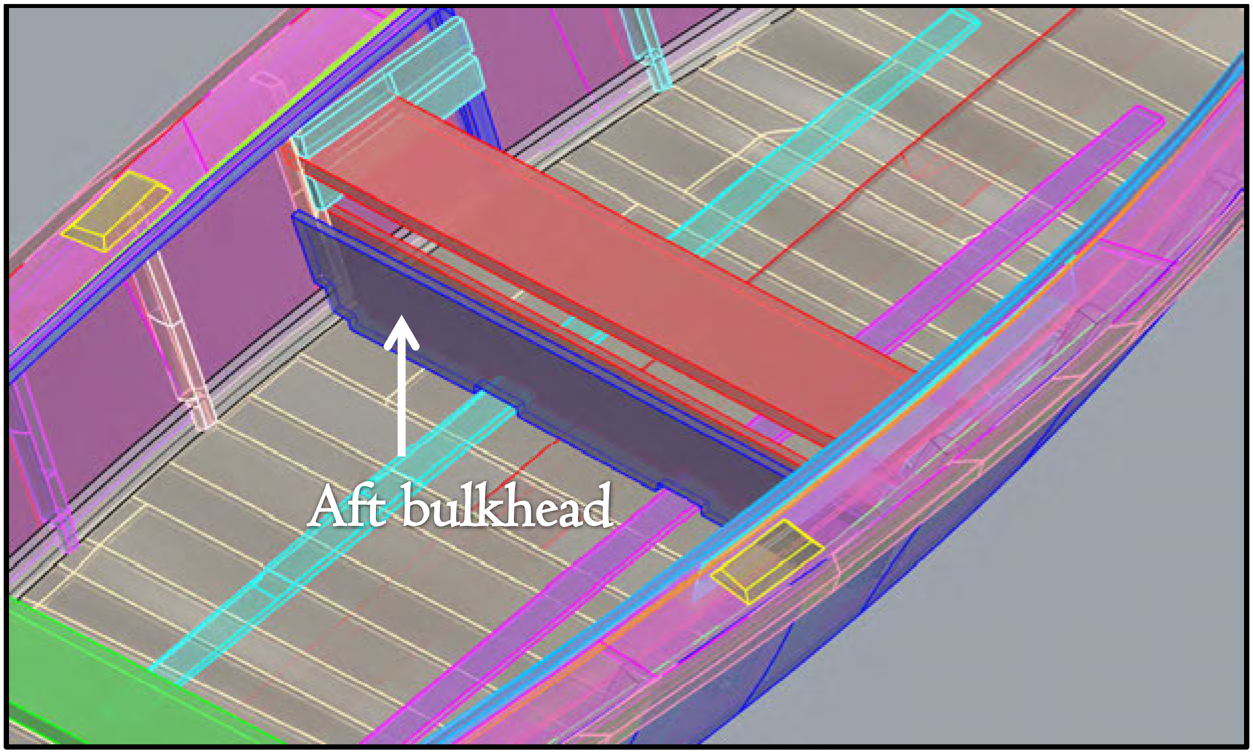

Figure 53. *Rhinoceros* model of WPT#2013.09.09 (ghosted view), showing aft bulkhead from stern perspective (Image by Nathan Richards).

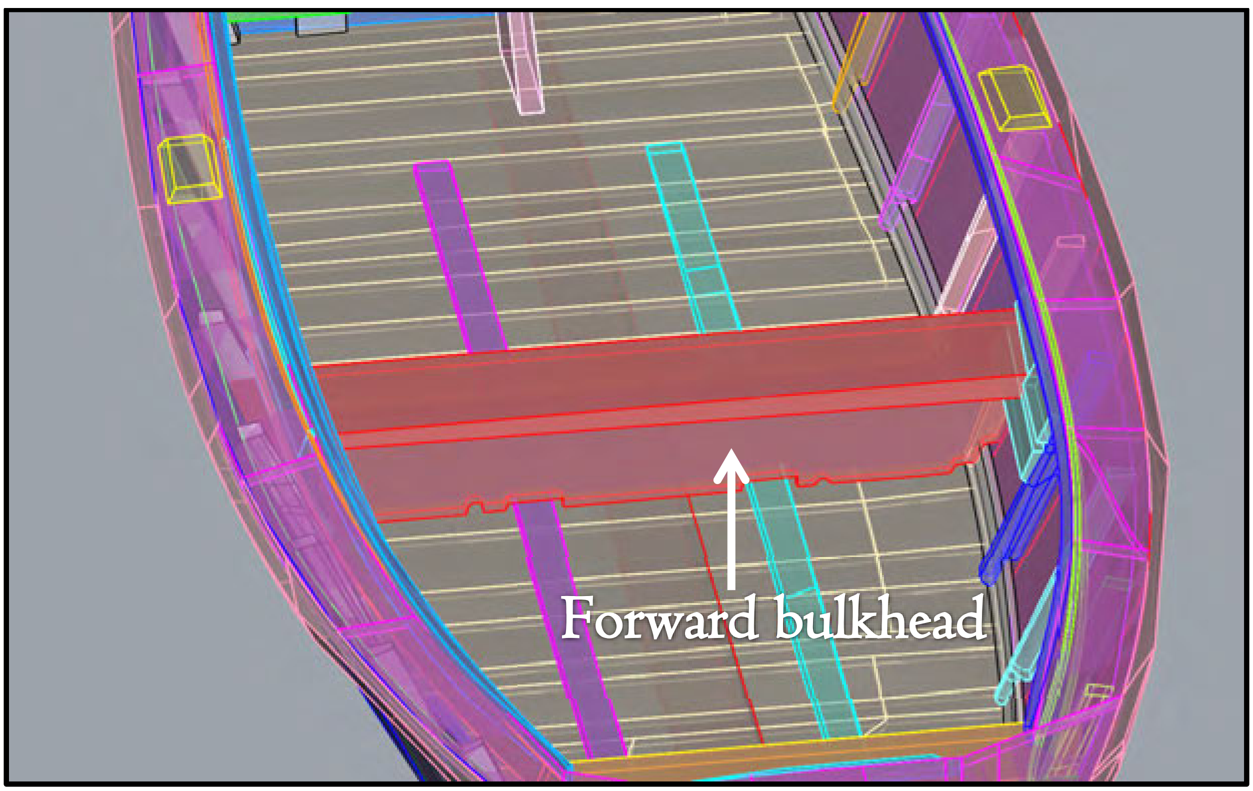

Figure 54. *Rhinoceros* model of WPT#2013.09.09 (ghosted view), showing forward bulkhead from bow perspective (Image by Nathan Richards).

103.5° from the bottom hull planking and the interior face of the transom, though the two sit flush, suggesting that the hull planking on the bottom is fitted to the transom angle.

The transom is supported by two transom frames and a knee. The transom frames are 2 cm (0.79") molded and 8 cm (3.15") sided. They are both 42 cm (16.54") in length. Each transom frame is 10 cm (3.94") from the edge of Frame 11 (along the bottom of the boat), which butts up against the transom, and 27 cm (10.63") from the stern knee, for a gap of 58 cm (22.84") between the two transom frames. These frames are not attached to the bottom hull planking, instead they are nailed into the transom planks for support of that feature. The stern knee is 3 cm (1.18") molded and 22 cm (8.66") sided. It is a regular trapezoid, with a length of 20 cm (7.87") on the face closest to the bottom of the boat, and 54 cm (21.26") on the outward face. It is attached to both the bottom hull planking and the transom with large bolts, creating structural stability for the vessel.

It is unclear how the stem connects to the internal or external surfaces of the hull planking, or interacts with the deck. This is due to the fiberglass coating on the outside of the boat and the paint layer on the inside. The interior face of the stem is a regular trapezoid extending from the hull planking to the deck. It measures 7.3 cm (2.87") across on the bottom, 9.8 cm (3.86") across on top, and 62 cm (24.41") high. The stem rakes outward, so the trapezoid face is not perpendicular to the bottom hull planking. This angle is 116.5°, compared to the centerline hull planking and keel of the boat.

The deck can be divided into three main sections: the bow deck planking, the port side deck and the starboard side deck. The bow deck planking comprises five planks of varying lengths and 2 cm (0.79") thickness. There is only one port side deck plank as well as only one starboard side plank. Both the port and starboard side deck planks attach to the bow deck planking and run the length of the outer hull to the transom. The bow deck planking is supported by two knees. The side decks rest on top of the transom and the bow knees and are attached with nails into the hull strakes and the top of the transom. The rub rail is attached directly to the exterior edges of the deck planking by nails.

Coaming pieces edge the interior of the deck. There were originally five pieces, but now only three are attached to the boat. The coaming pieces are 1 cm (0.39") thick and 3-3.6 cm (1.18-1.42") wide, with slight variance from wear along the boat. Coaming 1 and Coaming 5 are 359 cm (141.34") long and run parallel to each other and the centerline of the boat. Coaming 3 is 54 cm (21.26") long and sits at the edge of the bow planking, perpendicular to Coaming 1 and Coaming 5, as well as the centerline. Coaming pieces 2 and 4 (now detached from the boat) would have connected Coaming 1 to 3 and Coaming 3 to 5, following the line of the deck planking at a diagonal. Both pieces are 17 cm (6.69") long. Coamings 1, 3, and 5 are attached to the deck planking by nails at varying intervals. Coaming 2 alone is attached by 10 nails and shows evidence of repeated reattachment, given the irregular nail pattern.

On the outside of the boat, attached at the deck level, is a rub rail that runs the length of the boat on both sides. The rub rail is trapezoidal in shape, with the longest edge connecting the top of the deck and the side of the hull. The shorter edge sits off the boat. The longer edge is 8 cm (3.15"); the shorter edge is 6 cm (2.36"). The molded dimensions of the other sides are regular at 3 cm (1.18"). The rub rail is attached to both the side of the deck planking and the top of the hull planking by nails that run in almost a zigzag pattern down the length of the boat. The nails on top are regularly spaced and are offset from regularly spaced nails on the bottom face of the rub rail to create a stable connection to both pieces of the boat.

There are three thwarts in the boat. They are supported by two thwart beams on each side, for a total of twelve thwart beams. Each thwart is 3 cm (1.18") molded and 22 cm (8.66") sided. All thwarts are trapezoidal in shape, as they butt directly against the interior of the hull planking, following the shape of the boat. Thwart 2 sits at midships on the boat, and thus has a rectangular top face. Thwart 1 is 127 cm (50") long on its forward face, and 129 cm (50.79") long on its aft face; Thwart 2 is 144 cm (56.69") long on the forward and aft faces; Thwart 3 is 113 cm (44.49") long on the forward face and 100 cm (39.37") long on the aft face. Each of the twelve thwarts beams has dimensions of 2 cm (0.79") molded with a sided measurement of 5-7cm (1.97-2.76"). One of the beams on each side, in each set (six beams total), are notched so that the thwart fits into the notches, secured on both sides by the thwart beams (Figure 55 and Figure 56).

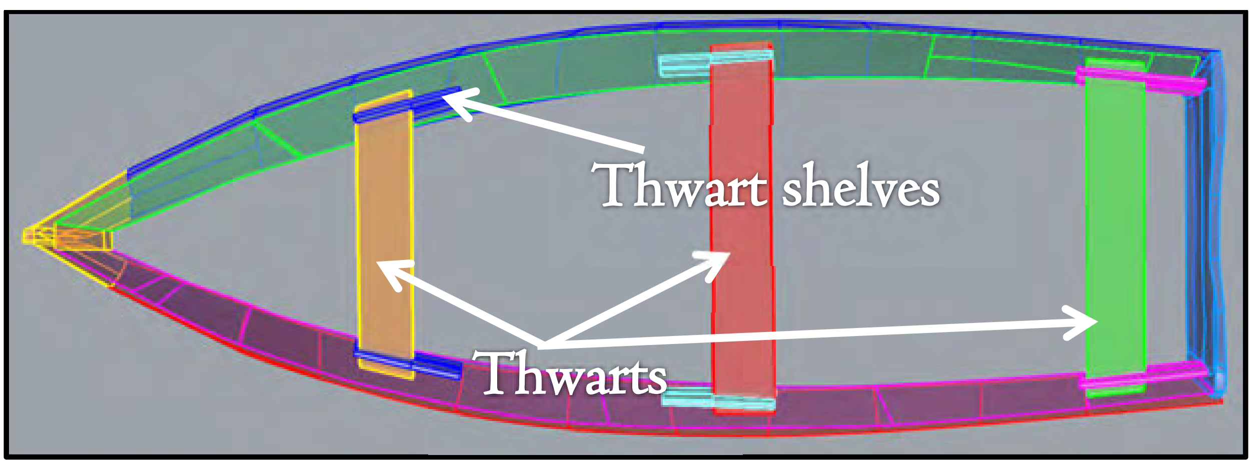

Figure 55. Arrangement of thwarts and thwart shelves, view from top (Image by Nathan Richards).

