THE OCONEE RIVER FLATBOAT:

AN ANALYSIS THROUGH EXPERIMENTAL ARCHAEOLOGY

By

Alyssa Saldivar

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Director of Thesis: Dr. Lynn Harris

Major Department:

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Abstract

In April 2019, a recreational fisherman found an unusual timber in the Oconee River of middle Georgia. This timber was later identified as a chine-girder, a large structural piece of a flatboat that would have been used in colonial Georgia. Vessels like this are rare and this timber allowed researchers to examine the vernacular construction of a flatboat type only previously documented in the Low Country of South Carolina. Using data gathered from fieldwork and historical evidence, several 3D models and a physical scale model were created to analyze the construction of this vessel. This study demonstrates that experimental archaeology can be used to identify construction techniques used by original boat builders.

The Oconee River Flatboat:

An Analysis Through Experimental Archaeology

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Alyssa Saldivar

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Director of Thesis: Lynn Harris, Ph.D.
Thesis Committee Members:
Nathan Richards, Ph.D.
David Stewart, Ph.D.
Mark Newell, Ph.D.

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Chapter 1: Introduction

Introduction

As the population in the New World pushed westward through North America, vessels that could easily carry people and cargo were needed to traverse the intertwining maze of waterways. Flat bottomed barges, often referred to as flatboats in several contexts, served many needs of the colonists as they were simple to build with minimal construction knowledge, navigated shallow environment well due to their draft, and had a large carrying capacity. By the late 18th century, these barges were extensively used as rice flats, cargo flats, and ferries (Newell 1997:18-31; Amer 1993:18-19).

This study was undertaken to provide a deeper understanding of the construction of chine-girder built flatboats using experimental archaeology. Historical research, fieldwork, and various forms of model building were all used to achieve this goal. The findings of the study will contribute to the limited amount of scholarship currently devoted towards a vernacular vessel type that was ubiquitous in waterways in South Carolina and Georgia from colonial times into the early 1900s. This work provides information about the decisions of the carpenters who built the boats and the actions taken to build them.

Historical Context of Flatboats

South Carolina

Since its colonization by Europeans in the mid-17th century, South Carolina's unique geography has played an intricate part in its economic development. The low country was an adversarial landscape for the new colonists in the area desperate for good soil in which to grow commercial crops. The low country, or the coastal zone of what is today South Carolina, extends inland 120 miles in some places. This area is near sea level and has little elevation change in the intermediate, meaning that tidal fluctuations can be seen for 100 miles inland (Clowse 1971:28). While the vast network of navigable waterways benefitted the colonist's transportation needs, the risk of flooding crops with salt water was great. The beginnings of the colony were difficult, with the colonists fighting the climate and environment as well as the diseases brought by the humidity and heat. The goal for the first few decades was simple: to gain good land and grow enough food for survival (Pressly 2013:5).

Once the land was settled and divided amongst settlers, commercial crops to expand the economy were brought in. Barbadian colonists settling on the Ashley River in the 1670s experimented with many crops to determine what would be most beneficial for the colony. Cotton, indigo, ginger, sugar, grapes, olives, tobacco, and rice were planted, the colonists realized quickly that while the summer heat was ideal for tropical crops, the cooler seasons would quickly freeze them. By 1675, a successful commercial crop had not been determined, and the colonists continued to focus on survival while slowly experimenting. The colonists were still able to barter with other goods found in the area, such as the valuable oak and cypress trees that littered the low country, and through raising livestock. Trade of this type of material kept the young colony alive before a commercial crop could be found (Clowse 1971:60-61).

By the 1690s, rice was being planted in bulk in South Carolina. While the planting process was rudimentary compared to the complex systems found later in the same area, they still proved valuable. In 1690, rice was the second highest export out of the low country, and by 1705, it was the first (Clowse 1971:122). In a matter of decades, rice cultivation in the low country soared. Early cultivation was led by the "reserve system" of planting, where fresh water from reservoirs such as ponds or swamps were used to flood fields. While successful, this system was heavily dependent on the weather to fill the reservoirs. By 1758, the tidal-flow method had been implemented, which allowed fresh water to be pushed into fields by the rising ocean tide. The tidal-flow system spread quickly through South Carolina, Georgia, and North Carolina; rice plantations being built near the major tidal rivers in each state. These plantations were complex systems of diversion canals, dikes, gates, and trunks. A miscalculation leading to saltwater entering the field was disastrous, as that field could not be planted for 3-4 years (Clowse 1971:127; Dethloff 1988:19-22).

This complex system needed skilled labor to ensure the maximization of each crop cycle. As rice was commonly cultivated in West Africa, many enslaved people who were sold to plantation owners in the South had a familiarity with the rice culture. In his study of enslaved Africans brought into the Carolinas, Daniel C. Littlefield found that over 43% of enslaved Africans came from rice producing regions (Littlefield 1981:86; Fields-Black 2008:161-186). As the rice culture of the Euro-Americans merged with the African rice culture, a uniquely American rice system was born.

Throughout the 18th century, as livestock and naval stores began to relax in exports, rice only rose. Throughout the first half of the century, complex systems of rice cultivation were implemented in the area, improving profits, and solidifying the area as the number one exporter. In the latter half of the century, the colony's growth stalled due to the Revolution, only to continue to thrive after independence. By 1800, most of the available land that was suitable for rice cultivation had been taken and built into large plantations operated with enslaved labor. The plantations in the Carolinas and Georgia produced 95% of the rice crop being exported from the United States (Dethloff 1988:46). In the 19th century, the rice systems two centuries in the making were imposing systems of dams, canals, gates, and rice trunks. These systems revolved around the flow of water, and many of the plantations had to be traversed with small, shallow draft flatboats that would not damage the rice crops they floated over. As most of these plantations were constructed in dense swamp land, the only way to transport the packed and ready-to-sell rice was by water on large flatboats (Newell 1997:20).

South Carolina's economic rise is tied tightly to developing their commercial crop, rice, which was deeply embedded into a maritime culture. The need for skilled labor and efficient transportation correlated directly with the waterways and which kinds of vessels would be on those waterways. From the early days of the colony, the network of waterways was significant to the survival and flourishing of the Carolinian economy, which then spread into the colony to the south, Georgia *(The Georgia Journal* 1810f:2; Pressly 2013:52*).*

Georgia

South of the Savannah River, James Oglethorpe landed with 68 men, 44 women, and 22 children in 1733. South Carolina was already well on its way to economic stability by this date, but Oglethorpe had different ideals for his colony. Prohibiting slavery and rum, this was already a vastly different beginning than the Barbadian-settled South Carolina to the north. Georgia also chose not to export a commercial good, choosing to stay out of the larger Atlantic economy that they were surrounded by. It was not until 1750 that Georgia began to change. The pillars of Oglethorpe's Georgia began to slowly fall, beginning with the lifting of the ban on slavery, which ended in April of 1750 (Pressly 2013:2). With this, a new frontier land was opened to aspiring planters. However, the influx of prosperity did not happen overnight, as the trade infrastructure was not yet established enough to attract many settlers.

Georgia's economy, pitted against the boom of South Carolina, was stagnant with little hope for the near future. With no commercial crop with which to enter the Atlantic market, Georgia had to find some export that could bring trade to the colony. As early as 1747, James

Habersham told the trustees that lumber was the only logical beginning to Georgia's success. Longleaf, or heart pine, was the dominant fauna in the coastal plain of Georgia, resting between the salt marshes and mountains (Peter Force Papers 1747). Cypress trees grew easily in the marshy low country. This valuable lumber was going to be exploited, if not by the Georgians, then by others. The 1760s marked drastic change in Georgia as Habersham's ideas were finally realized (Pressly 2013:51-52). Lumber became a valuable export, and as money trickled back into the colony, merchants did as well. Soon, trade flourished in Georgian ports. Like the rise of South Carolina, settlement populations grew and plantations sprung up along the major rivers, as it was the best way to travel and move goods (Drayton 1790:6). The Oconee, Altamaha, and Ogeechee rivers provided direct routes from the pine-dense coastal plains and were used to float large rafts of uncut lumber to the sawmills located on the coast (Morrison 2003:26).

As time progressed, Carolinians pushed south over the Savannah River and began to settle the area. The southern soil proved more fertile, with the harsh winters of South Carolina not being as much of a deterrent to more tropical crops. While sugarcane and other warm crops could not be planted, others like cotton, tobacco, and rice were embraced. Georgia's environmental constraints did not let rice spread as far inland as it did in South Carolina as the low country marshlands only extended twenty-five to thirty miles inland (Pressly 2013:12). Other crops took over where rice ended. Cotton thrived in the coastal plains of middle Georgia, easily accessed by the winding rivers. Rivers provided easy transport from inland plantations, meaning small, shallow drafted vessels were necessary to run an efficient plantation.

By the Revolutionary War, Georgia was well on its way to being as much of an economic power as South Carolina. With the commercial crop and, therefore, the merchant trade secured, Savannah dominated as the economic center of Georgia. Augusta thrived as it was upriver from

Savannah and bordered the ever-growing South Carolina. Plantations lined the rivers and streams in the low country, as it was the best transportation source due to roads being unreliable and difficult to traverse. The rivers that a plantation was connected to were just as much of a selling point as the acreage and soil. As waterways were the lifeblood of the low country, the vessels that traversed them were just as important to the health and growth of the colony or state.

Project History

In April 2019, Glen Rivers, a recreational fisher on the Oconee River, notified the Georgia Department of Natural Resources (DNR) that he had pulled a large timber from the river. The DNR put him in contact with Kurt Knoerl of Georgia Southern University, who was tasked with determining the timber's identity, construction, and historical significance. Knoerl, Michelle Damien, and this author went to survey the timber on July 6, 2019. Measuring 25.68ft (7.8m), the timber was a single piece carved into a near-perfect L-shape, forming the chine and the hull side (see Figure 1). This was later determined to be a chine-girder. The chine-girder is nearly intact, only damaged near one end where the shelf of the chine-girder is missing. Here, the chine-girder's width steadily decreases in size from its largest measurement to completely broken off at one end. Twenty-six treenails line the shelf of the chine-girder, all equal in diameter, except a single hole that is not in line or size with the others. Four tholes ranging from 1-1.5in (2.5-3.8cm) in diameter were noted at the gunnel, two approximately 4in (10.1cm) apart at either end

(Knoerl and Saldivar 2019).

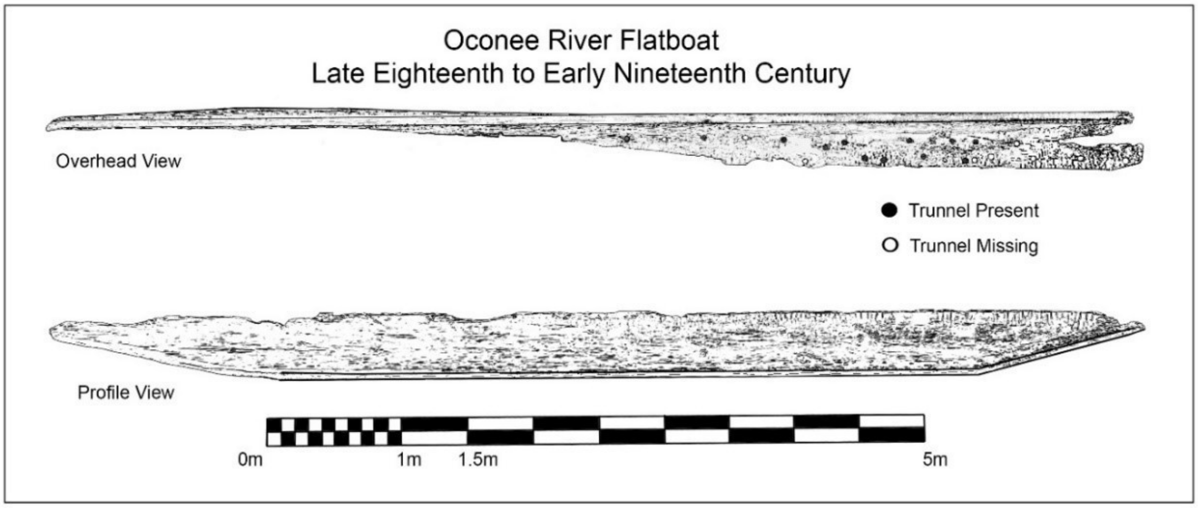

FIGURE 1. Scale drawing of Oconee River Timber (Courtesy of Kurt Knoerl).

Released by the Georgia DNR to Georgia Southern University (GSU), the timber now rests in the GSU Archaeological Repository in Statesboro, Georgia. GSU treated the timber with Wood Juice and attempted to keep the vessel from decaying any further. Detailed photography and measurements were taken of the vessel at the time of transfer.

In late 2019, Rivers reported finding another vessel in the same area as the timber was pulled from. With the help of another local, Gary Fowler, Knoerl made the 17-mile trek down river to realize that the new site was most likely from the same vessel as the timber. Due to weather and time constraints, only brief photography was able to take place, with the hope of returning to the site. Unfortunately, the COVID-19 pandemic swept across the nation, stalling research on this project and leaving the remains of the vessel at the will of the Oconee River.

Despite the limited access to the remains in the river, the timber preserved in the GSU Archaeological Repository is a valuable asset to the history of small watercraft design and construction. This boat is a unique representation of small craft construction in the colonial period of the Southeastern United States. Using experimental archaeology and model building, the Oconee River flatboats will be studied in comparison with the other flatboats found in the Lowcountry. This comparison will broaden our knowledge of small craft construction in the Southeast and give a greater understanding of the ship building knowledge in the area at the time of construction. Experimental archaeology in the form of model building will be used to define and understand the constriction sequence and the advantages and disadvantages of materials.

Research Questions

The research questions for this study examined the construction details of plank built and chine-girder built flatboats in the Southeast. The results of the study can be used to help identify other vessels as more flatboats are rediscovered in rivers and streams in the Lowcountry.

Research Questions

- What are the construction differences and benefits between plank-built and chine-girder built flatboats in South Carolina and Georgia?
    - Can the differentiations between plank-built and chine-girder built flatboats be identified using CAD virtual modeling software?
- Can differences in the process of construction of plank built and chine-girder built be determined and analyzed using experimental archaeology?
    - Can we identify the sequence of construction of the Oconee River flat?
    - What are the advantages and disadvantages of pine construction over cypress?

Theoretical Framework

In order to answer the research questions outlined in this chapter, this study utilized a theoretical perspective which would yield the best results. Given the physical nature of the research questions, experimental archaeology derived from processual archaeology was chosen to give a better understanding of the flatboat construction. This approach has been used to answer archaeological questions from archaeology's antiquarian beginnings onward into the more scientific and processual methodologies and has been slowly reintroduced to post-processualists as a valid form of research and discovery. This section will outline the history of this theoretical approach and how it has aided past researchers.

Experimental Archaeology Background

Experimental archaeology is the reconstruction of "past buildings, technologies, things, and environmental contexts, based on archaeological evidence" to achieve a greater understanding of the particular object being reconstructed or the tools used in the reconstruction (Souyoudzoglou-Haywood and O'Sullivan 2019:1). This method has been used by archaeologists for decades to expand their knowledge and understanding of the past. Millson's work, *Experimentation and Interpretation: The Use of Experimental Archaeology in the Study of the Past* gives a clear outline of the use of experimental archeology and the numerous approaches to its validity as a theoretically sound archaeological approach. Experimental archeology began with antiquarian and cultural historian archaeologists who focused on replicating the construction of artifacts and how those artifacts functioned in the lives of those in the past (Millson 2010:1). With Lewis Binford's "New Archaeology" and the birth of processualism built around scientific data and experiments, experimental archaeology was heavily relied on as an experiment that could be replicated and tested through the scientific process. Rigorous experiments to test hypotheses with experimental archaeology were conducted frequently by processual archaeologists. However, by the 1980s, the idea that science had saturated archaeology and stripped it of the humanistic aspect began to arise. Post-processual archaeology began to form with theoretical approaches that believed the rigid and repeatable experiments of processualism could not account for cultural aspects like "ideology or religion" (Millson 2011:2). Science, and any theory that was heavily supported by it, was shunned by many post-processualists, who believed that conclusions gathered from purely processual approaches could not be correct due to the lack of humanity.

The stark line created by dedicated post-processualists placed experimental archaeology firmly in the paradigm of processualism, and therefore not a valid form of methodology in post-processual theoretical practices. Michael Schiffer's article "Ethnoarchaeology, Experimental Archaeology, and the 'American School,'" however, argues that in the history of archaeological thought, experimental archaeology and the benefits of the discipline were, and are, too easily dismissed due to the cultural evolutionary thoughts that experimental archaeology often found itself defending (Schiffer 2009). While many archaeologists today turn away from the late 19th century studies, believing that the methodologies are flawed due to the beliefs of the practitioners, Schiffer shows that while the biases of the time may skew the conclusions, the basic conclusions of ethnoarchaeology and experimental archaeology, based on the advanced knowledge of the fields American fathers, are sound (Schiffer 2009:17). While experimental archaeology helped in the culture evolutionary view of history by classifying artifacts and tools in a timeline of "sophistication," there are attributes of the theory that can be used today (Schiffer 2009:10).

In the years since the rise of post-processualism, the lines have blurred with the reemergence of scientific methods being introduced into archaeology. *Experimental*

Archaeology: Making, Understanding, Story-telling, a collection of individual essays written by multiple authors and edited by Christina Souyoudzoglou-Haywood and Aidan O'Sullivan, asserts that while "experimental archaeology has traditionally been associated with positivist, scientific approach," it can also be used in post-processual studies focusing less on scientific data to reach a certain conclusion, but instead gathering information to study humanistic details of cultures (Souyoudzoglou-Haywood and O'Sullivan 2019:1). Experimental archaeology, while heavily associated with ethnoarchaeologists steeped in culture evolutionary and culture history beliefs, was, and is, a sound scientific method to understand some questions of basic tool use and construction of the past. With the newfound acceptance of experimental archaeology as a valid perspective to view from, it can now be relied upon to answer archaeological research questions with other detailed historical and archaeological research.

Thesis Structure

This thesis will be structured as follows: Chapter two will focus on the methodologies chosen for this study and how they are applied to the research questions. Chapters three and four will comprise of the results and analysis process, which is laid out in phases. This method was chosen for clarity, as each step of this study had a result that impacted the way the next methodology was chosen and undertaken. For this study, the results and analysis were separated into three distinct phases, each building from the previous. Phase one comprises the historical research and results. This research is pertinent to understanding how to construct a model of this vessel given the period, the environment, and the construction evident in the chine-girder. The results and analysis from phase one informed phase two, how the construction of each computer model was conducted. Each model was based on other vessels found in similar conditions outlined in historical research. The results of phase two were compared and critiqued based on the research of phase one and the recommendations of boat builders. After analysis, the results of phase two were used to start construction of the physical model (phase three). The results of each phase were then reassessed in the context of the original research questions in Chapter 5.

Chapter Two outlines the methodologies chosen for this study and how each one was used to gather as much data as possible to answer the research questions. The chapter follows this author's process from beginning to comb through historical sources, using field methods in an archaeological setting, and structuring how AgiSoft photogrammetry and *Rhinoceros 7* (*Rhino*), a CAD (Computer-Aided-Design) modelling software, was used to reconstruct the Oconee River flatboat. This chapter also explains how the results would be analyzed using the theoretical framework of experimental archaeology.

Chapters Three and Four outline the results of both the historical research conducted for this study, as well as the results of computer and physical model building. The third chapter culminates in the conclusion of phase one, the results of the historical research. Chapter Three takes the research methodologies and produces a foundation of historical context for flatboats in South Carolina and Georgia. Without this research, the need for flatboats, the environmental restrictions around their construction, and the economic benefits of using them would not be understood and there would be no foundation for the model building to continue. Chapter Four details the results of the photogrammetry models, *Rhino* models, and physical models. The completion of the computer models marked the end of phase two, which solidified the design and construction details that were used in phase three, the physical model build.

Chapter Five brings the historical research, field-work, computer models, and physical model together to answer the research questions originally proposed. This chapter will unveil the results of each of the models, which will be examined to determine their ability to answer the research questions. Chapter Five will then summarize the project, briefly revisiting each step of the project and providing ways in which it could have been improved. Finally, suggestions for further research will be made.

Chapter 2: Methodologies

Introduction

Archival research, fieldwork, 3D modeling, and experimental archaeology were used to answer this study's research questions. To use experimental archaeology successfully, a foundational knowledge of the historical context in which flatboats were constructed and operated is necessary before the construction of a model can begin. Archival research covering past archaeological projects and historical research was used to place the Oconee River flatboat in its appropriate context. Field-work was performed to gather valuable data to begin reconstructing the basic design and construction of vessel. This data was then used to construct historically accurate computer models on which a scale model reconstruction was based.

How each of these methodologies were employed is illustrated in this chapter, along with the advantages and limitations of each. The first section will outline the archival research, based mostly in South Carolina and Georgia. Here, how sources like images, past archaeological projects, and historic journals were gathered is shown. Next, the use of computer software to design build 3-D models from historic research and field-work is described. The final section outlines the construction techniques and theoretical applications used for the physical model, and how each technique was chosen based on previous research.

Historical Research

During the late 18th and early 19th centuries, Georgia began to thrive as a plantation-based economy. As the colony grew under the watchful eye of South Carolina, infrastructure to support new inhabitants followed. The growth, as well as the colony's close relationship with South Carolina, is well documented in archives in both states. As this study focuses on flatboats in South Carolina and Georgia, both state's archives were searched to provide context and evidence. Georgia's manuscript archives illuminate the deep connections between the two colonial powers, and South Carolina's waters hold comparative flatboat archaeological evidence. With the combination of both, the historical data gathered can be used to examine the context of flatboats in the Southeastern United States.

For this research, archives such as those located at the South Carolina Institute for Archaeology and Anthropology (SCIAA) were invaluable. SCIAA is responsible for most of the data on flatboats in their archaeological context, as well as research about how they would have been used daily in the areas in which they were found. The site maps, construction details, and research that SCIAA holds are the basis on which much of this research rests. The records found here, however, were limited for some of the vessels that were found in South Carolinian waters. While sites like the Laurel Hill Barge No. 2 were excavated and researched in depth, other vessels were not as thoroughly documented, meaning some measurements and construction details have been lost. Regardless, these records were instrumental in understanding the basic construction details of these vessels.

Other South Carolina archives used were the Lowcountry Digital Library, which contains digital scans of plantation journals, medical journals, almanacs, sketchbooks, and photographs. The collections identified as potentially useful were the following: Agricultural Experiments and South Mulberry Plantation Journal, 1841-1907 (bulk 1841-1867); Charles Fraser Sketchbook, 1793-1796; Drayton Papers, 1701-204; Rice Harvest at Mulberry Plantation (Berkeley County, SC); and Roslin Plantation Journal, 1813-1815. These collections include details of rice production, carpentry on rice plantations, ailments and injuries of enslaved plantation workers, and images of rice plantations and other industries in which barges or flatboats would be necessary. Each collection was searched and analyzed for any mentions of plantation boats, barges, or cargo carried down the river. While these sources did not produce the volume of information that was expected, the few things they were able to provide were valuable to this research.

The plantation journals were selected as potential sources for the identification of enslaved positions on the plantations. With the knowledge that other journals had the occupation or skills listed of each enslaved person, an entry that identified skilled carpenters or boatmen would have been a valuable find. Medical journals that discussed the treatment of enslaved workers would have also given clues as to the occupations of those living on the plantation. Almanacs were often used alongside a plantation journal or in substitution of one, identifying the best days to plant certain crops and the cycles of planting. The environment of the area was easily identified in the sketchbooks found in the Lowcountry Digital Library, with details of daily life in the Lowcountry captured in the drawings in each book (Fraser 1793:33).

As this study deals with a vessel that was found in middle Georgia, research of the area around Milledgeville was necessary. Archives such as the Digital Library of Georgia website maintains a record of newspapers from each county from as early as 1763, records of plantation sales, ferry crossing locations, and general knowledge of the area. The specific collections identified as potentially useful were Thomas Maguire papers, 1829-1949, Milledgeville historic newspapers archive, Eighteenth-century newspapers, and historic maps (Georgia Archives). Newspapers published in the surrounding counties of the Milledgeville area were also thoroughly searched. As with the collections from South Carolina, each was searched for mentions of plantation carpentry, boat building, or ferry crossings.