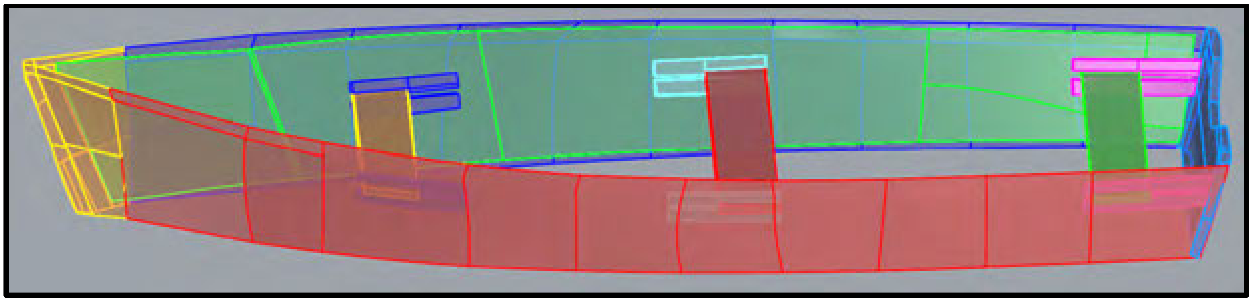

Figure 56. Arrangement of thwarts and thwart shelves, view from port perspective (Image by Nathan Richards).

These notches shorten the sided dimension on that side of the beam by roughly 2 cm (0.79"). All eight thwart beams for Thwarts 1 and 2 are 43 cm (16.93") long, while the four thwart beams for Thwart 3 are 27 cm (10.63") long. These thwart beams are secured to the frames by nails. The beams for Thwart 1 sit across Frames 3 and 4. The beams for Thwart 2 sit across Frames 6 and 7. The beams for Thwart 3 sit across Frames 10 and 11.

There is evidence on the transom of an engine mount, indicated by a small irregular plastic piece on the aft side of the transom. The piece is roughly 25 cm (9.84") wide and 20 cm (7.87") tall, and is approximately a square. The engine mount is illustrated in Figure 57.

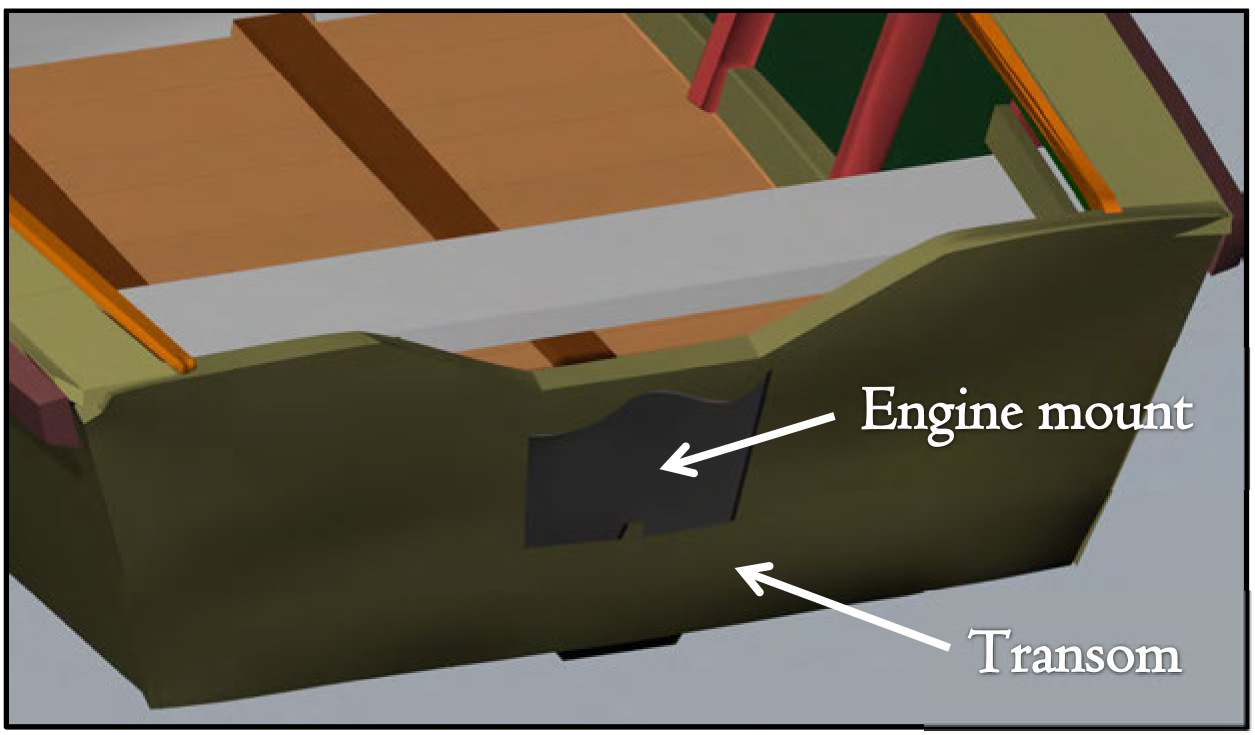

Figure 57. View of the engine mount against the aft face of the transom (Image by Nathan Richards).

Construction

Based on a preliminary examination and analysis of the boat's features, it was determined that the boat followed the traditional construction method of many North Carolina flat-bottomed boats, wherein the boat is upside down during the beginning phases of construction (Alford 1990:2). To do this, the stem, bulkhead, and transom were used as a framework, which created the backbone of the boat. An illustration of this construction method can be seen in Figure 41. Due to the external fiberglass coating, the construction of the stem itself is indeterminable. The entire transom can be seen, however, and is constructed from four pieces of wood, with two frames and a knee for structural support. It is also cut along the top for an outboard motor.

The bulkhead was probably utilized as a mold for the initial phase of construction because it does not serve as a watertight bulkhead and division of space is of minor importance on a vessel of this size. It instead lends lateral structural support to the boat at its widest point. The forward bulkhead has two limber holes that do not continue into the rear bulkhead. It is likely that both bulkheads were originally intended to have limber holes but plans were later changed. This is a possible indication that the forward bulkhead was the molding piece. Both bulkheads were notched to allow room for the bilge stringers and hull stringers.

Once the framework pieces were in place, the lowest side hull strake was the first to be attached to begin creating the port and starboard sides. There is evidence that this strake was nailed into the transom, and it is therefore likely that it was also nailed into the stem and bulkhead, though the fiberglass prevents confirmation of this. The bilge stringers were then inserted and nailed to the side hull strake. The bilge stringers do not extend the length of the boat; instead, they begin just forward of Frame 2 and end at the transom. Next, the bottom hull planking was nailed to the bilge stringers. The bottom hull planks that are forward of the bilge stringer were likely attached directly to the side hull and stern. The keel was attached once the bottom hull planking was completed. As stated with other boat features, the fiberglass prevents viewing how the keel was attached, but it was most probably nailed to the stem, transom, and bottom hull planking.

The next phase of construction began by flipping the boat upright to complete the upper and interior sections. First, the port and starboard frames were inserted and nailed to the bottom side hull strake and the bilge stringers, which they were notched to fit around. Frame 1, which is forward of the bilge stringers, was nailed to only the side hull. The remaining side hull strakes were then added by nailing them to the frames.

It is debatable whether or not the fiberglass was a part of the original construction. Older boats would have been wood at first, then fiberglassed later in life as leaks developed and as do-it-yourself fiberglass kits became available. Whether original or not, fiberglassing helped to ensure the waterproofing of #2013.09.09. If the boat was fiberglassed at the time of original construction, fiberglass would have been added before the additional exterior features (e.g., rub rails) were added.

With the major hull features and structure completed, work then began on the interior sections and additional support features. The hull stringers were slid into place between the notches on the bulkhead and nailed into the bottom hull planking. This attachment is evident at the ends of the hull stringers, which do not extend the length of the boat. The aft bulkhead was then put in to provide added support for the relatively thin side hull planking. The bulkhead was bolted through Frame 7 and the forward bulkhead, providing further evidence that the forward bulkhead was the molding piece. The transom knee was bolted to the transom and bottom hull planking for additional structural support.

Next, the thwarts and their corresponding supports were inserted between frames. The lower thwart supports were nailed to the interior face of the frames. The thwarts themselves, which extend the width of the boat, were then rested on the supports. They are wedged between a frame and the upper thwart supports, which were notched to fit around them (Figure 58). The forward most thwart, Thwart 1, is also notched around Frame 3. The upper thwart supports were then nailed to the frames.

Figure 58. Thwart 3 on the starboard side showing its placement between the notched thwart support and the frame (Photo by William Sassorossi, 2013).

In preparation for decking, the deck stringers and deck beams were inserted. The forward bow knee was nailed at the top of the forward face of Frame 1. The aft bow knee was nailed at the top of the aft face of Frame 2. The deck stringers were nailed to the interior face of the frames at the top, running from the transom to the aft bow knee. Both deck stringers site flush against the aft bow knee. The placement of these deck supports can be seen in Figure 59. The deck planking was then put into place. It was nailed variously to the deck stringers, deck beams, and side hull planking.

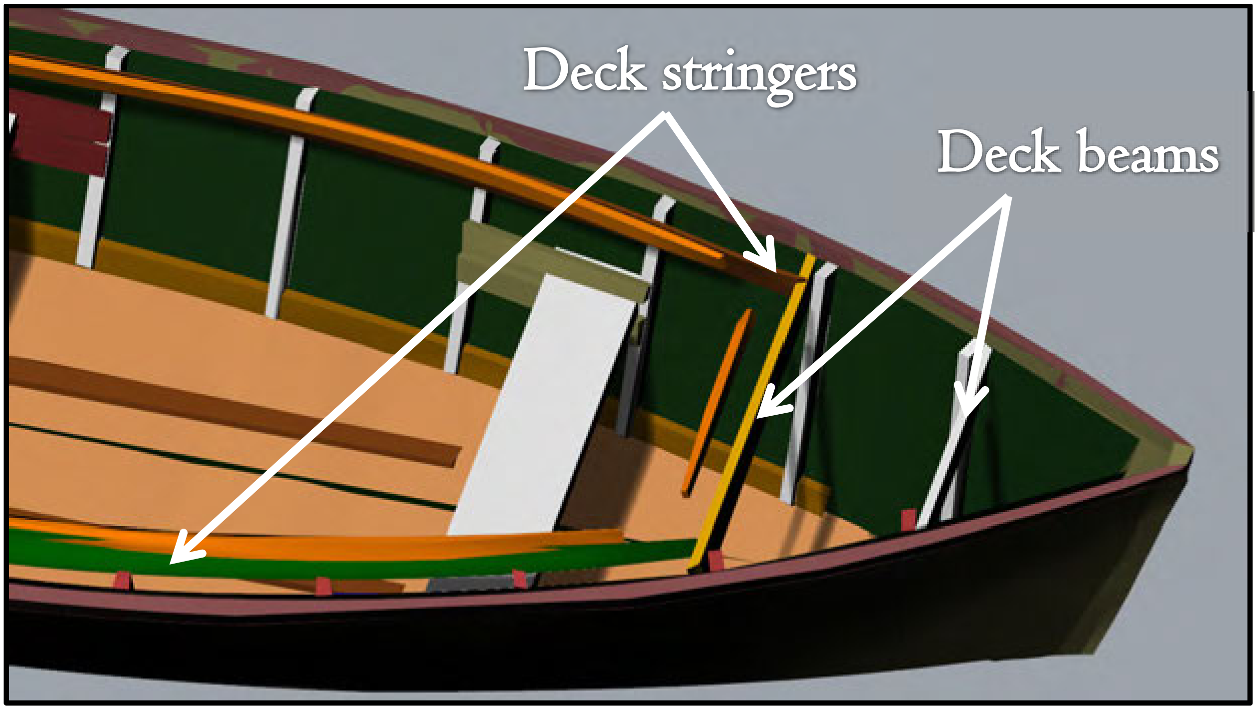

Figure 59. Placement of the deck stringers and the deck beams (Image by Nathan Richards).

The rub rails were then attached at the top of the exterior side hull planking and flush with the deck. They were nailed in an alternating pattern to the deck and the side hull planking. The coaming pieces were then attached to the deck on the interior by nailing them directly to the deck planking.

The final pieces added were both for propulsion: the oarlock fittings and the engine mount. The oarlock fittings were placed just aft of amidships in line with Frame 8. Composed of a single rectangular piece of wood with a metal mounting plate, the oarlock fittings are nailed into the deck at each corner. The plastic engine mount is placed near the center of the exterior transom; it is screwed into the exterior face of the transom along its edges through the center.

Repairs

Evidence of repairs was found on the hull. The stringer below the starboard side deck planking has a smaller stringer nailed to it from just forward of Frame 6 and slightly aft of Frame 8. There is a split on the side deck planking above it and this additional stringer appears to be a repair. The side deck planking is nailed down into the stringer in an attempt to keep the deck planking from splitting further.

Function

The shape and size of this vessel strongly suggest it was intended for use in calm, shallow waters. A flat bottom with a keel extending 2 cm (0.79") from the edge of the hull planking allowed this vessel to maneuver in very shallow water. Given the geography of the area surrounding where the boat is located, it was most likely used in Currituck Sound. The length and beam measurements of the vessel suggest a limited amount of cargo could be carried, as well as a limited number of operating crew or passengers. Three colors of paint have been discovered, with the top layer a shade of olive green. The other two prominent colors seen are battleship gray and forest green. This top coloring could indicate a method of camouflage, typical for use as a recreational, hunting, or sporting boat.