Historical research was necessary for the general foundation of understanding for this study. Without environmental and historical context for the vessel, assumptions about its construction would be impossible to defend. Archives such as those found at SCIAA, the Low Country Digital Library, and the Digital Library of Georgia were all excellent resources for determining the context in which flatboats existed, which will be expanded on in chapter three. The results and analysis comprise phase one of this study, which will in turn inform the decisions made in the computer and physical model building portions.

Literature Gap Analysis

After completion of the historical research, the next step was determining what areas of current historical and archaeological knowledge were deficient. An analysis of previous archaeological work showed that while chine-girder flatboats had been researched in the past, each article heavily relied on the others, meaning information on the basic construction techniques and the reason for construction differences were consistently recycled (Amer 1993; Fleetwood 1995; Harris 1992; McCabe 2009; Newell 1992; Newell 1997). This is not an error of the reports, as many were completed by state entities where a typical survey of the area was done, not a large research project. Historical mentions of chine-girder construction were few, with only one book, David Doar's *Rice and Rice Planting in the South Carolina Low Country* (1936), mentioning the construction process in a few paragraphs.

After noting the deficiency of information in certain aspects of flatboat research, a literature gap analysis was completed. This analysis highlighted the importance of researching chine-girder construction and why it was a necessary design, a topic that had only been briefly discussed in other reports, articles, and theses. The completed literature gap analysis was an excellent tool in guiding future research and how to approach answering the research questions. Chapter two will discuss the literature analysis further.

Field Research

Used alongside historical research, varying types of fieldwork were undertaken to gather data. The information gathered includes measurements of the recovered timber, observations from the wreck site, and deeper understanding of vernacular watercraft construction from speaking with knowledgeable boat builders.

Chine-girder Revisited

After it was pulled from the Oconee, Georgia's state archaeologist transferred ownership of the chine-girder to the Georgia Southern University Museum (GSUM). GSUM stored the chine-girder in their archaeological repository, where it was made available to the author for further research. Ease of access proved valuable as issues with the chine-girder's deterioration and hypothesized construction arose.

Due to a lack of research questions, time, and resources, the original measurements taken of the chine-girder by Kurt Knoerl and the author were incomplete. To ensure accurate and complete measurements of the chine-girder, it was revisited in the repository. Detailed photography and smaller scale measurements were taken during these times. This also provided the opportunity to search for tool marks in a more controlled environment while equipped with tools previously unavailable to the researchers. Wood samples were gathered from the timber for species identification and carbon dating at the Center for Applied Isotope Studies at the University of Georgia. Another visit was later made by a skilled archaeologist and boat builder to identify an exact construction technique.

Deposition Site

While the chine-girder provided excellent information regarding the construction of the vessel, the wreck site could solidify assumptions. The location of the Oconee River flatboat's wreck site is approximately 15 miles below the Sinclair Dam. This hydroelectric dam was built in 1952 and is opened on an irregular cycle dependent on rainfall in the area. The dam makes the Oconee River an abnormal wreck site. When the weather forces the dam to open, millions of gallons of water are released, washing approximately 20 miles of river sediment quickly down river. Due to the tumultuous nature of the river, artifacts are being periodically removed and redeposited as the path of the river changes rapidly. This violent flood is how the Oconee River flatboat timber was found originally (as discussed in Chapter one), and how the suspected other half was also located. However, due to time constraints, weather issues, and lack of resources, the area was not revisited to attempt to locate the remaining wreckage until October 2022.

Apart from the dam creating a problematic environment, the state's approach to underwater archaeology also poses a limitation that must be discussed. The wreck site location falls on state land, meaning the Georgia Department of Natural Resources is the agency that had jurisdiction over the site. Georgia does not have an underwater archaeology unit, so the DNR and the state archaeologist were responsible for processing and assessing the paperwork required for an archaeological permit. On July 11, 2022, a permit, listed in Appendix A, was granted by State Archaeologist Rachel Black, with a working window of one year. Neither the permit nor the site has a designation number, so the site will continue to be called the Oconee River Flatboat in this study.

With help from another local with extensive knowledge of the river, Gary Fowler, the author traveled to the site in October of 2022. This trip would not have been possible without the help of Mr. Fowler, as a fan boat was the only vessel with the capability of navigating the area's extremely shallow waters (Figure 2). GPS coordinates were used to relocate the location where the original timber was pulled from the river, as well as the location of the remaining wreckage.

The water level in the area of interest was low enough that a walking survey was the best option to find any sort of archaeological remains (Figure 3).

FIGURE 2. Gary Fowler and Alyssa Saldivar in front of Fowler's fan boat, on the Oconee River (Image by Ryan Bradley).

FIGURE 3. Photo of the Oconee River showing the shallow water environment and the water hazards (Image by Alyssa Saldivar).

In one area, snorkel equipment was used to dive to a depth of approximately 3-5ft to survey the eastern bank of the river. Buried in the embankment, a cut plank matching the planking width calculated from the original chine-girder was found and measured (Figure 5). Other planks were also found in the area, but only the submerged plank matched the wood type, size, and period (Figure 4). While the expedition 15 miles down the Oconee River was less successful than originally hoped, it was beneficial to visualize the densely forested area that flatboats would have operated in and identify the few pieces of vessel that remained in the area.

FIGURE 4. Photo showing planks and debris found in the Oconee River search area (Image by Alyssa Saldivar).

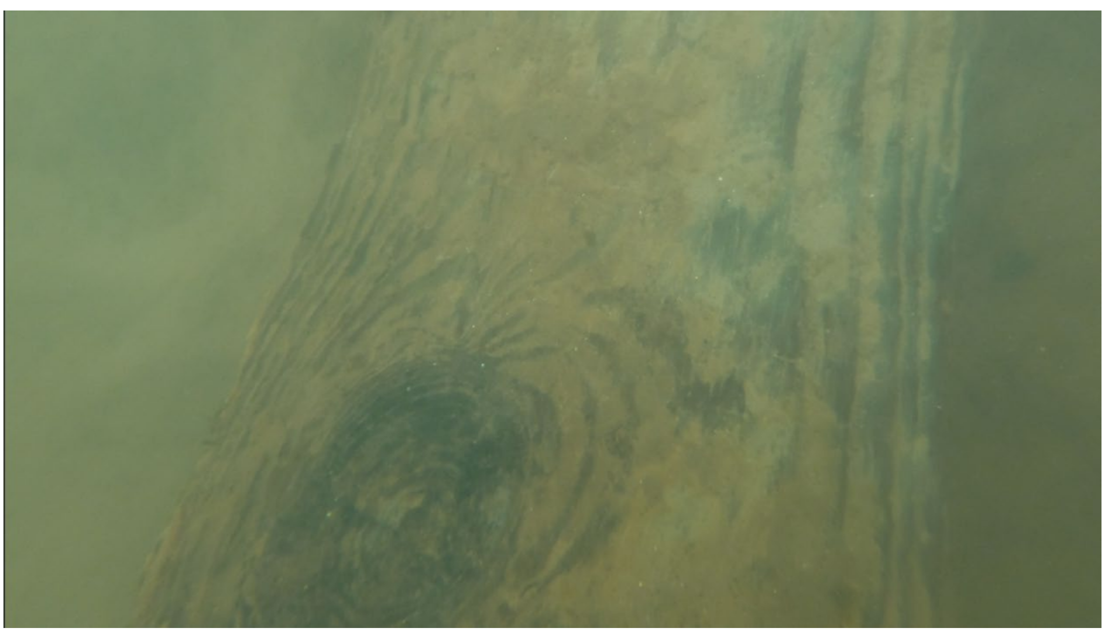

FIGURE 5. Photo of plank embedded in Oconee riverbank (Image by Alyssa Saldivar).

Correspondence

The Oconee River flatboat timber is a unique piece that has never been seen as part of flatboat design before. Chine-girders on other flatboats found in South Carolina present with different shapes, features, and ratios- that are not mirrored in the Oconee flatboat, while the same basic principle of construction is featured. Due to this construction variation, communication with boat builders that have seen and built these flatboats is an important piece in understanding how this vessel would have been constructed to withstand everyday use. A series of questions was asked about their experience in boat building, experimental archaeology, and finally the fine details of how they believe the Oconee River flatboat was constructed to float the river. The information gathered from these questions can be found throughout this study but is heavily discussed in Chapter three.

Computer Model Building

Computer and experimental modeling were used to illustrate the construction details, design, and sequence of the Oconee River flatboat. To ensure accuracy, the *Rhino* model was built from the exact specifications captured in a photogrammetry model processed using Kotaro Yamafune's Agisoft Metashape workflow, gained by this author by attending a workshop provided by Yamafune in May and April 2023 at the South Carolina Institute of Archaeology and Anthropology. The workshop focused on photogrammetry in terrestrial and underwater archaeological sites. Once the chine-girder was digitally reconstructed using *Rhino*, the missing sections of the flatboat were built around the existing chine-girder. With the computer model finished, exact measurements could be exported and used to build a physical scale model of the vessel, replicating historic ship building techniques.

Photogrammetry Model

Due to the recovery methods, the Oconee River timber was subject to emergency archaeology. Without an excavation and conservation plan, Georgia Southern University provided a safe haven for the timber, where emergency conservation could be performed. This timber, in an ideal setting, would have been left in water until PEG treatment (Cronyn 1990:257-261) could be undertaken, which is expensive, time consuming, and requires conservation training and space. Given the sudden extraction and the months of drying before archaeologists could examine the timber, extended conservation was not possible. Georgia Southern University recognized the need for treatment and was able to treat the timber with Wood Juice, a commercially sold wood preservative normally used for furniture, which slows the rate of deterioration of wood by filling wood cells with a stable structure, similar to PEG (Preservation Solutions 2020:1-2). While this treatment treatment *may* have helped the rate of decay, trained conservators have recommended shying away from this process. The treatment is sold for commercial use, and conservators have no way of identifying the chemical compound, meaning reversal potential and the true long terms effects of the treatment are unknown. While this emergency conservation has slowed the decline of the artifact, it has deteriorated since the application of the solution. As a rare and unique object in Georgia's colonial history, photogrammetry can freeze the artifact in digital form, and can be used in the future to track the rate of decline. Given the need to preserve this important vessel, advanced photogrammetry methods were needed.

Two photogrammetric models were made using separate methods and data sets. The first method consisted of using a GoPro 8 video, freezing stills from the footage, and running the Agisoft Metashape program using basic settings with no enhancements. This produced a usable model, but it had some "holes" in the model that were not rendered properly. This model had an error rate that made it unacceptable to use for data. The second photogrammetric model was produced using Kotaro Yamafune's methodology, which produces visually stunning and scientifically accurate data sets.

Photos were taken with a Nikon DSLR to complete this model. The photos were taken slowly in a precise pattern that allowed for the best outcome once uploaded in the Agisoft software. This process was repeated after the chine-girder was turned on its side, producing two datasets for two separate models which would later be merged. For each model, 100% photo alignment was achieved, meaning that the software was able to place every photo in order and identify from where exactly in the room each photo was taken (Figures 6 and 7). After photo alignment, a mesh was built from the points identified in each photo, creating a 3D wireframe model of the chine-girder. Once the shape was confirmed, texture was added from the photos, which created a polished and accurate 3D model.

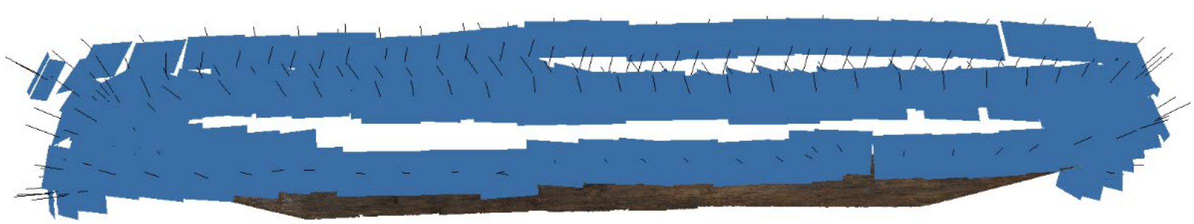

FIGURE 6. Photogrammetry model with photo positions shown for side 1(Image by Alyssa Saldivar).