Most of the objects on the deck layer have been removed, obscuring any opportunity to identify distinct functional features. Oarlock fittings are all that remain of features on the deck planking. On the transom section, evidence remains of an engine mount, allowing for an outboard motor to be used for power. Few internal features, especially a lack of defined storage space, may indicate the vessel was used for short trips as opposed to longer excursions. There is a bottle opener, located on the aft bow knee, possibly providing evidence of a recreational craft.

The observational evidence of paint scheme and presence of a bottle opener, as well a shallow draft design, combined with the geographical location of where the vessel was found, all indicate it was most likely used as a sporting/recreation boat. Power to move the boat could come from either an outboard motor or by a person rowing, allowing for two modes of maneuverability. The freedom to maneuver within the boat and the ability to reach shallow water, allowed a duck hunter easy access to secluded locations, as well as providing unobstructed range to shoot. The ability to maneuver in shallow water allowed people to work in conditions in which other watercraft were unable.

HAMBONE'S SHAD BOAT
(WPT Vessel#2005.03.01)

Ryan Bradley and Jeremy Borrelli

Introduction

In 2014, Ryan Bradley and Jeremy Borrelli recorded two watercraft as a part of the Currituck County Maritime Heritage Fellowship (CCMH). The purpose of the 2014 fellowship was to provide written, photographic, and digital documentation of two historic boats located in the Currituck Heritage Park ("Hambone's Shad Boat" and the "Slick Boat"). This chapter outlines the work undertaken to record "Hambone's Shad Boat" (Figure 60). Work for the 2014 season began June 23 and was completed on August 15. The time appropriated for each boat was about three weeks, with an extra week for writing the final report and completing additional archival research. Total station recording, hand-drawings, and *Rhinoceros* modeling work was divided equally between the Research Fellows Jeremy Borrelli and Ryan Bradley.

The overall aim of the project was to provide the Whalehead Preservation Trust with a compiled record on each boat, coupled with a digital model. The model will then serve as a preservation record detailing each boat's construction. This record will be used for educational programs focused on local watercraft construction techniques, styles and functions, as well as for additional display material for the exhibits throughout the park. This boat is one of a few remaining examples of North Carolina wooden shad boat construction made by locally renowned boat builder W. Otis Dough of Roanoke Island, NC.

Boat Details

Location: Whalehead Club Boat Shed, Currituck Heritage Park, Corolla, North Carolina.

Rig/Type of Craft: North Carolina Shad Boat

Trade/Use: Utility craft associated with hunting and fishing in Currituck Sound.

Width – 273.5 cm (107.68") at widest point

Length (overall) – 978.2 cm (385.12").

Propulsion: The boat once had a 283 Chevy converted to Chris Craft marine engine (Morris 2014:44). Currently, no engine is installed.

Date of Construction: 1906.

Original Owners: Hunt Club of Back Bay, VA, Casey Jones, Ambrose Twiford, Levie Bunch (Morris 2014:73).

Present Owner: Whalehead Preservation Trust

Disposition: Display vessel.

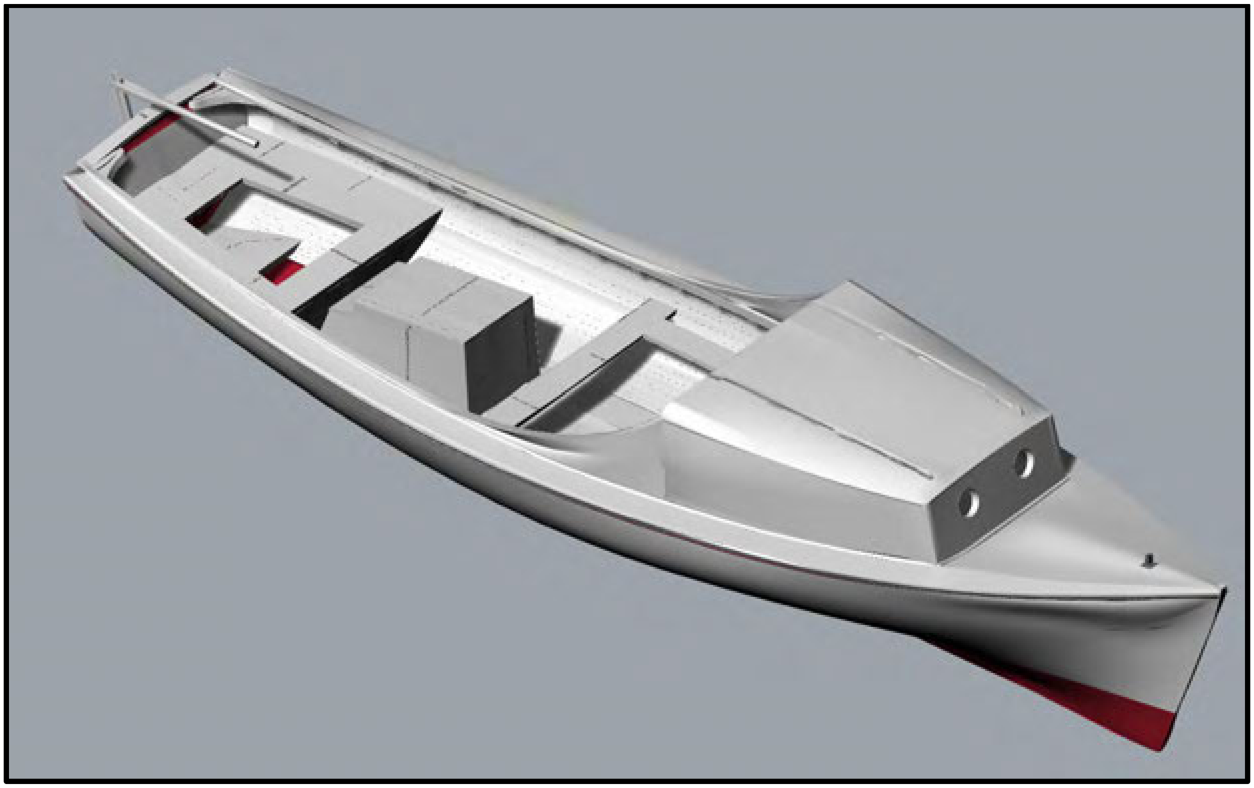

Figure 60. "Hambone's Shad Boat" (WPT Vessel#2005.03.01) -- rendered 3D model by Ryan Bradley and Jeremy Borrelli (Image by the authors).

Methodology

This section explains the methodology undertaken in the recording process on "Hambone's Shad Boat." The methodology is comprised of two parts consisting of fieldwork and digital reconstruction. A third section is included to discuss limitations encountered in the field.

Fieldwork

Fieldwork on Hambone's Shad boat was conducted inside the Whalehead Boat Shed near the Corolla Lighthouse on the grounds of the Currituck Heritage Park. This offered both advantages and disadvantages in the recording process. Advantages included all-weather working conditions and a wooden structure for the strategic placement of datums. Limitations are discussed in a later section. The first day's objective was to divide the boat up into layers or recording sections, and then create drawings of the sections for a point catalogue. The boat was divided into 24 layers and 30 drawings were created, after which the process of shooting points began.

To begin shooting an occupy point must be created. This is an arbitrary location and acts as the "0" or "origin" point from which the rest of the points will be referenced. It is important to maximize advantageous shooting locations for the purpose of saving time. The first location, in this case named T01, was chosen because its field of view offered a vantage point which maximized point shooting data collection. The next step was to setup a backsight. This point is also arbitrary, but helps position the total station in a fixed location that will be the basis for all of the points to be recorded. A subsequent step entails choosing the location for datums. Datums are points that are strategically placed around the perimeter of the boat. These are then used as reference points to resection the total station every time it is moved to a new location. At least three datums need to be utilized for each resectioning. Since the recording occurred in the shad boat shed, pieces of duct tape were placed on planks around the structure that offered advantageous positions. With datums in place, the process of shooting points may begin. For this project, a team of two people performed the necessary tasks in recording. One individual worked the total station, zooming in on the points chosen by the other individual who has the point catalogue, a pointer, a piece of chalk, and a flashlight illuminating the point location. The person with the point catalogue recorded the location of points taken on the boat on the hand drawings created earlier. As points were shot, they were saved into separate layers to make the reconstruction process easier.

Due to the extensive restoration carried out on this vessel, there were no external hull plank seams visible. Instead of using hull planks, chalk was used to create strategically placed shooting points that would be capable of showing the curve of the hull (Figure 61). This method was utilized in other areas where planking seams were not visible, including the roof and sides of the cabin, the forepeak, and transom.

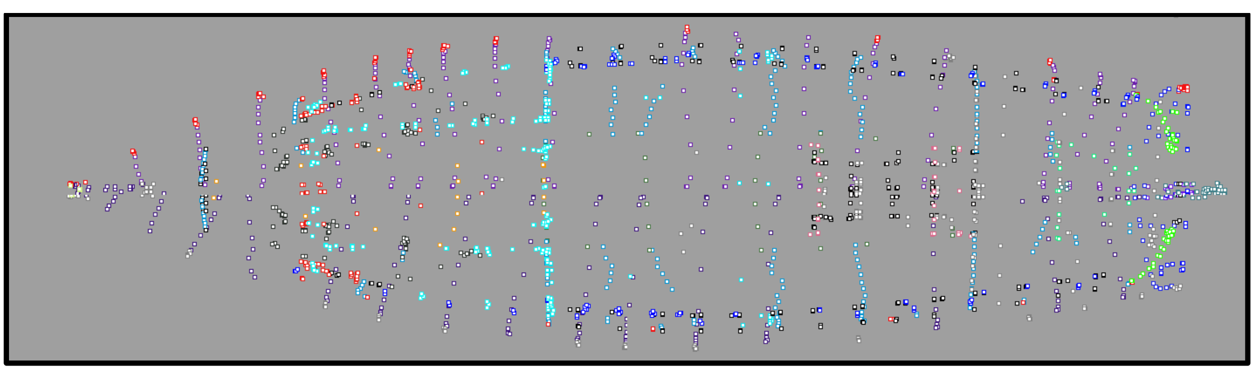

Figure 61. Point cloud of exterior hull (Image by Ryan Bradley and Jeremy Borrelli).

Points were shot whenever seams, ends, corners, and sides were visible. Much of the interior hull was recorded in this way, as were the ceiling, engine box, poop, and helm deck. 2,282 points were organized into 24 layers by the end of the recording process.

After the points were collected it was necessary to take hand measurements to get the rest of the structural dimensions that the total station was unable to reach. These were taken predominately in the cabin structure where the total station could not go. These measurements make it possible to "build" these structures in the drafting program. In addition, photographs were taken documenting the locations of structural elements to aid in the reconstruction process.

Reconstruction

Digital reconstruction of the boat was completed through the use of a computer aided drafting program, McNeel *Rhinoceros* (version 4.0). *Rhinoceros* is an expansion upon previous CAD programs, and is useful for maritime heritage recording projects due to its ease of handling two and three-dimensional curvature, because it is relatively inexpensive, and can fit well within a project's budget. The strength of *Rhinoceros* in terms of this project's goals for reconstruction lies in the fair and accurate representation of a surfaced hull model that has the ability to serve as a basis for visualization, hydrostatic analysis, and the production of lines plans for traditional dissemination (Hytell 2011:28). At the end of each day of fieldwork, all points would be downloaded as AutoCAD drawing interchange format (.dxf) files onto the field laptop computer. Following the completion of all fieldwork, the total point data was saved as a 3D model format (.3dm) file on *Rhinoceros* for final reconstruction.

When the total station information is uploaded into *Rhinoceros* it is represented by a cloud of points in the overall shape of the boat (Figure 61). The aim of reconstruction is to find the correct sets of points that comprise individual timbers and connect the dots using a combination of lines and curves in the *Rhinoceros* toolbar. It is much like finding the constellation in the seemingly arbitrary collection of points in the sky. Measures taken during the fieldwork help decipher the cloud. The layers created during the recording process separated the collections of points into their respective structural units with a different color for each, easing interpretation of the confusing point cloud. Additional layers were also created as needed during reconstruction, which aided in further separating the starboard and port side points. Each layer was comprised of the entire structural unit such as "engine," or "coaming."

Some of the timbers could not be recorded using the total station due to prior restoration that made those sections of the boat inaccessible. In order to adapt to this during fieldwork, one or two random points were taken on either a part of the frame set to establish its general location. From that point, previously created curves on Rhino could be used to manually build the structural unit. This technique utilized hand measurements taken on these timbers that lessened the degree of error and confirmed accurate dimensions. This was primarily necessary on the frame sets that were composed of a combination of floor timbers, futtocks, and deck beams. After each timber was delineated or built and all the points connected, a surface would be placed in between the curves to visually render the timber, creating the three-dimensional visualization of the boat (Figure 62).