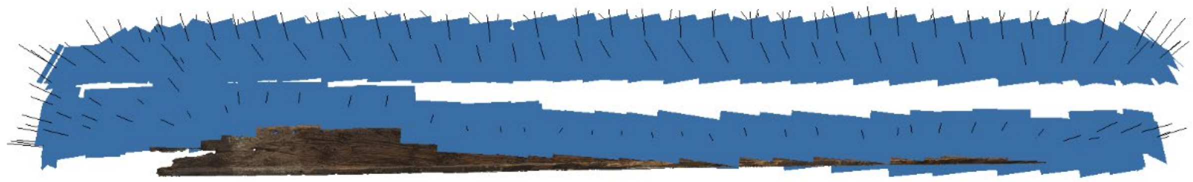

FIGURE 7. Photogrammetry model with photo positions shown for side 2 (Image by Alyssa Saldivar).

The methodology outlined above was then repeated for the second data set of photos. The separate models were then trimmed to remove all outside objects. Once cleaned, the models were merged together into the same project file, where the photos were realigned with the new positioning (Figure 8). Once aligned, new layers of mesh and texture were added, filling in all "missing" sections of the separate models and producing a solid 360-degree model of the chine-girder. This can be seen in Figure 9, where both models are merged together, and the floors of each model are present. Once the photogrammetry model was scaled in each direction, the accuracy was tested against hand taken measurements. The photogrammetry model's accuracy was within ¼in. This completed model was used for the basis of the *Rhino* model, which ensured the structure of the reconstructed model was based specifically on the exact angles, shapes, and positioning of the chine-girder.

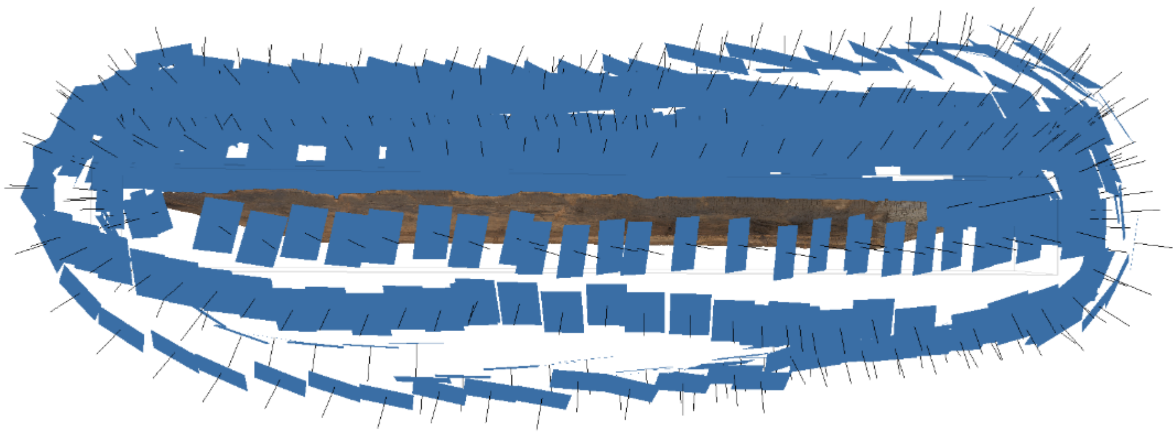

FIGURE 8. Photogrammetry model showing new photo alignment, with both sides now visible in one model (Image by Alyssa Saldivar).

FIGURE 9. Photogrammetry model point cloud showing both sides of the model merged. Both floors of each separate model are visible (Image by Alyssa Saldivar).

Rhinoceros 7 Model

McNeel's *Rhinoceros 7* was chosen to build multiple versions of the potential Oconee River vessels due to its successful use of building ship and boat models in the past (e.g., O'Brien 2022). Building each version in this CAD software allowed for many experimental versions of the vessel to be built, considered, and carefully dismissed. Each version was based on flatboats and chine-girder vessels that had been found in South Carolina in similar environments. Using information gathered from the wreck site, the chine-girder itself, and archival research, a final build was chosen that best represented what the Oconee River vessel would have looked like.

An export of the finished photogrammetry model was first imported into the *Rhino* software, where the model was checked again for proper scaling (Figure 10).

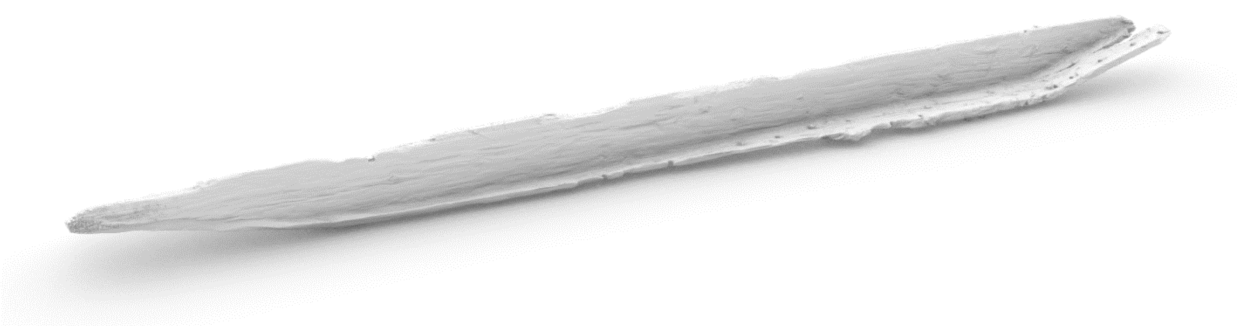

FIGURE 10. Photogrammetry model exported into Rhinoceros 7 (Image by Alyssa Saldivar).

To create the most accurate model possible, lines and angles were drawn using *Rhino* tools over the exact specification of the photogrammetry model. The goal of this process was to combine the physical measurements of the chine-girder and the photogrammetry model's angles to extrapolate what exactly was missing from the chine-girder due to a potential wrecking event or deterioration. Figure 11 shows the photogrammetry model and the *Rhino* built chine-girder directly on top of each other, showing how closely the two matched.

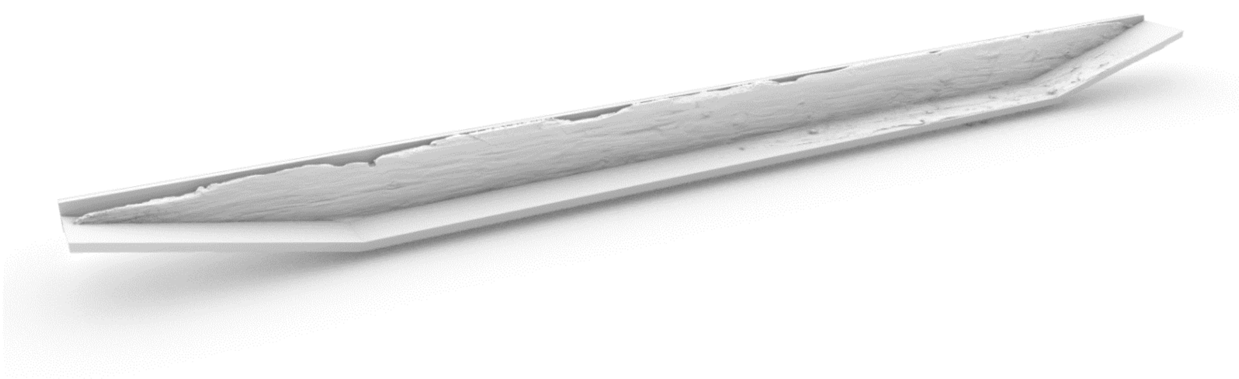

FIGURE 11. Photogrammetry model with new Rhino built model laid over it (Image by Alyssa Saldivar).

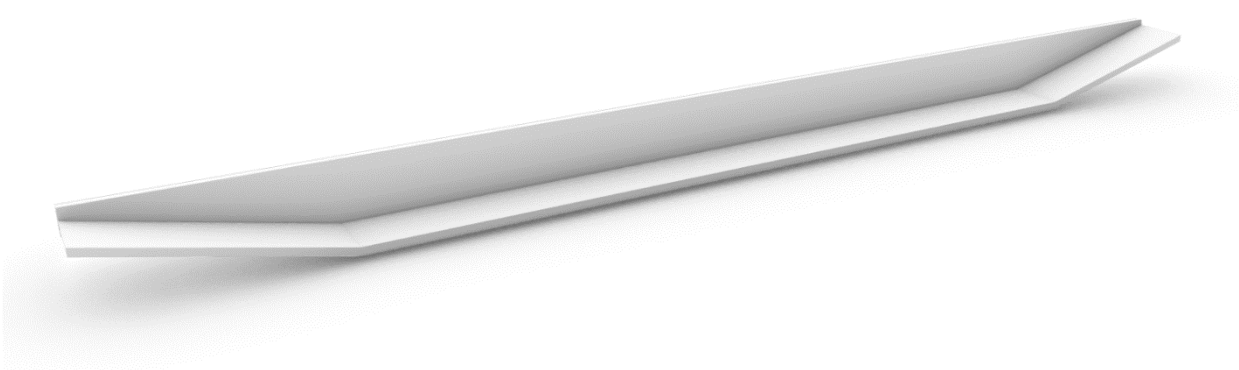

FIGURE 12. Completed chine-girder built in Rhino, without photogrammetry model (Image by Alyssa Saldivar).

Once an acceptable version of the chine-girder was built inside *Rhino*, the photogrammetry model layer could be turned off, leaving just the constructed chine-girder. This process resulted in the most accurate representation of what the chine-girder would have looked like at the time of original construction (Figure 12).

A cargo barge was the first model to be built using this software. The model used a beam to length ration of 1:3, as seen on prior craft found in South Carolina (Newell 1997 and Amer 1993:18-19). The hypothetical sections of the vessel were built directly off the chine-girder, with construction based on research on barges found in South Carolina. The chine-girder was mirrored to create the other side of the vessel. Then, planking, stringers, stretchers, knees, and treenails were inserted based on measurements taken from the field and from archival research of other flatboats in South Carolina.

The second model built was given a 1:9 beam to length ratio, which would have been considered a quarter ditch barge, similar to the Conway Narrow flat (Newell 1992). These vessels would have been easy to maneuver through rice canals and smaller waterways and were mentioned in Doar's book as a lighter craft (Doar 1936:34). As a chine-girder had already been constructed in *Rhino,* construction of this model was simple as plank width and positioning of the second chine-girder were the only measurements that needed to be changed.

The third vessel was a ferry flat, built to similar measurements as the barge but with different internal structures. While still maintaining the 1:3 beam to length ration, this flat was simpler in design when compared to the overbuilt barge. While this vessel conflicts with archival research of other chine-girder built flatboats, it is built around the present chine-girder, considering the strengths and weaknesses of this timber rather than the designs of other craft. Consultation with William "Rusty" Fleetwood suggested that the design would withstand the everyday burden that this vessel would encounter as a ferry.

Rhinoceros 7 Results

After the models were constructed, the validity of each was considered. Factors such as the environment in which the vessel would have been used and the plausibility of construction were investigated. Phase two was completed once the model with the most credibility was identified, and the construction of the physical model could begin.

Physical Model Building

After an appropriate vessel was chosen from the *Rhino* models, a physical model was built to identify the construction sequence and to study the variation of difficulty between cypress and pine in the assembly. The model was built in Lexington, South Carolina using hand and power tools.

Application of Theoretical Framework

The theoretical framework that shaped this section of research is based on experimental archaeology which was discussed in Chapter one. The goal was to better understand the construction practices by creating an experimental model. The model size and the tools used to create it were chosen specifically to answer the research questions outlined in the study. The historical research outlined earlier heavily informed to construction practices used (Doar 1936:34). To replicate the process of original construction as closely as possible, power tools were only used only after it could be demonstrated the construction process was possible with hand tools. Appropriate Georgia heart pine was sourced from an 1844 home in Augusta, Georgia, which was the closest match to the period that could be found. Each decision that was made in the building process attempted to account for the environmental reasoning, the larger scale, and the conditions in which the shipbuilders would have existed. While the exact conditions could never be replicated completely, for the purposes of this study and the research questions asked, the conditions in which the model was built were sufficient.

<u>Practical Uses</u>

This section will outline some previous studies that have successfully used experimental archaeology to answer similar research questions. As experimental archaeology has been employed by archaeologists for well over a century, the studies here were chosen specifically to represent experimental projects that are similar to this study.

This first example of a similar experimental archaeological project is the design and construction of a medieval round house. This project was conducted by the Centre for Experimental Archaeology and Material Culture (CEAMC) to learn how the houses were constructed, and what the living conditions were inside them in a multitude of environments. In this case, the experimental archaeologists had a plethora of archaeological and historical evidence to rely upon to accurately reconstruct an early medieval round house (Souyoudzoglous-Haywood and O'Sullivan 2019:5-14). Using appropriate tools and materials that had been found in archaeological sites of round houses, the team was able to construct the house in approximately 39 days. As the focus of this study was the post-construction living conditions, the true experiments began after the reconstruction was complete. Using a "range of scientific instruments," the team of archaeologists were able to confirm hypotheses about overall living conditions inside the houses over time (Souyoudzoglous-Haywood and O'Sullivan 2019:12). The reconstruction and investigation of the early medieval round house is an amazing example of experimental archaeology in terms of reconstruction based off past archaeological and historical research to answer questions that other research cannot. While this case study goes further than studying just the reconstruction of the house, the basic principles of research design are similar to what this study accomplishes.

The second example that will be referred to is the experimental maritime archaeology conducted by the Viking Ship Museum. The Viking Ship Museum has been using the process outlined in Figure 13 to understand how Vikings constructed and operated their vessels. The process outlined heavily informed how this study was conducted, as it demonstrates the best practices to successfully reconstruct a vessel of the past. Unfortunately, a full-scale reconstruction of the Oconee River flatboat will not be completed due to time and resources restrictions. However, the research questions proposed in the study can be answered by reaching the “reconstruction models and drawings” step.

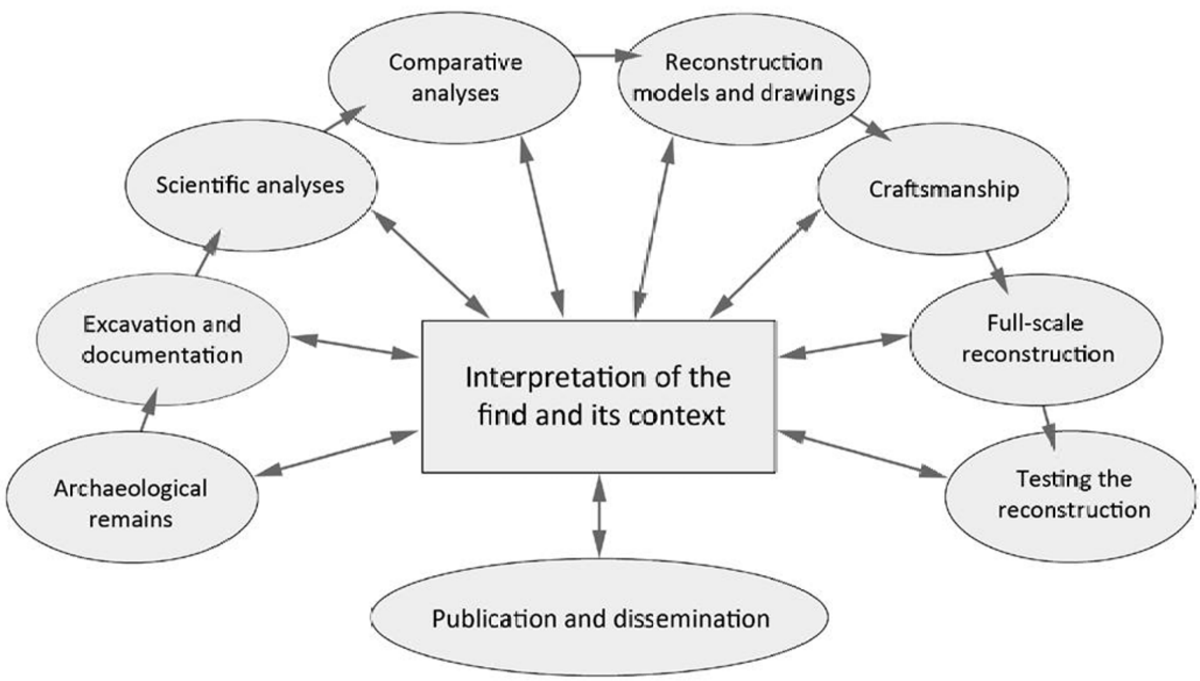

FIGURE 13. Process and methods of experimental archaeology as applied at the Viking Ship Museum (Flores and Paardekooper 2014:234).

Previous Experimental Flatboat Construction

Two vessels, the Magnolia Flat and the Conway Narrow Flat, have been constructed using experimental archaeology methodologies. These were both undertaken by Mark Newell and shipbuilders such as William "Rusty" Fleetwood, who is focused on the construction of small watercraft in the Southeast. The Magnolia Flat was built based on measurements and construction techniques gathered from vessels found in South Carolina, while the Conway Narrow Flat was built as a replica of a single flatboat found in Conway, South Carolina (Newell 1997:78-83; Newell 1994). Both experimental builds informed how this study approached the construction of the Oconee River Flatboat model. Apart from the archaeological presence that these flatboats have both in the remains of historic vessels as well as the experimental reconstruction of them, other published works that focus on the use, environmental significance, and cultural history of the watercraft will be examined. The following section examines how these vessels have been treated in published works and how flatboats are currently understood.

Construction

Finally, with the completion of phases one and two, phase three could commence. To begin, the measurements to which the *Rhino* model were built were calculated into scaled measurements, shown in Appendix B. With the available wood, a 1:9 scale model was all that could be accomplished without having to scarph two sections together. Keeping the small scale in mind, the efforts of who would have likely been enslaved people to build the original would have significantly dwarfed the work required to construct the model. Regardless, the construction of a physical model provided insight into construction techniques that could not be visualized or studied using software like *Rhino*.

The construction process began with the two chine-girders. Due to wood availability, the traditional method of each chine-girder being carved from the same tree was impossible. However, each chine-girder was from the same source and similar in grain pattern and density. Using a bandsaw to replicate a two-man saw, the outer hull of the chine-girder was cut flat. For ease, the other three edges were cut based on the dimensions of the chine-girders. After the wood blocks were of the appropriate length, width, and height, the angles for the ramps were measured and cut with a double-edged pull saw. With this, the outer hull of each chine-girder was finished, with the rabbet and inner shelves left to be carved out by hand. The rabbet was the first section to be carved out and removed. This work was completed with hand tools, as the rabbet was too delicate to use larger saws. Using a Dremel, hammer and chisel, and a Flexcut palm carving set, the rabbet slowly took shape as layers of dense pine was removed.

Once the rabbet was carved at the appropriate angle, the interior of the chine-girder needed to be carved. This proved difficult due to the chine-girder including the ramps, as no solid cuts could be made deep into the timber with any saw without compromising the ramp and shelf structure. Instead of saws, large portions of the excess wood on the interior were removed in chunks using a system of small cuts where a hammer and chisel could be used to force out larger sections of wood. While this system worked in the beginning where carving did not need to be precise, it did not work near the ramps or as work neared the shelf or hull wall. The majority of the carving process for the interior of the chine-girder had to be completed using small carving tools only, and the interior angle took many hours to perfect and match.

After the hard angles of the chine-girders were perfected, planking that matched the dimensions based on the original chine-girder were cut using a bandsaw and a double-edged pull saw. Starting with the vessel in an inverted position, planking was dry fitted into the rabbet to form a general shape and ensure that the planking, with each piece being slightly different, would fit into place with each other. From this inverted position, treenail holes were drilled out for each plank. Both the chine-girder and planking were drilled together to provide accuracy and ensure a secure fit. As the holes were drilled, treenails were placed into position and hammered into the plank and chine-girder, locking each plank into place. Once the hull planking was completely nailed into place on the bottom of the shelf (including the ramps), the model was flipped to begin the interior planking and stringers.

Before the interior planking could be laid in, two stringers made of six pieces were placed into the vessel. The stringers were placed longitudinally into the vessel, directly on to the interior of the exterior planking. Each stringer was the same height as the chine-girder shelf, providing a flush surface to place the interior planking on to. Two holes per plank for each stringer were drilled for treenails to be hammered into. Once the completed stringers were secured onto the exterior planking, the interior planking was fitted into place.

Each interior plank was dry fitted into place and shaved down to fit inside the chine-girder for a tight fit. After each plank was laid in, holes were drilled through the planking and into each of the two stringers in the opposite pattern as the first set, with the treenails now forming an “X” pattern in the stringers. The planking on the floor of the vessel was set in first, leaving the ramps exposed. Starting at the edges of the ramps, the final planks were set in. The last plank on either side had to be cut down in width to fit into the space where the floor of the vessel began to lift into the ramp. These smaller planks were given a singular treenail on each stringer to secure it into place. With most of the vessel constructed, the final structural pieces could be added.

To cover the exposed interior of the vessel and to keep water from intruding between the two sections of planking, the headers were added last. The headers were secured to the chine-girders and the stringers using the same treenail method seen before. After they were secured into place, they were sanded to the correct ramp angle on the bottom and the correct height at top. The final additions to the vessel itself were thole pins in one of the four places along the edge of the chine-girder where the sweeps would have been positioned. As before, a hole was drilled in each position before a thole pin could be glued into place.

With the thole pins in place, the construction of the vessel was completed. The final step was to coat the vessel in beeswax to mirror a coating of sap and oil which would have been applied to make the vessel as watertight as possible.

Conclusion

Each method mentioned here was chosen to produce the best results to answer the research questions proposed in Chapter one. Following the theoretical approach chosen, the historical research, photogrammetry, *Rhino* model construction, and the experimental model building each produced solid results in which the study could build from further. Those results will be outlined and examined in Chapters Three and Four.

Chapter 3: Historical Research Results

Introduction

This study encompasses some history of the South Carolina Lowcountry, the history of Georgia's move into the Atlantic economic sphere, and the past archaeology conducted on vessels similar to that of the Oconee River flatboat. This chapter will analyze the historic context in which small, flat-bottomed barges existed, as well as their complex construction. The environmental and economic motivations for constructing a vessel like a wooden barge will be determined and examined, and historic sources will illustrate when, how, and by whom these vessels were used. Once the historical need for the vessels is understood, the construction of vessels found in South Carolina will be analyzed. After the historic and construction framework is solidified, I will include an analysis of documented barges in the archaeological record, as well as a historiography of the work that has been done on these vessels recently.

Flatboats in Context

Both South Carolina and Georgia had environments that required the exploitation of their inland and coastal waters. Dense maritime and coastal forests meant that foot travel was dangerous and time consuming, rivers always being the better options for settlement location. In Georgia, Frederica, Augusta, and Savannah were the first settlements to begin to grow and prosper due to their proximity to the water (Pressly 2013:12). Vessels that were simple to construct, carried heavy cargo, and could traverse the ever-shifting tidal waters of the inland rivers of Georgia and South Carolina were imperative for a successful colonial economy. Flatboats, modified for specific uses, were the ideal working vessels for this environment.

South Carolina and Georgia's environments possess similar features. Both states have large expanses of low-lying coastal land which hold swamps, marshes, and numerous streams

(Johnston 1810:46-48). Where the low land begins to slowly rise to the fall line, the lumber industry takes root. Below the fall line, in the Lowcountry, is where flatboats are found due to the shallow and calm water. Flatboats were used as the slow moving and cheaply made work horse of these rivers, excellent at carrying cargo and navigating the treacherous, dark, shallow waters of the Lowcountry. The only vessel documented by archaeologists in Georgia that has a field report is that of the Altamaha River- Harper Lake flatboat, well below the fall line (McCabe 2009). Watercraft like these would have been used prior to the rice revolution as ferry craft and cargo vessels to supplement the lumber industry that used the rivers to float lumber down.

The riparian nature of the Lowcountry also required ferry crossings to traverse these states. Ferries would need to hold cargo, passengers, and carriages, meaning that the flat, wide nature of these vessels were perfect for this type of use (Drayton 1790:6). In two newspapers located in Milledgeville Georgia, The Georgia Journal and the Georgia Argus, ferries were mentioned repeatedly. In many articles in the first two decades of the 17^{th} century, ferries were listed as important pieces of large real estate tracts, greatly increasing the value of the plantation (*Georgia Argus* 1810c:4; 1810e:3; *The Georgia Journal* 1812:4; 1814b:3; 1814d:3; 1815:3). Ferries were also used as landmarks on the Oconee River for navigation (*Georgia Argus* 1815a:4; *The Georgia Journal* 1814c:3). These craft are most notably associated with the rice systems that flooded the Lowcountry in the mid-17^{th} century, as they were perfectly suited to the marshy environments that rice thrived in (Amer 1993:18-19; Fraser 1793:33; Newell 1997).