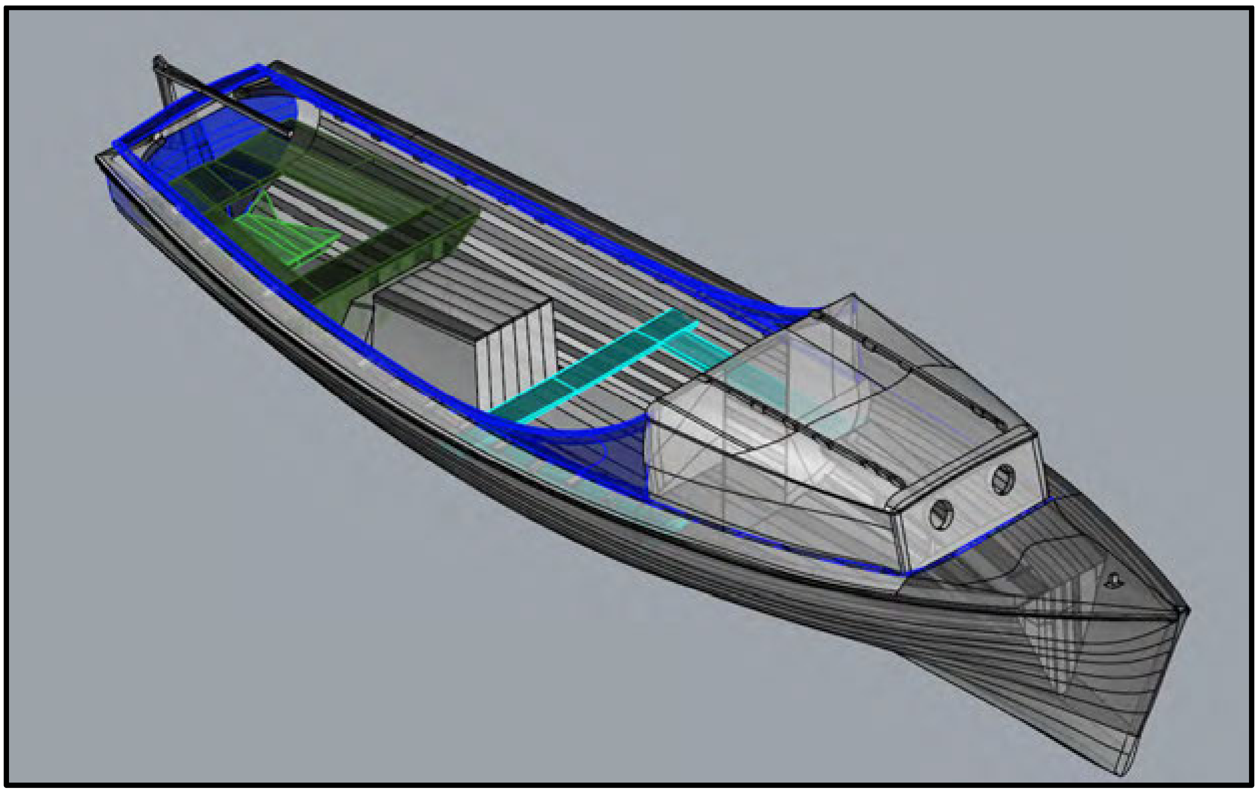

Figure 62. Final "ghosted" rendition of virtual model of "Hambone's Shad Boat" (Image by Nathan Richards).

Limitations

The boat is located in the Whalehead Boat Shed, which protects the vessel from the elements, but provides a challenging space for recording the vessel using a total station. The boat is flanked on each side by another shad boat and a smaller gas boat limiting the field of view for point recording. This prevented ideal point recording positions being established, which may have caused some inaccuracies in the process.

Because the boat has been restored it was impossible to record the outer hull as individual planks because fiberglass, epoxy, paint, and other synthetic material were used in the restoration process. This is true of the deck planks, washboard, interior hull, cabin, stem, and much of the rest of the vessel. The interior hull planking obscures the position, shape, and size of nearly all of the floor timbers, futtocks, and deck beams, as well as the keel. There is planking obscuring the stem construction, so it is unclear how this particular vessel is constructed at the bow aside from what is known historically about these types of boats. It is unclear if this vessel was initially a sailing vessel when it was constructed. The interior hull obscures the planking amidships, which might indicate that there was one present at an earlier time.

Historical Information

"Hambone's Shadboat" (WPT Vessel#2005.03.01) was designed and constructed in 1906 by W. Otis Dough (no known plans of the vessel exist). This boat has undergone restoration more than once in its lifetime. Casey Jones, with the help of Grissie Barco of Currituck County, repaired and replaced sections of the boat to make it seaworthy again after purchasing it. At the time of Jones' ownership a *hobble* was present on the stern of the vessel (Figure 63). The *hobble*, a term originating on Roanoke Island, refers to the application of a series of "squat" boards added to the stern of the vessel to square out the end. This additionally negated the significant tuck of the transom allowing these vessels to get on plane when underway (something that was difficult to do until more powerful engines were invented and available for installation later in the century). Casey Jones sold the boat to Mr. Twiford (also known as "Hambone"), who removed the hobble due to an infestation of nesting muskrats. Hambone would later re-install the hobble (Morris 2014:73, and Morris 2014 pers. comm.). On Hambone's Shad Boat the hobble has been removed, perhaps in the restoration process performed by Bobby Sullivan of Currituck County.

There is a possibility that this boat was built as a sailing vessel. There is no record to dispute or confirm this. According to one source, Ben Daniels is credited with being the first to put an engine in a shad boat in 1908, two years after Hambone's boat was constructed (Muir and Alford 1997:9). If this is true, then this shad boat would have been made for sailing and had a centerboard trunk and a mast step. According to Mr. Morris, this boat did have a pole mast when Mr. Twiford owned the boat, but it was only used as a hoist for heavy objects like duck blinds or sink boxes (Morris 2014, pers. comm.).

Figure 63. Picture of Hambone's Shad Boat with the hobble still attached (Photo courtesy of Travis Morris).

Historical Context

The Shad Boat is the official state historic boat of North Carolina as designated by the North Carolina General Assembly in 1987. Originally called the Albemarle Sound Shad Boat, it is since referred to as the North Carolina Shad Boat as its use by residents of North Carolina extends to areas as far north as the North Carolina and Virginia border and as far south as the Core Sound. The development of the shad boat came about as a result of the need for a vessel that could harness the power of wind, draft very little water, while also retaining elements of sturdy construction and utility (Alford 2004:18-19).

The individual credited with designing the first shad boat is George Washington Creef of Roanoke Island, NC sometime around the 1870s. He and another builder, named Mann H. Basnight, constructed the round-bottom hull based on a half-model carved by Creef. Prior to the shad boat, dugout log canoes, referred to as "kunners", were the primary craft relied upon for heavy work in the sounds.

Creef relied on the dwindling populations of juniper to make his new craft. The shad boat needed only a single plank for the keel rather than three whole logs required for kunner construction. This made its construction more economical. The rest of the hull is carvel planked making replacement of damaged or rotten boards relatively easy. Researchers suggest Creef's design shares attributes associated with a Bahamian dinghy and Whitehall yawl boats seen in the area during the Civil War (Alford 2004:18-20).

In addition to the development of the hull, the vessel's specific rigging makes this particular craft unique. The shad boat utilized a spritsail, jib, and topsail, which although unusual, gave the boat an advantage when hugging the heavily wooded interior shores of North Carolina (Alford 2004:18-20). These boats became popular in the shad industry thanks to their wide beam, making it capable of holding large catches of shad hauled in each spring. Soon other builders began duplicating Creef's design. One of those individuals was W. Otis Dough who would become a well-known builder of shad boats. Dough's boatyard was located just north of Creef's on Roanoke Island. Dough ran the boatyard in Manteo with the help of his sons constructing shad boats until the 1930s. According to Travis Morris, Dough built both shad boats currently restored and displayed in the Whalehead boat shed, as well as the motor boat *Red Wing* (used to transport liquor during prohibition). A gas-powered, inboard motor powered Hambone's boat for most if not all of its life (Morris 2014:76).

Another Wanchese resident, Ben Daniels, installed a three and a half horsepower Lathrop internal combustion engine in his shad boat in 1908 (Figure 64). He is credited as the first individual to make the conversion to gas powered shad boats in North Carolina. It was not long before the multitudes switched from sail to motor. According to researcher and North Carolina native Earl Willis Jr.:

> The transformation of the shad boat's propulsion system from sail to engine was a relatively simple task: The mast was unstepped, the centerboard and its well were removed; the centerboard slot was plugged and a batten or two attached to the keel for additional depth; the existing two-inch thick sternpost was replaced with one or three inches to accommodate the propeller cut out; a shaft alley was bored; and, finally, the engine was mounted (Willis in Muir and Alford 1997).

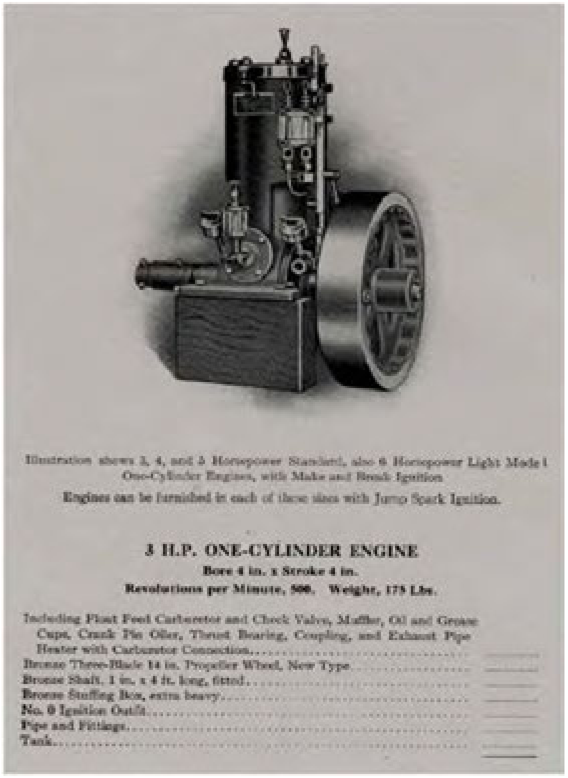

Figure 64. Advertisement featuring the Lathrop engine (Lathrop and Company 1925)

Another modification that was necessary to make these craft engine adequate was the addition of the “hobble.” Daniels likely figured out quickly the boat was unable to get up on a plane thanks to the significant tuck of the heart-shaped stern (Harrison 2012) (Figure 65). An unknown individual managed to solve this problem by boxing in the stern with a series of squat boards (Figure 66).

Figure 65. Heart-shaped stern from the 3D model (Image by Ryan Bradley and Jeremy Borrelli).

Figure 66. *Rhinoceros* model of Hambone's boat without the hobble (Image by Ryan Bradley and Jeremy Borrelli).

This flattened out the aft-hull section forcing the stern to rise up on top of the water at higher speeds. Builders such as Dough altered the construction of the now gas powered shad boats to reduce the tuck. This model could be compared to other examples of shad boats to see if the tuck on this boat is reduced. Given the fact that its building date preceded the introduction of gas motors by two years, it should be closer to the sailing vessel variety. As the horsepower increased, the shad boat still relied on the hobble for proper planing at higher speeds. Despite the advantages offered by the hobble it did have its drawbacks. A significant downside was the constant threat of rot. Because it was an aftermarket alteration there was a separation between the hull and hobble which trapped water and leaked (Harrison 2012).

Structural/Design Information

Hambone's boat, thanks to a marvelous restoration, looks much like it did when it was first constructed, or at least the restorer's interpretation of it. The restoration process has smoothed out the lines along the external hull. Fresh paint and fiberglass hide any nicks, dings, or signs of wear. The hobble, so crucial to its propulsion, yet detrimental to its hull, is removed. The engine that powered it is no longer there. The cabin is clean and clear of debris and smells slightly of paint thinner. Gone are the remnants of game fish or fowl. The intact ceiling and replaced interior hull obscure the "gracefully curving frames cut from the spreading buttress roots of the white cedar tree" (Alford 1990:18). Despite these cosmetic cover-ups, it is an old boat, now over a hundred years old, representing one of the few remaining examples of the North Carolina Shad Boat.

Conclusion

This is not the final word on "Hambone's Shad Boat." There are a number of considerations for future research on this vessel and others of its type. The first recommendation would be to have a conversation with the man who restored it, Bobby Sullivan. A conversation of this type would shed a lot of light on its construction and design. Further research into the hobble would be another recommendation to continue this project, as this feature may be one of the vessel's most important and interesting features. It would also be worthwhile to compare the tuck and the transom on this model of boat to other similarly constructed boats still in existence.

THE SLICK BOAT: A CONCAVE TUNNEL BOAT (WPT Vessel #2013.09.14)

Jeremy Borrelli and Ryan Bradley

Introduction

In 2014, Jeremy Borrelli and Ryan Bradley recorded two watercraft as a part of the Currituck County Maritime Heritage Fellowship (CCMH). The purpose of the 2014 fellowship was to provide written, photographic, and digital documentation of two historic boats located in the Currituck Heritage Park ("Hambone's Shad Boat" and the "Slick Boat"). This chapter outlines the work undertaken to record the "Slick Boat" (Figure 67). Work for the 2014 season began June 23 and was completed on August 15. The time appropriated for each boat was about three weeks, with an extra week for writing the final report and completing additional archival research. Total station recording, hand-drawings, and *Rhinoceros* modeling work was divided equally between the Research Fellows Jeremy Borrelli and Ryan Bradley.