Construction Details

This section will address the construction of these vessels and how they differ from other small watercraft which were operating on the inland waterways of the Southeast. It will discuss the types of barges found in other parts of the world and how their construction holds clues to unravelling the origins of the Oconee River flat boat's method of construction. Additionally, this chapter will provide a discussion of terminology used in past analysis of barge design, as well as determining what language will be used in this manuscript when focusing on the Oconee River flat.

Terminology

Before further discussion on barges and their construction can continue, a thorough discussion of terminology is needed. In the case of flatboats, in some cases referred to as barges, there are many sections of the vessels that have, in the past, been referred to using more traditional ship construction definitions that do not convey the meaning or purpose of the piece. The following section details some issues with definitions that can easily confuse or cause interpretive issue.

<u>Chine-log or Chine-girder</u>

The largest issue for the purposes of this paper is the difference between a chine-log and a chine-girder. Chine-log and chine-girder are often used in conjunction with each other in other literature discussing flatboats in the Southeast (Alford 1993; Harris 1992; Newell 1992; Newell 1997; SCIAA 1989; SCIAA 1993). For this study, a separation of definitions is made considering definitions of other ship construction techniques. No matter how the terms are used, they define a longitudinal strengthener, with only subtle differences which have not necessarily been highlighted before when discussing barges. A chine-log is a square timber, normally with similar molded and sided dimensions, that is placed in the interior of a vessel's chine to either add more longitudinal strength along with a keel structure, or to provide strength in the absence of a keel. To improve their durability and structural importance, mortises are cut out of the chine-log for stringers to be inserted into. In hard defined ship construction terms, especially when discussing flat-bottomed steamships of the western United States, chine-logs are more a structural addition than a mandatory piece of a vessel's construction (Kane 2004:93-94).

A chine-girder acts as both a longitudinal support but also as the outer hull of a vessel. Chine-girders are also normally carved to receive ceiling or hull planking, shifting them from a square or shaved down timber like a chine-log, to a complex timber with multiple planes. The example in Figure 14 shows a chine-girder, with a small rabbet carved into the bottom section to receive outer-hull planking. They are shaped like an L, with the horizontal thickness facing each other to form the structure for planks to be added to form the floor and outer hull of the vessel. Other chine-girders found are smaller, only constituting the chine of the vessel instead of the entire side as seen in Figure 14. Chine-girders form the outer, and in some cases the inner, hull of the vessel, where chine-logs are inserted into the chine of the vessel. Vessels with chine-logs can still be constructed without their chine-log (though it would be longitudinally weak), but vessels that have a chine-girder could not be constructed without one. This is a determining factor in the structural basis of the vessels (Harris 1992; Kane 2004; Newell 1992).

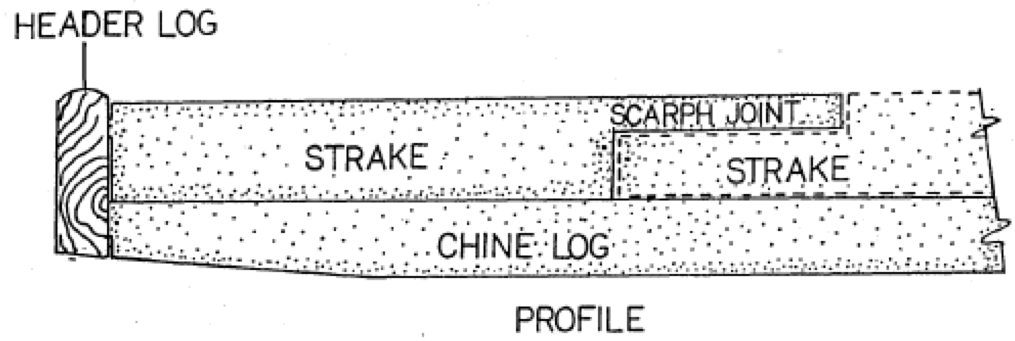

FIGURE 14. Image showing chine-girder ("chine log" in the image) only extending half way to the gunnel of the vessel, instead of consisting of the entire side of the vessel (Harris 1992:29)

As small vernacular watercraft, the flatboats of the southeastern United States potentially do not abide by the strict rules of mass ship construction, and the definitions proposed by the author consider the vernacular nature of the vessels discussed here. Enslaved shipbuilders or plantation owners were not considering what each section of their vessel was named when they were constructing it. These vessels differ greatly due to the needs and experiences of the ship builders. For this study, *chine-girder* is defined as the L-shaped longitudinal support structure that served as the basis of construction for these vessels, as shown in Figure 15. This specific wording has been used in conjunction with chine-log before by authors like Newell, Harris, and Amer, but will be thoroughly separted in this study.

FIGURE 15. Cross-section of Oconee River chine-girder (Courtesy of Kurt Knoerl).

Stringers

Other structural pieces that need to be defined are stringers. In site reports of the past, the pieces that are shown highlighted in red in Figure 16 have been called keelsons (Harris 1992; Newell 1992). This is due to a lack of keel in these vessels, and the want of archaeologists to place a keel (something so integral to the construction of a ship) in the site plan. In vessels with a keel, longitudinal pieces running parallel to the keel to add structure are called stringers, and this definition will be retained in this study. The timbers that continue from the position of the stringers up the bow and stern ramps will be referred to as ramp stringers, as they are a separate timber from the floor stringers.

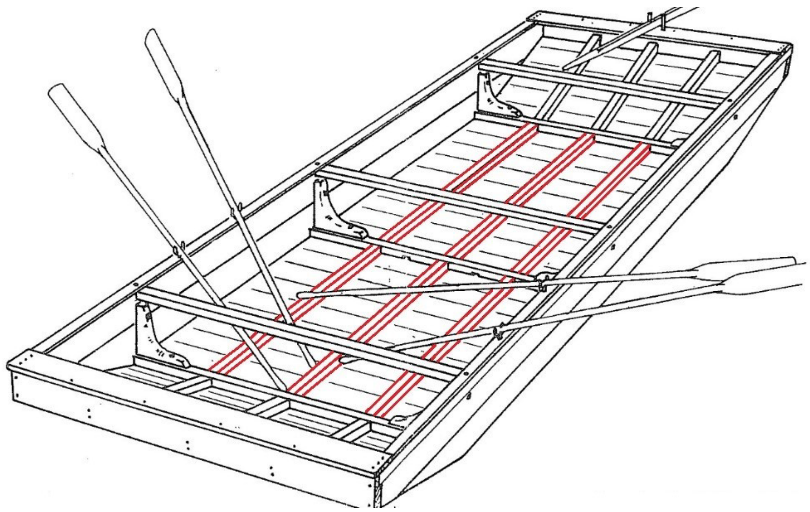

FIGURE 16. Flatboat drawing with stringers highlighted (Drawn by William R. Judd, edited by Alyssa Saldivar).

Sweeps

Another simpler definition is the difference between a sweep and oar. Sweepers, or sweeps, are longer and normally thinner than oars. They can be used for poling the vessel as well as for oaring it across the water. Sweeps were often used as the steering method of barges, as partially shown in Figure 16. Unlike sweeps, oars are shorter with the paddle being generally wider at the end. Sweeps were normally located on the stern of a flatboat or barge as the main steering aid (Newell 1997:255).

Overall, most of the definitions used in ship construction are applicable to flatboats, just the same as any other vessel. The structural pieces that are usually mistakenly named are those rarely found in "typical" ship construction. The vernacular construction of these vessels makes naming conventions difficult for most small craft, but much can fall into the present categories of ship construction. Confusion in defining terms creates a critical margin for error when discussing vessels that do not fit easily in the traditional shape and design of primarily western-built sailing vessels.

Physical Construction

While square wooden flatboats may seem simple, the construction of each vessel differs drastically and follow loose rules of construction that focus on function (Harris 1992; Newell 1997). Due to the ease of construction, many shipbuilders would create their own plans and construction designs to suit the specific need of their environment. The differences in environment impacted all decision making in the construction of these vessels- from the availability of types of wood dependent on location, to the human-made environmental features such as canals that would impact the daily use of these vessels. Apart from the minor differences that were made to improve the usability of the vessels, they were constructed in two distinct ways: plank built, and chine-girder built.

Plank Built

These flatboats were constructed of a hull made of planked wood, readily available by the mid-19th century. Lumber made it easy to construct a plank-built flatboat, as there was no need to find a suitable tree, only the need for access to a lumber mill. This does not mean to dismiss the idea of carpenters constructing plank-built flats on their own by cutting trees into planks but may contribute to the decline of large chine-girders and the rise of plank-built flats. While using planks would allow for carpenters to be less particular in their choice of trees to cut, carve and saw, these vessels required a greater number of fasteners and joint pieces to assemble the craft. This, of course, would imply a level of upkeep that would potentially not be found in their chine-girder-built flatboat counterparts (Newell 1997:15-20).

Returning to the discussion of lumber, large cypress was more commonly found in swamp and coastal land, whereas pine was often reserved for inland craft, possibly meaning that more plank-built craft would be found inland. Some inland areas of North Carolina, South Carolina, and Georgia would only have pine readily available, resulting in either smaller chine-girders or plank-built craft (Outcalt and Sheffield 1996:18). Something that this author notes is the difficulty of carving pine versus cypress. Pine is easily cracked and broken which would make it much more difficult to get the angles needed to form a chine-girder. However, the difficulty was likely not considered by a plantation owner who gave instructions to enslaved people who had to do their best to improvise with what they had.

Chine-girder Built

The origin of this type of construction is often debated. Some scholars propose that the tradition was originally used in Europe or Africa and brought to the Southeast by immigrants or the enslaved. Others believe it was developed independently of other influences in the rice plantations of the South (Newell 1997:26). Regardless of its origin, this construction method is unique and has been recorded in only a small number of archaeological sites in South Carolina and Georgia. Chine-girder built flatboats increased the strength and carrying capacity of the vessel and limited the number of repairs necessary. These were normally built from large cypress trees taken from the swamp lands surrounding plantations (Doar 1936:34). Where cypress was not plentiful, like inland sections of the Southeast, pine trees would have been substituted for the sturdier cypress.

Chine-girders constitute the two structural side pieces of the rectangular-shaped flatboat. Cut from the same tree, the two sides are identical in length and width, carved so planks could be easily fastened to either chine-log. They are normally 2-4 centimeters thick and were up to 50 meters long. After carved, the natural drying process would allow the Chinegirder to pull inward, locking the headers of the vessel in place and creating an even tighter hold than what fasteners provided. Most chine-girder flats are found with one to three stringers. The balance of weight between the two chine-girders is reliant upon the treenails connecting the thwart-ship planks to the chine-girder underneath. With this construction, the flatboats need little in terms of extra fasteners and joints, as the chine-girder itself takes much of the structural burden (Newell 1997:15-20).

These flatboats are sturdy and easily repairable unless severely damaged, something that would not be concerning on slow-moving and shallow water. Most repairs would be made to hull planking on the ramps from being pushed up a river bank. These repairs would have been a simple task due to the construction of the chine-girder built flatboat. Normally made from cypress, these chine-girders were heavy, but ultimately buoyant. Large cypress trees were readily available in the swampy marshes of the coastal regions of the southeastern U.S. but were often difficult to remove from the waist deep and reptile-infested water. Of course, this arduous task fell to enslaved men, who would take cypress trees that needed strong men to float and carry them from the swamps. Doar's description of the harvesting of these cypress trees is as follows:

> The carpenters went into the swamps, felled great cypresses, measuring 3 and 4 foot at the butts, split them open by boring augur holes the whole length, then hewed them into sides from 30 to 40 feet long with slanted ends, brought them home by water and constructed the huge flats or lighters for harvesting the rice and smaller ones for ferrying hands across the river, for carrying seed rice, mud forbreaks and other light work (Doar 1936:34).

Though the origins of this tradition are debated, it is obvious given the distribution of the known chine-girders that it was frequent in the Lowcountry of South

Carolina and Georgia, and in some cases extended into the rivers further inland. In North Carolina, South Carolina, and Georgia, there have been several chine-girder or chine-girder built flatboats that have been thoroughly investigated by both historians and archaeologists. Others have been found, but time, budget, and environmental restrictions have prevented survey or further research.