Boat Details

Location: Currituck Heritage Park, Boathouse Shelter

Rig/Type of Craft: Concave Tunnel Inboard Motorboat

Trade/Use: Recreation

Principal Measurements: Length: 647.8 cm (255.04")

Width: 266.7 cm (105")

Depth: 120.5 cm (47.44")

Freeboard: 66.9 cm (26.34")

Draft: 54.2 cm (21.34")

Propulsion: Ford Crusader 302 Block Engine, 225 HP

Date of Construction: 1971

Original Owners: Earl Slick, Narrows Island Hunt Club, Pine Island Hunt Club

Present Owner: Whalehead Preservation Trust

Disposition: Display vessel

The aim of the project is to provide the WPT with a compiled record on each boat, coupled with a digital model. The model will serve as a preservation record detailing each boat's construction. This record will be used for educational programs focused on local watercraft construction techniques, styles and functions, as well as for additional display material for the exhibits throughout the park.

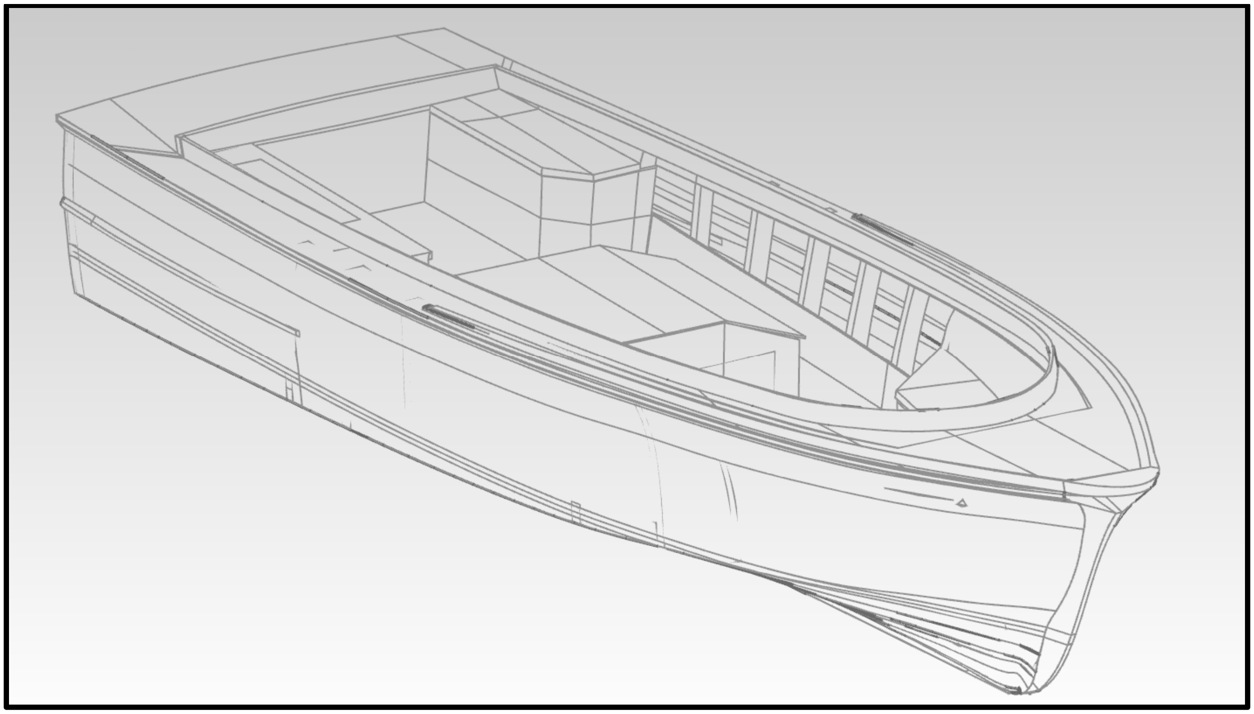

Figure 67. Depiction of the Slick Boat (WPT Vessel #2013.09.14) (Image by Nathan Richards).

The "Slick Boat" is the last concave tunnel boat built by the prominent boat-builder Patrick O'Neal of Coinjock, NC prior to his death in 1972. O'Neal, who is credited with designing this hull type, was the only builder in Currituck making this style of boat. Since local boat-builders in Currituck didn't create plan drawings to aid in shaping the hulls, the boat itself represents one of the only remaining records for the design as well as the culmination of over twenty years of perfecting the hull type (Morris 2014:37-44).

Methodology

This section will outline the recording methodology utilized on the Slick Boat. The project is divided into two different stages beginning with the fieldwork carried out to gather data and ending with the digital reconstruction. The last subsection will discuss the predicted and actual limitations experienced of the chosen methodology.

Fieldwork

Field recording of the Slick Boat began on June 25 and was completed on July 11. The aim of the fieldwork was to conduct three-dimensional computer mapping of the boat's complex hull structure and shape. Following a well-established methodology for recording ships, low tech (hand drawings) and high tech (total station) methods were employed (Lemée 1999; Hocker 2003; Stewart 2008; Ray 2009). The primary tool used in this project was a Topcon ES series total station, with the ability to engage in reflectorless point acquisition. This way large numbers of data points can be recorded quickly and accurately, without the need of a prism. The key benefit of this approach is that it allows the curving, three-dimensional nature of the ship's structure to guide the recording system. Prior to any recording, however, the boat was moved into a position underneath its shelter that afforded the most vantage points for the total station and the best access to the boat. Once the boat was put into its final position it would not be moved until the completion of the project.

Each timber of the boat was inspected and hand drawings were made of each. During this process, the structure to be recorded was examined by identifying areas that could potentially provide information about the size, shape, and location of timbers, as well as the ways that groups of timbers join together to form structural units. These structural units dictated the systematic mapping and point recording rather than following traditional archaeological methods of establishing an arbitrary grid system onto the boat. Several of the frames were inaccessible following the boat's restoration but those that could be seen were drawn from all angles. Perspective views were drawn for other features of the boat such as the seating and stringers. These drawings were used as guides for the total station as well as for additional measurements on segments that the total station could not view (Figure 68).

The next step in the process involved virtually setting up a spatial network. This required choosing a beginning location that afforded whoever was working the total station the most viewpoints on the vessel while also establishing the most datum points possible. Next, an occupy point was named T01 that is essentially the original fixed location at 0, 0, 0 on the x-, y-, and z-coordinate planes from which the "world" that the total station and all subsequent points are related to. To ensure accuracy of the data, all other points then needed to be shot in relation to T01 so that each one existed in relation to the same arbitrary point. Once the occupy point was created, a backsight was shot in on the adjacent awning to that of the Slick Boat, which gave a second reference point for establishing the location of the total station.

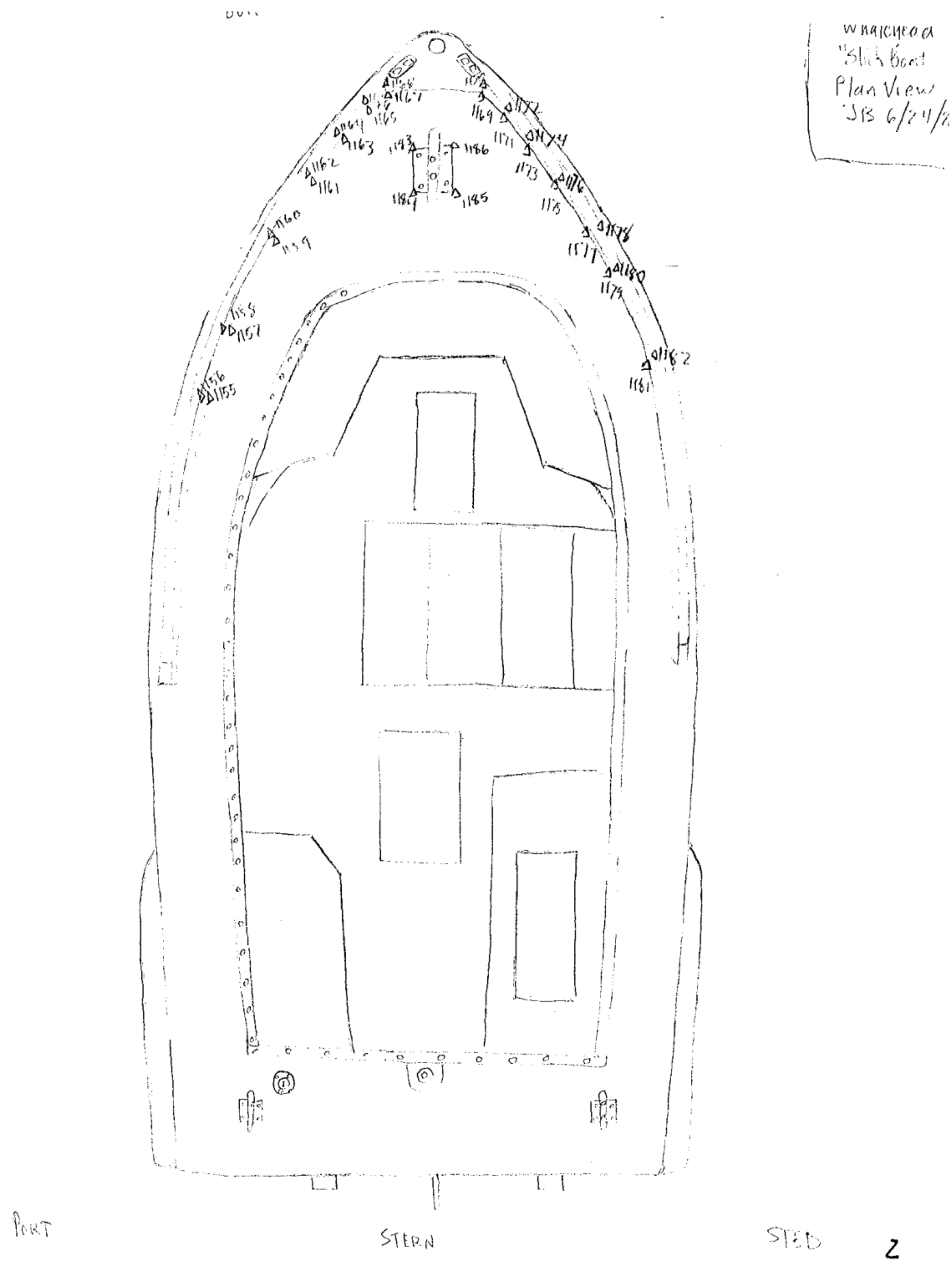

Figure 68. Example drawing – showing plan view of Slick Boat (Drawing by Jeremy Borrelli).

After the occupy and backsight points were established, the next step was to determine datum points around the boat. The total station is reliant upon line of sight to collect spatial information, therefore to increase efficiency it is necessary to minimize movement of the station as well as maximize shooting potential at each selected location. A total of 14 datums were ultimately chosen to act as the control points for defining the spatial boundaries around the boat. These control points were fixed locations that served as points of reference as the total station was moved around the boat (Figure 69). Since this recording system does not utilize a Global Positioning System (GPS) to establish the total station's exact spatial location, multiple datums would be used in lieu of multiple satellites to ascertain the location of the station in space. To elaborate, much like a GPS that uses three or more satellites to establish the machine's location on Earth, as the total station was moved around the boat at least three datums were required to ascertain the station's position in the spatial area created during initial setup. This process is termed resectioning, and during the course of recording the Slick Boat the total station was resectioned 30 different times.

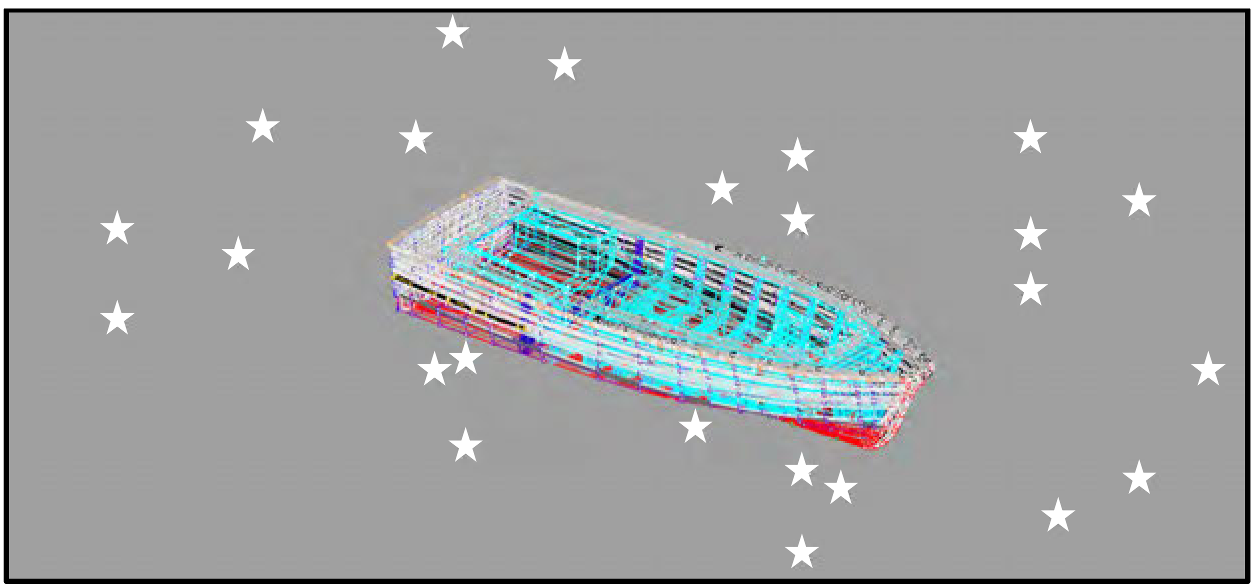

Figure 69. Image of wireframe model of the Slick Boat, showing the datum locations (stars). Stars represent the fixed datum locations and the remaining points signify the various shooting positions of the total station (Image by Nathan Richards).