The Trent River flatboat was found to be of a French Huguenot design due to the longitudinal planking between the chine-girders, which is like that of the Zwammerdam barges found in the Rhine River in Europe, and unlike those found in the United States (Newell 1997:70-71; Hocker 1991:51-54). The Zwammerdam barge no. 2 was dated to the 2nd to 3rd century AD, proving with ease that the chine-girder design had existed for many years before it appeared in the North American archaeological record (Hocker 1991:51-54).

Modifications

Apart from the separation of chine-girder and plank built, other modifications and construction details can be identified. Some vessels required a difference in beam, others an additional piece for river access, and some had masts and sails. These differences were determined by what these craft were built to do, but they still could be easily identified as wooden flatboats by their overall shape.

Ferry craft normally followed a beam to length ration of 1:3, significantly shorter than rice flats. This was due to the environment they were in and the work they were tasked with. Roads frequently encountered the many rivers that wound through the Southeast, and flatboats were an easy way to get people and cargo across the rivers safely. Due to this task, ferry flatboats were wider and had an “apron” built on to the angled end of the vessel which would be lowered onto the bank to allow passengers off (Newell 1997:25). Most of these craft also had wide-angled ramps on either end to allow the easy loading and off-loading of cargo. These vessels were sturdy enough to transport livestock or carriages with horses. Rice flats were the opposite, they were built to slip through narrow canal passages that littered the marshland and coastal plains. Canal systems were often constructed on rice plantations, as the controlled flow of water was necessary for the flooding and draining of rice fields. These vessels needed to keep their cargo capacity but fit easily through the canals, meaning their beam to length ratio increased, often closer to 1:9 (Newell 1997:28).

Photographic evidence indicates the addition of another modification to these vessels- sails. While the use of a mast or sail is not mentioned in the construction of the vessels that this study focuses on, it is important to note that this was a modification that was potentially used. Figure 18 shows a barge in the South Hadley Canal in South Hadley, Massachusetts, using two polers and a full sail. While this is not in a similar geographic area, it is important to note that these modifications were made in the past. Another photograph from 1900 in South Carolina shows another flat with one small mast, a sail, and two sweepers (Figure 17). This photograph represents a period from later than which this study focuses but indicates that this technology was widespread and used on a variety of vessels of differing sizes.

FIGURE 17. Flatboat with sails in South Carolina in the 1900s (The Charleston Museum, Charleston, South Carolina).

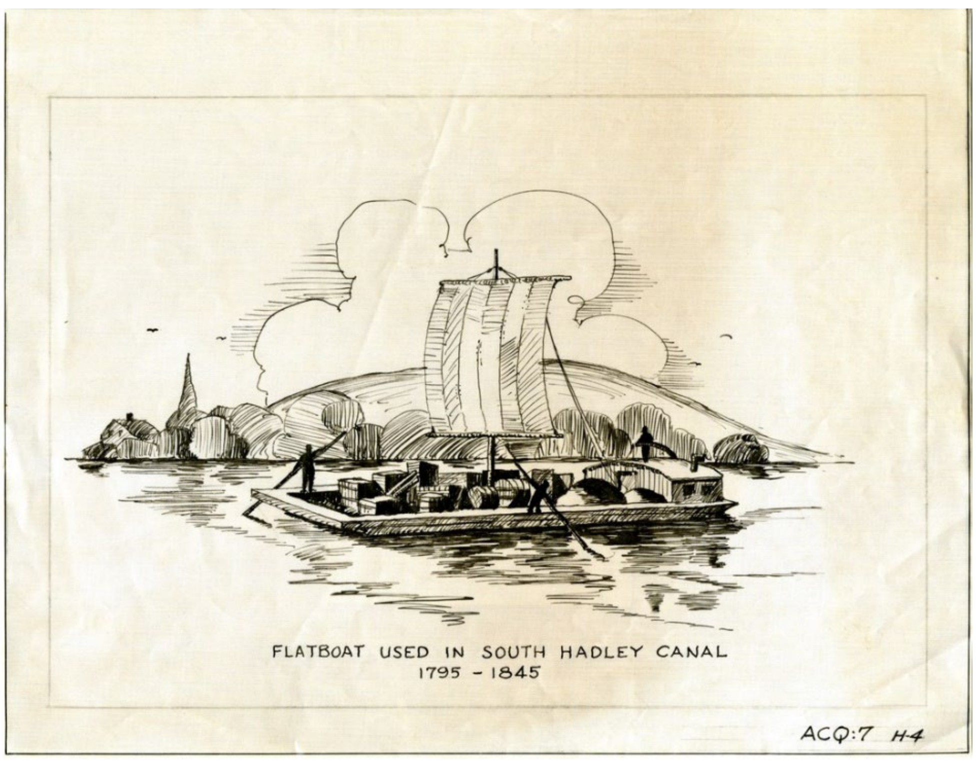

FIGURE 18. Flatboat barge in South Hadley, Massachusetts, under full sail (South Hadley Historical Society).

The recognition of these modifications is critical for the future examination and identification of these vessels. While flatboat construction is simple to identify, the use of a particular flatboat is hidden in the modifications made in addition to the basic design. Each of the modifications above can give clues to how that flatboat was used, which gives archaeologists a better chance at identifying the vessel and understanding the context in which it was used.

Chine-girder Heritage and Use

While the origins of the chine-girder design are still debated, authors like Mark Newell suggest that the design came across the Atlantic with immigrants and the enslaved. The inland waterways and the production of rice in West Africa were remarkably similar to the environment of the Southeast. As rice was commonly cultivated in West Africa on the “rice coast” (modern day Senegal, Sierra Leone, and Liberia), many of the enslaved Africans sold to plantation owners in the South had a familiarity with rice culture (Littlefield 1981:34-36). In his study of enslaved Africans brought into the Carolinas, Daniel C. Littlefield found that over 43% of enslaved Africans came from rice producing regions (Littlefield 1981:86; Fields-Black 2008:161-186). Other areas where flatbottomed vessels were constructed include Northern Europe, where shallow waterways were frequent. The idea that chine-girders were the logical next step from the dugout, which already had a heavy presence in North America, is another suggestion. Despite the debate, chine-girders have existed in North America in some form from the 17th century until modern, metal vessels began to proliferate (Hocker 1991:50; Newell 1997:27).

Dugouts

Dugout canoes have been used in North America and around the world for thousands of years. Authors like William "Rusty" Fleetwood describe vessels that were built from a split dugout design, where timbers were placed in the center of the split girder, expanding the beam and allowing for more cargo to be floated. He suggests this design to be a "hybrid" between the Native American dugout and European designs (Fleetwood 1995:31). The merging of designs, understandings, and cultures indicate a uniquely American line of vessels that traversed the waterways of the Southeast. It is very possible that shipwrights only strove to build vessels that exceeded expectations on the shallow water that surrounded them, inventing their own designs that were not necessarily handed down through other cultures' watercraft. Regardless of the chine-girder origins, different variations of the construction technique existed in North America from the early 18th century into the late 19th century onward (Amer 1993; Harris 1992; Newell 1997; McCabe 2009).

For example, the periagua, also called periauger, pereaugur, or piragua, is a common vessel in the colonial Southeast. While the term is used to define many vernacular watercrafts in the Southeast, one definition commonly used in the Southeast is a keel log similar to dugout canoe but more "V" shaped to allow planks be added to the side to increase the freeboard (Fleetwood 1995:31-32; Pecorelli et al. 1996:22-23). In another, similar definition, a dugout is spit down the center, and timbers are placed in between to increase the width of the vessel. The latter definition nearly matches the construction of a chine-girder built flat, if only less perfected. This construction technique is credited to French Huguenots that settled in Carolina in the 1680s (Fleetwood 1995:40-41).

Steamships

If the periagua can be classified as the beginning of the chine-girder in North America, the late 19th century steamships that moved swiftly up the cool, shallow rivers of the Western United States were the ultimate modification of a simple design. As Adam I. Kane describes in his work, *The Western River Steamboat,* Western steamers had to be shallow-drafted, flat-bottomed, and "malleable" to withstand the shallow water and occasional beaching that they would undertake on the rough waters. Long, narrow flat-bottomed steamers were not only faster and handled the tumultuous currents of the Western rivers better, but they also were able to hold more cargo. However, with the added length, a new problem arose. Hogging and sagging were a frequent issue with the longer steamers, as they had no strong longitudinal support due to their lack of keel (Kane 2004:93-94). Builders attempted to fix this issue by adding keelsons or stringers down the length of the vessels, but it was not enough to hold the mass of top-heavy weight on such shallow drafted vessels.

Due to the longitudinal issues that these vessels were facing, the hard chine was a place of structural importance where they could potentially add more support. Three construction designs and methods were used to provide additional structural support: bilge keelson chines, chine-girders, and rounded-knuckle chines (Figure 19).

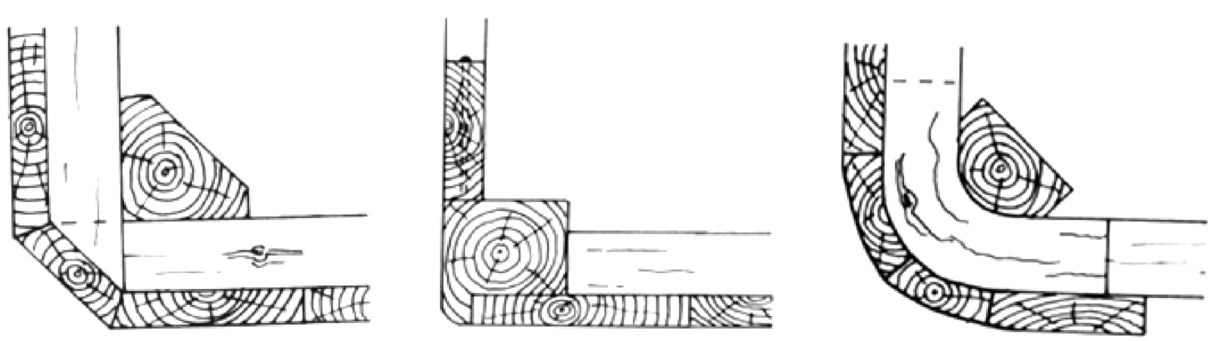

FIGURE 19. Cross-section views of "bilge keelson chine, chine-girder, and rounded-knuckle construction" (Kane 2004:100,102,104).

The latter two construction designs seen in Figure 19 are both reminiscent of chine-girder construction that can be found in vernacular watercraft of the Southeast. The chine-girder construction has a rabbet for hull planking to be inserted in, similar to chine-girders found in the archaeological record in the Southeast (Knoerl and Saldivar 2019; Newell 1997). The rounded-knuckle construction, while not as sharp of an angle as the chine-girders found on flatboats, still has the same basic principle, strengthening the chine by providing a single solid piece where the side and bottom timbers can be attached. Each of these construction methods indicate that chine-girder construction is synonymous with shallow river travel. Chine-girders provide longitudinal support that is severely lacking in flat-bottomed vessels and is not specific to the Southeast or small vessels (Kane 2004:93-94).

The study of vessels like western steamers can show researchers the variety of chine-girder use, as well as a potential connection to the origins of the construction (Kane 2004). Were chine-logs and chine-girders used in the Western rivers separately from flatboats in the Southeast? Did the construction type follow settlers to the West? The answers to these questions could potentially narrow and trace the traditional design and origins of these vessels.

Dugout canoes, other small watercraft, and large steam vessels that traversed the inland waterways were adapted to be the best vessel for their particular purpose. Each region in the world has waterways that require vessels suited for their environment, and the chine-girder is no exception. Likely evolved from numerous locations like West Africa and Europe or a progression of a craft that has existed in North America for millennium, the chine-girder built barge is a staple of the Southeast and its waterways (Newell 1997:27).

Historiography of Flatboats

The history, construction, and use of these flatboats has been outlined in few published works. As these sites are vernacular watercraft, they do not have names or blueprints like larger ships that are studied do. The best representation of how these vessels have been built was drawn by William Judd for SCIAA, as shown in Figure 20. This section will focus on the research that has surrounded these vessels archaeologically.

Archaeological Sites as Primary Sources

Much of archaeologist's understanding of flatboat construction is due to the rediscovery and research of the vessels in South Carolina. Without these sites, little would be known about the structure of these vessels as they are vernacular watercraft that were not often documented by ship builders. Currently, the states of North Carolina, South Carolina, and Georgia, have rediscovered flatboats in their inland waterways. Numerous levels of fieldwork and recording have been practiced on each of these sites, spanning from simple surveys and recording to full archaeological investigations including excavation and removal. Due to time and resource constraints, only vessels from South Carolina and Georgia will be used in this research. The following sections are a list of the sites that will be consulted in this study (Harris 1992; Newell 1991; Newell 1997).