To ensure accurate recording, a two person team was needed to operate the total station: a shooter controlled the station and organized the points as they were shot, and the spotter determined and guided the shooter to the best spots on the boat to shoot in. The spotter was also responsible for logging each point taken on the hand drawings so that a detailed record of the points already taken and potential future points could be evaluated (Figure 71). Points were shot first along the exterior of the boat to obtain the curvature of the hull and tunnel shape, and then the interior structure. As points were shot, they were saved into layers within the total station data recorder. When the shooting moved from one structural unit to another, the shooter changed the layer to the unit currently being shot. In total, 16 layers were created to organize a total of 1,384 points.

Figure 70. Photo illustrating the two-person team digitally mapping the exterior hull of the boat. Spotter Ryan Bradley catalogues the points on the hand drawings and shooter Jeremy Borrelli maneuvers the total station to the locations on the boat indicated by the spotter (Photography by Jeremy Borrelli, 2014).

Once all of the points that could be taken with the total station were collected, it was then necessary to obtain hand measurements to get the remaining measurements. This information would be essential for completing the reconstruction of the framing later on. To supplement the measurements and drawings, photographs were taken of each feature on the boat as well as different areas where multiple timbers come together and the potential for confusion in the points was greater. These photos were saved as a catalogue to reference when reconstructing the boat in the virtual modeling software.

Reconstruction

Digital reconstruction of the boat was completed through the use of a computer aided drafting program, McNeel *Rhinoceros* (version 4.0). *Rhinoceros* is an expansion upon previous CAD programs, and is useful for maritime heritage recording projects due to its ease of handling two and three-dimensional curvature, because it is relatively inexpensive, and can fit well within a project's budget. The strength of *Rhinoceros* in terms of this project's goals for reconstruction lies in the fair and accurate representation of a surfaced hull model that has the ability to serve as a basis for visualization, hydrostatic analysis, and the production of lines plans for traditional dissemination (Hytell 2011:28). At the end of each day of fieldwork, all points would be downloaded as AutoCAD drawing interchange format (.dxf) files onto the field laptop computer. Following the completion of all fieldwork, the total point data was saved as a 3D model format (.3dm) file on *Rhinoceros* for final reconstruction.

When the total station information is inputted into *Rhinoceros* it is represented by a cloud of points in the overall shape of the boat (Figure 71). The aim of reconstruction is to find the correct sets of points that comprise individual timbers and connect the dots using a combination of lines and curves. It is much like finding the constellation in the seemingly arbitrary collection of points in the sky. The layers created during the recording process separated the collections of points into their respective structural units with a different color for each, easing interpretation of the confusing point cloud. Additional layers were also created as needed during reconstruction, which aided in further separating the starboard and port side points. Each layer was comprised of the entire structural unit such as floors or futtocks.

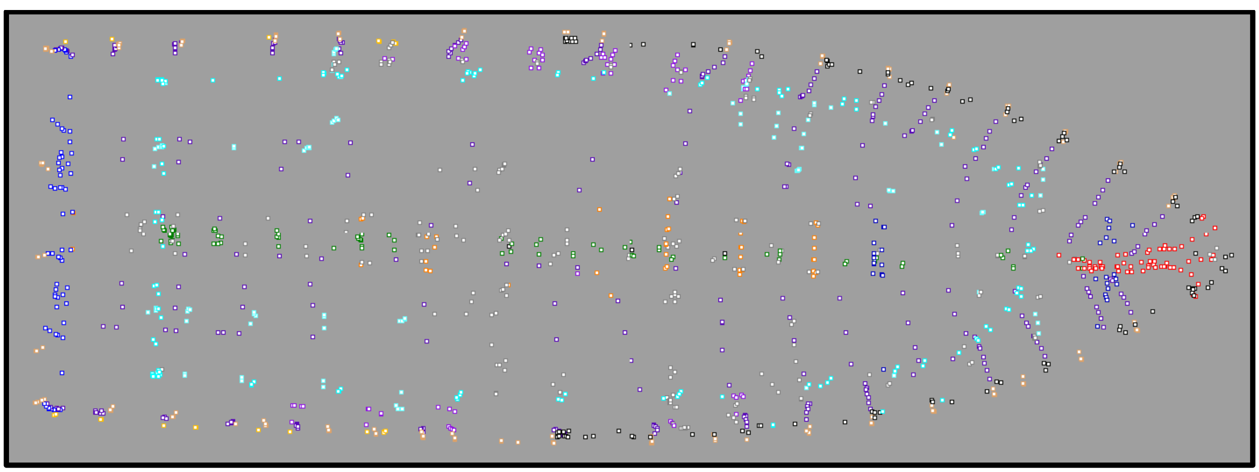

Figure 71.Plan view of the Slick Boat total station point cloud data (Image by Nathan Richards).

Some of the timbers could not be recorded using the total station due to prior modifications, such as the boat's recent restoration, that made those sections of the boat inaccessible. To avoid this during fieldwork, one or two random points were taken on either a part of the frame set to establish its general location. From that point, previously created curves on *Rhinoceros* could be used to manually build the structural unit. This technique utilized hand measurements taken on these timbers that lessened the degree of error and confirmed accurate dimensions. This was primarily necessary on the frame sets that were composed of a combination of floor timbers, futtocks, and deck beams. After each timber was built and all the points connected, the lines and curves would be surfaced. Once a surface is put on the timber, it can be visually rendered with colors and textures, or displayed in "ghosted" views to show internal structures creating the complete three-dimensional visualization of the boat (Figure 72).

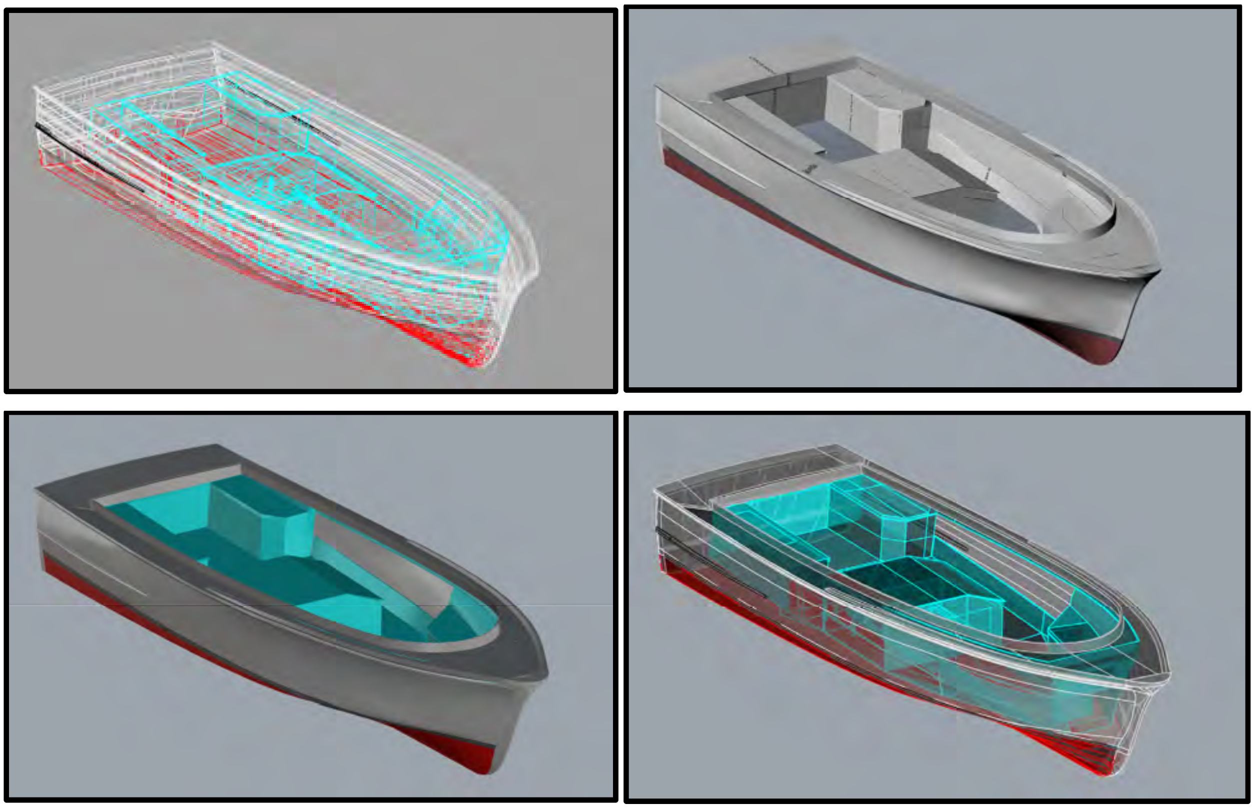

Figure 72. "Wireframe (L-top), "Rendered" (R-top), "Shaded" (L-bottom) and "ghosted" (R-bottom) perspectives of the reconstructed Slick Boat (Images by Jeremy Borrelli and Ryan Bradley).

Limitations

With every digital recording methodology there are limitations and fundamental issues that need to be addressed. The chief issue with recording the Slick Boat was the fact that the boat had been previously restored. The total station relies upon line of sight to collect data. If it isn't possible to maneuver the machine to a position where at least a few points on every timber can be recorded, then the degree of error rises when hand measurements are needed to reconstruct certain timbers and curves of the boat within *Rhinoceros*. Many of these measurements were difficult to obtain, and required crafty choreography to navigate tape measures around permanent fixtures such as the engine of the boat. Furthermore, additional resectioning and control of the tilt of the station was needed inside the boat to get at a vantage point that allowed for minimal data collection on these timbers. Due to the fact that normal archaeological procedures call for hand measurements on boats when traditionally mapping a site or structure, the margin of error can be seen as minimal and therefore a justifiable part of the process.

Ideally, this methodology is most accurate on boats that have not been restored. This allows researchers access to the majority of the structure not only with the total station, but also for hand measurements and photography. In the future this may be a worthwhile consideration for future boats chosen for recording.

Other potential inaccuracies inherent to using a total station in the field include shooter error, poor leveling of the station, or lack of backstop for points at too far of an angle for the laser to get an accurate reading. The benefits of using *Rhinoceros* are that it allows for this type of inaccuracy and can be easily corrected manually during the reconstruction process through the use of different curve types to fair a line that may have points that are slightly flawed. The benefits of using the total station and ease of reconstruction using *Rhinoceros* far outweigh the limitations and pitfalls of the recording process. By further formalization of the methodology through the use of standardized timber forms, coding systems and step-by-step guides for documentation the process can become even more streamlined and effective for recording intact boats in any collection.

Historical Information

The Slick Boat was constructed by Patrick Henry O'Neal at P.H. O'Neal Boatworks in Coinjock, North Carolina in 1971. No plans for the vessel have been located. The boat was restored in 2012 by Sonny Briggs, Briggs Boatworks, Wanchese, NC. This section will discuss pertinent historical information collected during the course of fieldwork. The information is divided into two main parts with the first containing a brief summary on the physical history of the vessel. The second will outline the historical context of the boat to explain the circumstances of its construction and elaborate upon its life history. Information was gathered primarily through interviews with local historian Travis Morris who was personally involved with the boat and its builder as well as Carl Ross, who continues the boat-building tradition in Currituck County. Other sources include files on the boat owned by the Whalehead Preservation Trust, and material located at the Outer Banks History Center.

Historical Context

The Currituck Sound is part of the Albemarle-Pamlico National Estuary, which is a large estuarine system located in northeastern North Carolina and southeastern Virginia. The system is generally shallow, on average less than 10 feet deep, with primarily wind-driven circulation rather than tidal flow. Thin barrier islands separate the Sound from the Atlantic Ocean and the system receives its saline input from the southern entrance at Oregon Inlet following the closure of Currituck Inlet in 1828 (eventually resulting in low salinity levels in the Sound) (McKay et al. 2012:3). Historically, these conditions created an environment conducive to significant aquatic vegetation coverage that allowed for flourishing waterfowl and fish communities (Sincock et al. 1964:1-3). The local population of Currituck adapted to these changes by adopting specialized boats which allowed them to navigate through the area and exploit these abundant natural resources. Following the end of the Civil War a unique boatbuilding tradition emerged characterized by handmade watercraft designed for their utility of travel in this environment.

One of the most respected and well-known boat-builders was Mr. Patrick O'Neal in Coinjock (Figure 73). In 1921 Patrick Henry O'Neal (1897-1972) began P.H. O'Neal Boatworks located on the west side of the Chesapeake-Albemarle Canal, approximately one-half mile north of the Coinjock Bridge (Figure 74). Life in Currituck was highly seasonal and the work varied upon the time of the year. Following this seasonal pattern, O'Neal spent the winters carrying sportsmen in search of waterfowl and long net fishing in the Sound following the end of hunting season, but during the summer he would design and construct boats as well as use his craftsmanship to carve duck hunting decoys at his boatyard. O'Neal's shop would stay in operation for the next fifty years until a year before his death in 1972 (Morris 2014:37-44).

Figure 73. Photo of Currituck boat-builder Patrick H. O'Neal, designer of the concave tunnel boat in North Carolina (Photo courtesy of Travis Morris).

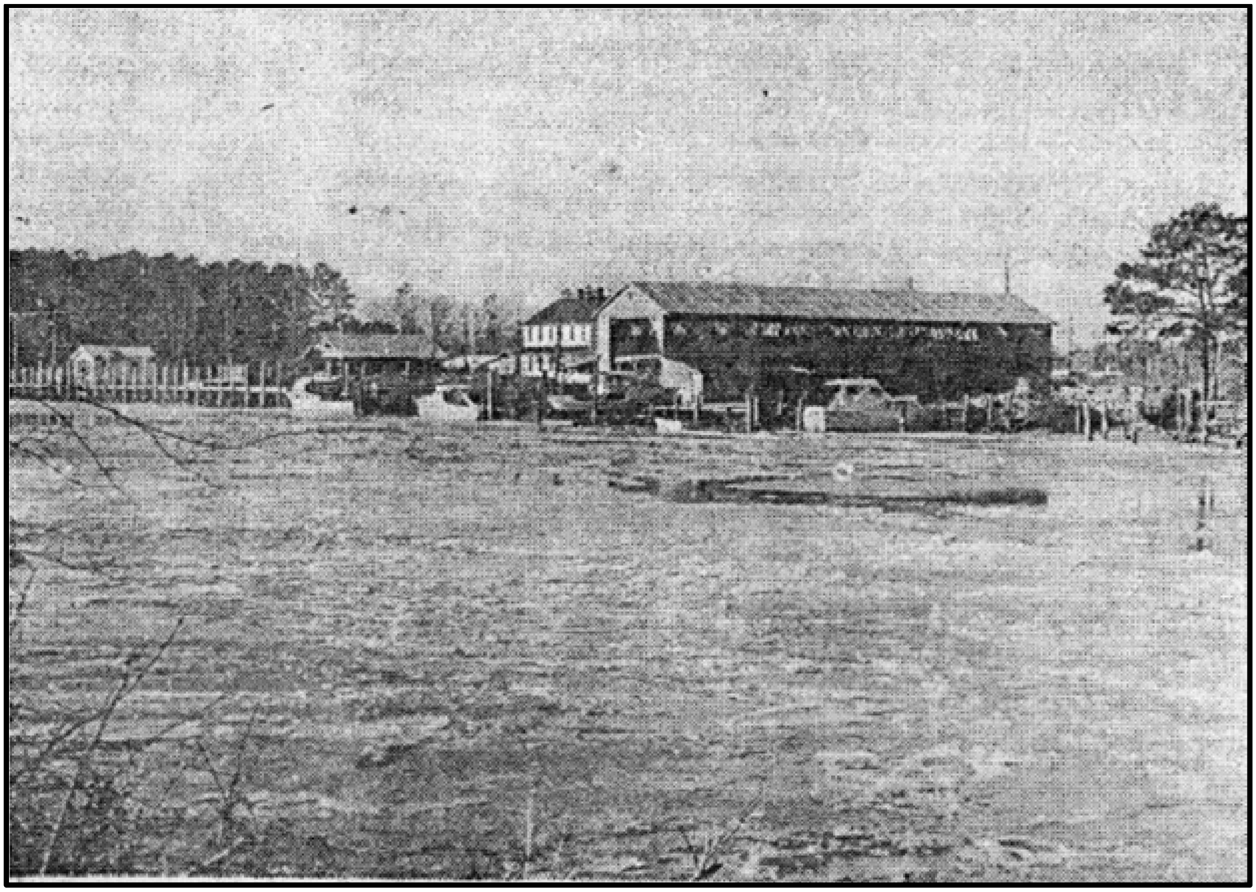

Figure 74. Image showing P.H. O'Neal Boatworks on the Chesapeake-Albemarle Canal from an article in the *Virginia Pilot* (Photo courtesy of Travis Morris).

O'Neal is credited for designing and perfecting the concave tunnel boat hull that was utilized by boaters throughout the Currituck Sound during the twentieth century. In the historical record, the concave tunnel hull design is first mentioned in a 1941 patent filed by Andrew Jackson Higgins, owner of Higgins Industries, a New Orleans based company. The patent described a style of landing craft used during the Second World War that drastically affected the way troops could be transferred from naval transports to the shore. This along with the three other types of landing craft designed by Higgins affected the war strategy to such an extent that they earned him the commendation of "the man who won the war for us" by President Dwight D. Eisenhower (Brinkley 2000). The tunnel hull design is outlined in the 1941 patent:

> … has a flat transverse spoonbill bow merging into a V-bottom which continues to the midship region, the keel rearward of the midship region having reverse curvatures, and the bottom of the boat being transversely flat from the midship region to the stern, and

> having a median tunnel beginning at a point back of the midship region and increasing in cross-section as it approaches the stern, the tunnel lying above the propeller. A hull of such shape entrains aerated water beneath its forward portion and travels upon aerated film, the air bubble continually escaping as they travel laterally up the slope of the V-bottom to the chines and the tunnel drawing up solid water from the depths which displaces any aerated water which may pass rearward of the midship portion of the hull so that the propeller thrusts against a solid body of water, avoiding cavitation. In a hull of this type, skin friction between the hull and the water is reduced to a minimum, enabling the boat to be driven at relatively high speeds with economy of power. It also provides a shallow draft boat, which is capable of being driven upon a shelving beach and retracted therefrom under its own power (Higgins 1941).

The last two sentences describe the primary benefit of Higgins Boat during the Second World War, whereby these craft would efficiently transfer soldiers and equipment during pivotal battles including the D-Day Normandy landings. In Currituck County, however, this hull design had the potential for several utilitarian functions. Due to the shallow depth of the Currituck Sound, boats needed to sit high in the water and also be designed to withstand potential grounding situations. The ability of the hull to protect the propeller and reverse the boat off a sandbar would be a useful tool for both inexperienced and seasoned boaters. This was especially useful for individuals who used the boats to tow skiffs and transfer hunters to good shooting locations, as these were often very shallow and treacherous. The box tunnel had been a preferred style, but this hull design didn't compensate for the aerated water getting trapped and pushed to the stern of the boat forming a bubble around the propeller, resulting in cavitation (Higgins 1941).

Furthermore, as more boats transitioned to engines of increased horsepower, a more efficient hull was needed. For locals during this time, the numerous waterfowl hunting clubs that were established along the Outer Banks meant a continuous stream of wealthy individuals looking to vacation and enjoy themselves on the Currituck waterways. The hunt club owners were typically the only ones who could afford the marine engines and therefore the hunt clubs primarily acquired the tunnel boats. These boats needed to not only be utilitarian, but also fast and comfortable for passengers. Guests would be ferried using these boats to and from the shallow water float rigs and blinds for hunting where they would be met by local guides aboard flat-bottomed skiffs. They would also be used to relay decoys and other float rigs to the hunters out in Currituck Sound (Morris 2014:40). The concave tunnel hull compensated for the increased demand for speed, while retaining the stability of its predecessor. After hunting season in the late winter and springtime, these motorboats would also be used for recreational fishing in addition to towing the skiffs and hauling nets for long net fishing.

In the early 1940s Patrick O'Neal was commissioned to build several boats for the US Navy. It is unclear whether during this time he was exposed to the popular Higgins Boat style, but soon after he began designing his own boats with a concave tunnel hull. The first of these boats he built was for Carl White of the Pine Island Hunt Club in 1946 (Figure 75). The standard for these boats at this time was for inboard motors to be installed in the hull, with a single propeller. Many of these engines came from old cars or tractors and were converted for marine use. O'Neal continued to be the sole builder on the Currituck Sound to make the concave tunnel hulled boats, which soon replaced the standard inefficient box tunnel shape. After trying a variety of other boats, in 1971 White convinced Earl Slick, owner of the Narrows Island Hunt Club, to get O'Neal to build another tunnel boat (Travis Morris 2014, pers. comm.) (Figure 76).

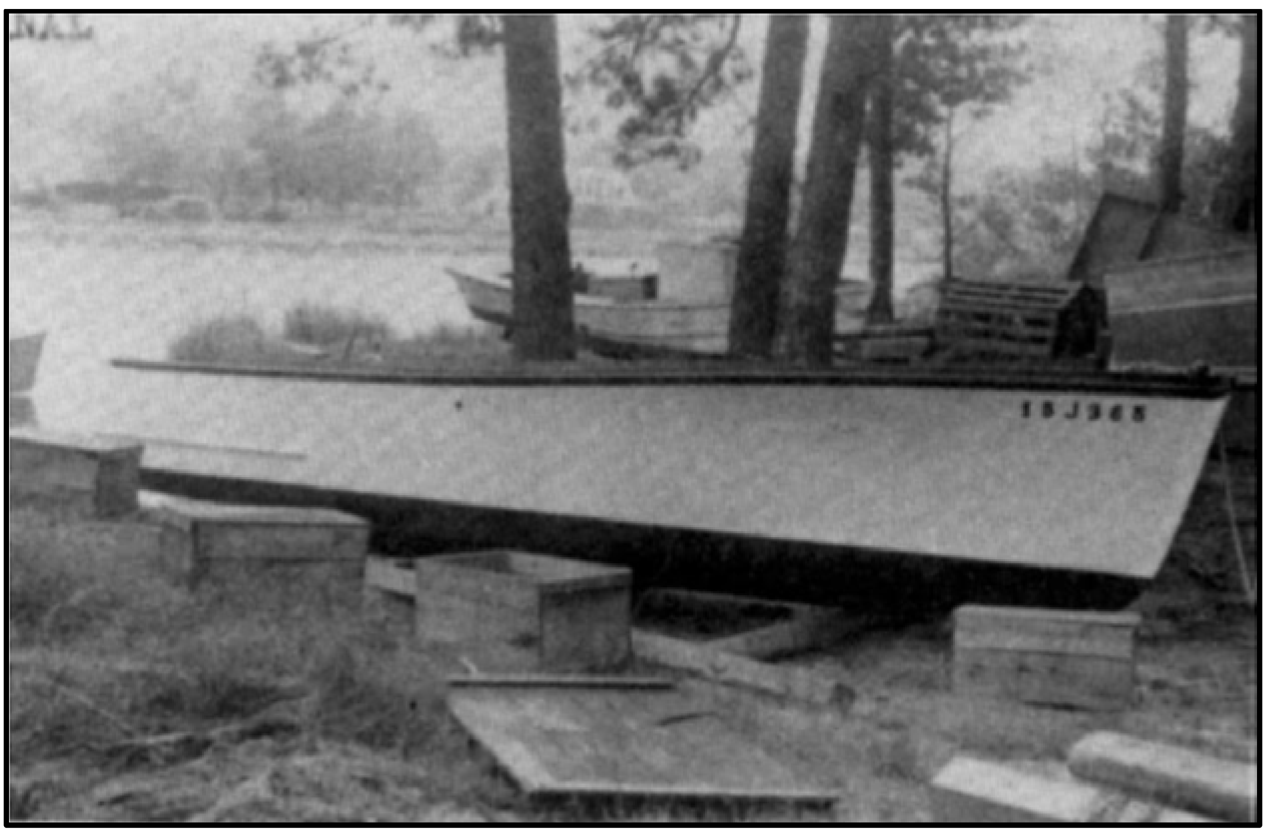

Figure 75. The first concave tunnel boat built by Patrick O'Neal for Carl White of the Pine Island Hunt Club (Photo courtesy of Travis Morris).

At a cost of approximately $7,100, O'Neal constructed the last inboard concave tunnel boat he would build in 1971. The boat was built from juniper and extended about twenty-one feet in length and eight feet in beam. The following year Slick purchased the Pine Island Hunt Club, which was one of the older clubs on the Outer Banks (established in 1910 on the previous grounds of an older club). Slick used his newly commissioned boat to take his guests to blinds and float rigs during hunting season as well as bass and rock fishing later in the winter (Figure 77). He was a very private man and it was considered a privilege to be taken out on one of Slick's boats. Equipped with a Ford Crusader 302 block engine, the tunnel boat was fast and highly efficient. Many of these boats had cabins put on to shelter the passengers from the elements, but Patrick O'Neal preferred using spray hoods that did not affect the weighting of the vessel. This made it easier and quicker for the boat to get up on plane when underway. This would be a useful feature later in the boat's life (Travis Morris 2014, pers. comm.).

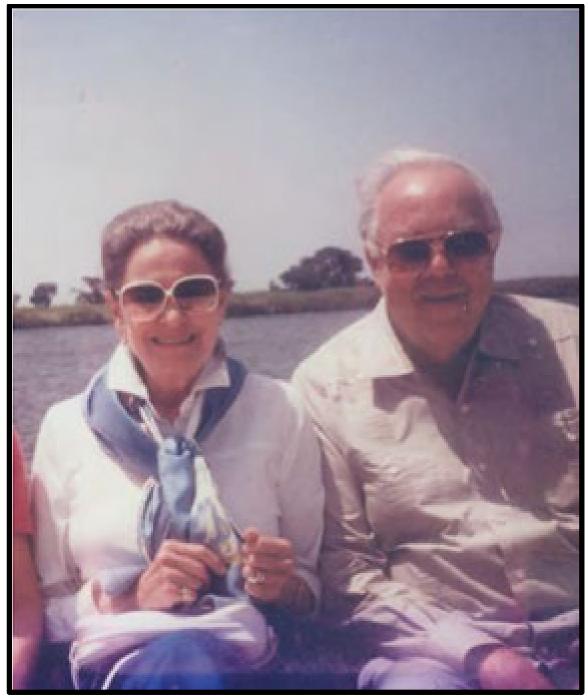

Figure 76. Photograph taken of Mr. and Mrs. Earl Slick departing the Narrows Island Hunt Club (Photo courtesy of Travis Morris).

Figure 77. Image showing a tunnel boat in action tending to a hunting skiff and blind during hunting season. The boat depicted was the second concave tunnel boat built by Patrick H. O'Neal for the Bells Island Hunt Club in 1948, named Mother Goose by its second owner at Piney Island (Photo courtesy of Travis Morris).

When Carl White died, Narrows and Pine Island Hunt Clubs switched to outboard motor boats in replacement of the previous inboard style. With the introduction of the new style, Slick donated his old tunnel boat to Currituck County for use in the Fire and Rescue Department. Not much is known about its use during this time, but it was eventually sold to Travis Morris, who held it for several years. In 2012 Morris donated the boat to the Whalehead Preservation Trust, who then commissioned Sonny Briggs of Briggs Boat Works in Wanchese, NC to restore the boat. Due to the deteriorated state of many of the timbers, the restoration required replacing certain pieces to retain its structural integrity. While it is by no means seaworthy, the refurbished boat is currently on display on the grounds of the Currituck Heritage Park in Corolla, North Carolina (Travis Morris 2014, pers. comm.).

Structure and Design Information

This section will discuss the structural properties of the Slick Boat and how the boat was likely constructed based on observations made during the course of fieldwork. The section is divided into two main parts including a general discussion about concave tunnel boats followed by a brief description of the mechanical features of the boat such as the motor and steering mechanism.

General Description

The Slick Boat is a 6.48 m by 2.68 m (or 21.25 ft. by 8.75 ft.) concave tunnel wooden motorboat. The hull consists of a complex keel, three-piece stem, flat transom, and a single layer of planks running fore to aft. Juniper is the only type of wood used in the boat, which was common during the time it was constructed due to its natural abundance along the coastline of North Carolina. The fully formed keel is 493 cm (194.09") long, 5.48 cm wide (2.16"), and 40.19 cm (15.82") high in the stern and slopes to an estimated 12 cm in height where it meets the stem. On the interior of the vessel the keel widens to 20 cm (7.87"). This widening could be evidence of two possible types of keel: batten and rabbeted (Figure 78). Based on the increased width of the interior keel of the Slick Boat, it is more likely the battened keel technique was used in this instance.

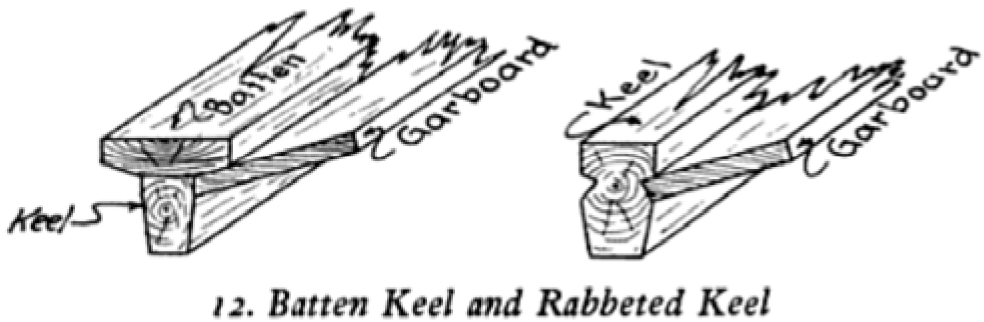

Figure 78. Image of two different types of keel potentially used when building the Slick Boat (Chapelle 1994:43).

Prior to the advent of the strong epoxies utilized in modern day boatbuilding, the Slick Boat follows the older technique of constructing a three-piece stem. The stem notched into the keel and the two were secured using a third triangular batten (Figure 79). Larger bolts fastened the batten to each piece and as it was tightened the batten pulled the keel and stem together forming a single structure. The stem is 133 cm (52.36") long, 10 cm (3.94") wide, approximately 14 cm (5.5") thick, and terminates aft of the first frame set.

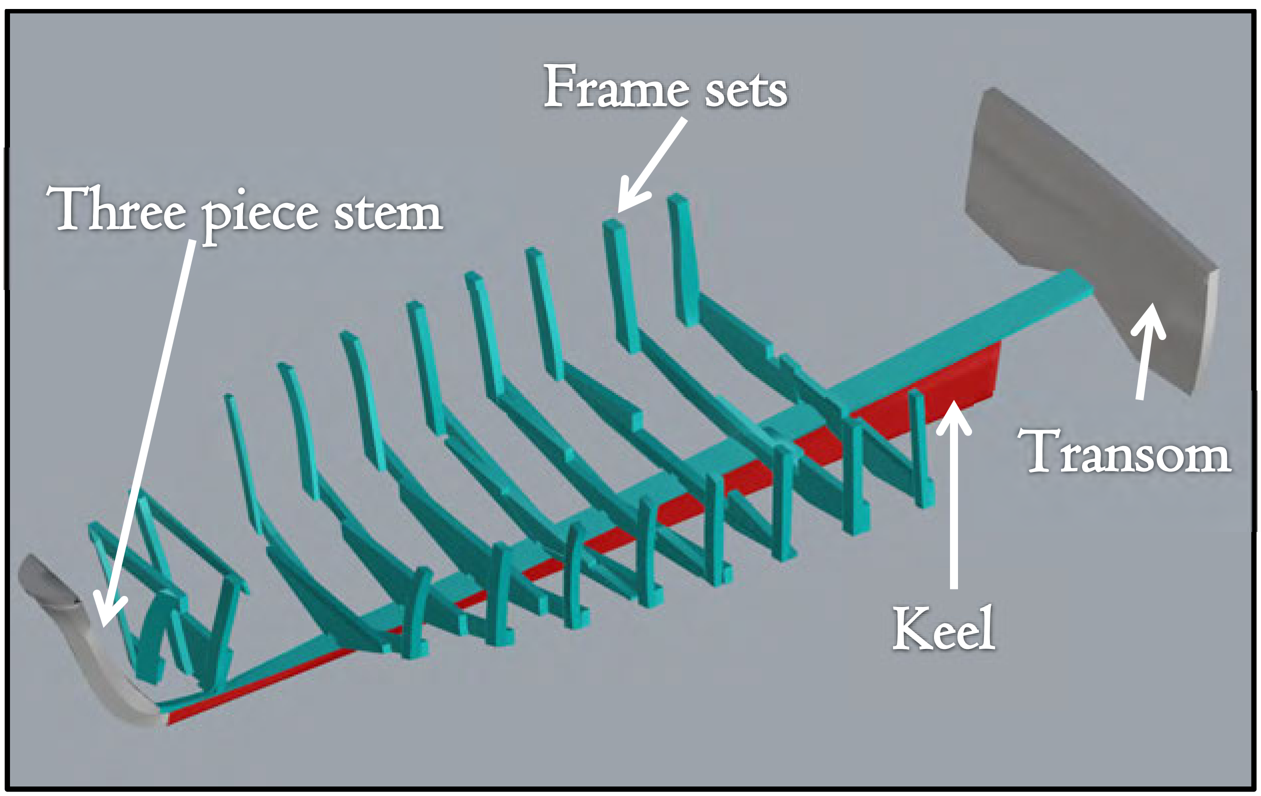

Figure 79.Image depicting the exposed inner framing of the Slick Boat with an exploded view of the aft-most frame set to demonstrate the shaping of the floor timbers that forms the concave tunnel. The box on the left side of the image shows the reconstructed three-piece stem (Image by Nathan Richards).

There is a moderate deadrise at the bow and slight tumblehome in the stern of the boat. The juniper planks that form the hull were carvel planked running fore and aft from the stem to the transom. Each plank was carved by hand causing slight differentiation between them but average about 11-12 cm (4.33-4.75") wide and 3 cm (1.18") thick. With the paint added during the boat's restoration it is difficult to determine the exact number of planks used to form the hull, but according to seams noted during fieldwork it appeared that at least twelve planks were used. According to Carl Ross, who continues the tradition of boatbuilding in Currituck County, after the floors were bolted onto the keel, the planks would be steamed in the boat shop and bent around the floors. Additional guides were then placed on the outside of the boat in the general shape of the hull that the builder wanted (Carl Ross 2014, pers. comm.). To form the tunnel of the concave tunnel, the steamed planks were twisted further than normal to create the channel. At the stern, the floors were cut to help direct the planks as they bent outward (Figure 79). Following typical v-bottomed boat construction the stern is relatively flat, but in cross-section the tunnel rises about 14 cm (5.5") from the chine (Alford 1990:11).

As stated previously in the patent for the Higgins Boat, this hull type is structurally interesting for several reasons. By curving the hull planks outwards the gradual rise of the tunnel leads the water that is broken by the speed of the boat at the bow outwards and away from the propeller. In typical box tunnel hulls this aerated water would move to the stern, increasing the potential for a bubble forming around the prop, causing cavitation. The stern of the boat sits lower in the water, and as the aerated water is removed, it is displaced within the tunnel by solid water rising from below. This drastically increased the efficiency of the motor and allowed for higher horsepower engines to be used. Furthermore, the tunnel still protected the prop from fouling when run aground, allowing boaters to reverse under the boat's own power in a grounding situation. This was a highly innovative boat hull for use in the shallower waterways like the Currituck Sound.

The framing of the boat generally consists of a single floor, a rider floor, and two sets of futtocks (Figure 79). There were ten frames that could be recorded, and based on interpretation of those frames it is likely there were 14 in total. The presumed third frame set is hidden below a seat at the bow and is missing from the reconstructed model. The floors average 5 cm in sided and approximately 18 cm (7.09") molded. Since the floors were used as guides for the hull planking, the lengths change from the bow to the stern. The forwardmost floor measured 31.31 cm (12.33") and the aftermost floor visible for measurement was 203 cm (79.92") long. Attached on the aft face of the floors are two futtocks of about the same width running to the chine. Bolted to the front of these at the chine are two additional futtocks that run vertically to the washboard. The second futtocks average 72.02 cm (28.35") in length. The rider floors sit atop the floor timbers and typically follow them in length and thickness.

At the seventh frame set two stringers are notched into the rider and floor to support the weight of the engine. These two stringers run longitudinally to the tenth frame. Frame nine marks the beginning of the changing frame structure with the removal of the first set of futtocks, leaving only the floor, rider, and vertical futtocks bolted now to the floors that go from the starboard to port chine. From the tenth frame working aft, the dual exhaust pipes from the engine cut into the rider and rest on the floor. Additional stanchions are attached to the forward face of the floors to brace the frame from the vibrations of the pipes. Directly aft of frame ten, the hull planks begin to form the tunnel of the hull, and the floors begin to change from their standard trapezoidal shape to compensate for the concave tunnel.

There are several additional structures on the boat including a single large seat in the bow, which would have concealed passengers from the spray of the water underneath the spray hood mentioned above located on the upper washboard. Two additional seats are located in the stern, with the starboard side containing a cooler for drinks or game caught that day.

Mechanical Features

To house the engine of the boat, a separate compartment was built with a folding top for easy access to the machinery. The wheel and controls were placed on the aft face of the box (Figure 80). The propeller ran into the keel structure aft of the tenth frame and two exhaust pipes ran aft and through the transom just above the waterline.

The steering mechanism currently consists of a series of wires and pulleys that wrapped around the wheel and down the starboard side of the boat at the chine until eventually connecting to a tiller apparatus at the interior of the transom just above the keel (Figure 81).

Figure 80.Photo showing the engine compartment and ignition controls (Photo by Jeremy Borrelli, 2014).

Figure 81. Photo of the wheel and wire spool used to guide the steering wire to the tiller apparatus in the stern (Photo by Jeremy Borrelli, 2014).

Conclusion

This in-depth examination of O'Neal's Slick boat has the potential to be extended to a number of other scholarly studies. For example, the potential exists to compare and contrast hull designs and construction techniques for all four remaining concave tunnel boats built by Patrick O'Neal currently owned by the Whalehead Preservation Trust. There is also the prospect of investigating connections in form and function between the tunnel hull design of Second World War-era *landing craft, vehicle, personnel* (abbreviated LCVP, commonly referred to as the "Higgins Boat") and the concave tunnel boats built by Patrick O'Neal. Finally, a study of the life history of the Slick Boat during its time in use for the Currituck County Fire and Rescue through county records and North Carolina boating registration file would illuminate the significance of this boat further.

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