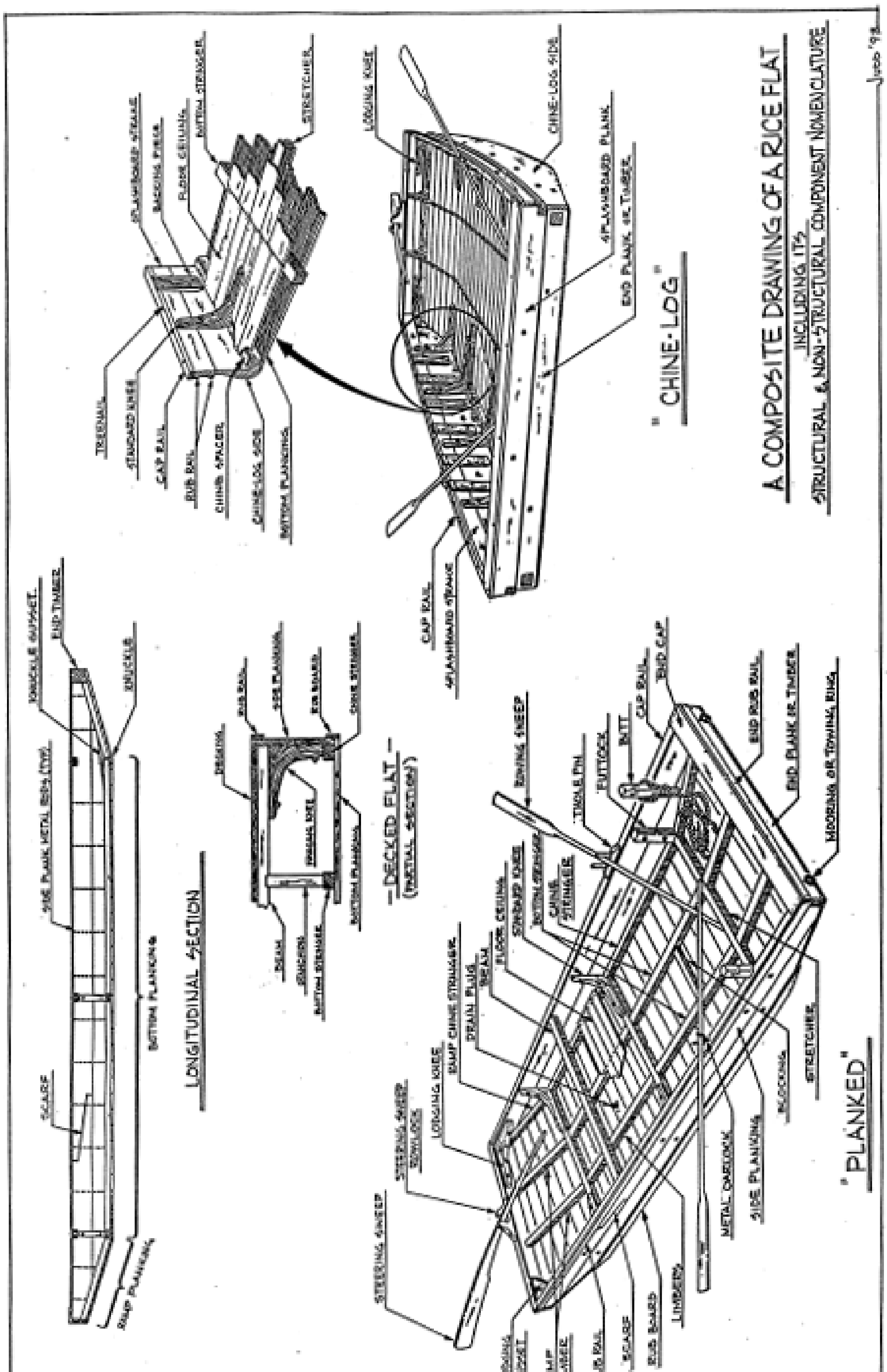

FIGURE 20. Diagram of flatboat construction, both "chine-log" (chine-girder) and "planked" (William Judd 1992).

Avant's Ferry-Black River Peg Flat

This ferry craft was found by Mark Newell during a 1985 survey of the Black River. Located near a historic ferry landing, this vessel was assumed to be a discarded ferry craft. The construction techniques and angle of the bow and stern also supports this hypothesis. Measured at 47.99ft long, the chine-girder is one of the largest found (Newell 1997:61-62). Whether or not this vessel was removed from the water is not mentioned in current sources but will be examined later.

Pee-Dee River Ferry Flat

This ferry was documented in 1986 by Mark Newell. Only a quarter of the flat was observed, as Mark Newell could not remove the wreck from the silt and mud. This flatboat has a minor difference in the construction and carving of the chine-girder; it is a "reverse adaptation" of the more commonly seen technique (Newell 1997:62-63). While the survey was short, this construction difference could provide a helpful tool in investigating the origins and methods of building a chine-girder flatboat.

Potatoe Ferry Flat

Another incomplete survey, this chine-girder flatboat was also found near a historic ferry landing in South Carolina. With a beam of only 7.34ft, the craft itself could be anywhere from 20-60ft in length (Newell 1997:63).

Conway Narrow Flat

This plantation flatboat was found in 1986 and was recorded by Mark Newell in 1987 (Newell 1992:1). In the year after it was located, it was moved into a freshwater pond near Conway, South Carolina, by the Horry County Museum. After it was moved, the craft continued to deteriorate rapidly as it was reburied by plant life. This author has doubts if it could still be found today, 35 years after its original discovery (Newell 1997:66-68).

Laurel Hill Flat- Barge #2

Reported to the South Carolina Institute of Archaeology and Anthropology (SCIAA) at the University of South Carolina by sport divers, the Laurel Hill flat was the center of a full archaeological investigation. At nearly 56ft in length, both chine-girders are impressive in size and the largest to have been surveyed (Harris 1992:25). The archaeological report written by Lynn Harris, a SCIAA underwater archaeologist at the time, provides detailed measurements, scaled sketches, and a complete artifact list. One noteworthy difference between this flatboat and the others is the abundance of iron and the height and width of the Laurel Hill flat's chine-log, which indicates a later design and construction.

Brown's Ferries No.1 & No.2

These plank-built ferries were found near a historic ferry site in South Carolina. These vessels are built without chine-girders and are assembled in a more traditional manner of boat building (Newell 1997:64-65). With complete measurements and lines drawings for each of these vessels, they will be excellent in the understanding of plank-built constructed flatboats.

Friendfield Flat

Another plank-built flat that was found in South Carolina, the Friendfield flat was a rice plantation flat that was found inside of a canal (Newell 1997:69-70).

Mepkin Mud Barge

This flatboat was also found in a canal adjacent to a rice field. The flatboat was identified as being pine and having iron fastenings. Mark Newell noted in his findings that the vessel was in such good condition that it could be floated with minimal repairs (Newell 1997:71-72). The integrity of this vessel means that detailed measurements were able to be taken, which will be helpful for further analysis.

Literature Gap Analysis

Published literature that is pertinent to this thesis spans across archaeological site reports, materials on the natural environments, experimental archaeology projects, theoretical discussions on ship construction, and primary sources from the colonial to antebellum era. Due to the rare nature of flatboats discoveries and description of their construction, pieces from many sources will have to be assembled to produce a comprehensive study of the construction and environment surrounding these flatboats. The following section will examine the gaps in the current history and understanding of flatboat construction and use, as well as why this study is necessary to deepen the knowledge surrounding these watercraft.

As seen in Table 1, few publications have mentioned flatboats in detail. Articles and books that only passively concern themselves with flatboats were not included in this analysis, as it was pertinent to show how little these vessels have been studied. The purpose of this analysis is to emphasize how these vessels have been researched before and where that research pertains. By looking at the state in which the publication pertains, how the construction of the vessel was detailed, the environmental circumstances, cultural history, and whether the vessel was excavated or reconstructed, the need for this thesis can be identified. It will be emphasized that while wooden flatboats in the Southeast have been identified and studied, further analysis is necessary to understand the odd construction techniques employed on these watercrafts.

In most cases, publications or reports concerning these vessels have been in South Carolina, as most flatboats have been found there. Unfortunately, Georgia has not had the resources to conduct the type of research and fieldwork that South Carolina has. This lack of research on the inland waterways of Georgia is a key point in this study, as flatboats were frequently used in the area and are likely to be found in the same density as in the Lowcountry of South Carolina. The single report mentioning a flatboat in Georgia is a brief field report of the state underwater archaeologist's findings of a vessel in the Altamaha River. The circumstances in which these vessels were used in Georgia has yet to be discussed thoroughly in any publication. While the research in Georgia has just begun, South Carolina's flatboats have been more thoroughly examined, which can illuminate how these watercraft would have been built and used in similar circumstances and environments in Georgia.

The environmental and cultural history, construction details, and archaeological methodologies of the wrecks researched in South Carolina supply an excellent data set to study the Oconee River flatboat. As seen in Table 1, the publications that have focused on flatboats and their uses in the Southeast have been studies that consider the environment, the cultural significance, and the construction of these vessels. Only one study includes a reconstruction: Mark Newell's "Preliminary Documentation of a Chine-girder Barge at Conway". This article and accompanying research will be heavily relied on for the methodology of experimental archaeology and the results.

Conclusion

By analyzing historical resources, the uses of these vessels, how they were built, and the need for them in the context in which they were found, answers about the Oconee River Flatboat and its construction can be uncovered. The methodologies later used will be informed by the history that has been established here, as a basic understanding of the area as well as the previous work done in the Southeast is necessary to move forward. As shown here, this study will rely on both written histories of the area, archaeological sites similar to that of the Oconee's, and past experimental archaeology conducted. The next chapter will outline the methodologies chosen based on this understanding of the history and historical research conducted in the past.

#	Author	Title	Type ie. Journal, Book, Dissertation	Year	State	Construction Details	Environmental Circumstances	Excavation / Fieldwork	Cultural History/ Possible Use	Reconstruction?
1	McCabe, Christopher P.	The Altamaha River-Harper Lake Flatboat	Report	2009	GA	X	X	X	X	
2	Amer, Christopher M.	The Malcolm Boat	Journal	1993	SC		X	N/A		N/A
3	Harris, Lynn	The Waccamaw-Richmond Hill Waterfront Project 1991	Journal	1992	SC	X	X	X	X	
4	Newell, Mark M.	The Historic Working Small Craft of South Carolina	Dissertatio n	1997	SC	X	X	X	X	X
5	Newell, Mark M.	Preliminary Documentation of a Chine-girder barge at Conway	Journal	1996	SC	X	X	X	X	X
6	Doar, David	Rice and Rice Planting in the South Carolina Low Country	Book	1932	SC	X	X	N/A	X	N/A
7	Fleetwood, Rusty	Tidecraft	Book	1992	SC	X	X	N/A	X	N/A

TABLE 1. Table showing the historical and archaeological publications mentioning flatboats in the Southeast.

Chapter 4: Model Building Results

Introduction

This chapter focuses on the results from all model building described in Chapter two. The photogrammetry model, each *Rhino* model, and the physical scale model are described in detail, with exact construction methods and discoveries outlined. The historical results in Chapter Three marked the completion of phase one. Phase Two began with the construction of three separate *Rhino* models and compared results. After the analysis, phase three (the construction of the physical model) began.

Photogrammetry Models

The first step in the model building process was creating a strong photogrammetry model of the existing chine-girder. This process was necessary to identify any construction techniques or minor details in the shape of the timber that could not be identified with hand measurements. A scaled photogrammetry model also ensured that any measurements that were missing or in question could be retaken at any moment with access to the photogrammetry software. This was particularly helpful during construction of the *Rhino* models, as many small measurements that were of concern to the construction of the theoretical model could be checked multiple times. Two separate attempts were made to create a viable photogrammetry model: the first using old photogrammetry methods, which produced poor results, and the second using Kotaro Yamafune's newest methodology, which produced excellent results that were appropriate for scientific data.

The first photogrammetry model, while largely a failure, did show interesting features of the vessel that were not originally noticed during inspection when first measured, or even when it was moved into its new location at the Georgia Southern University Museum. Once the timber could be seen in a virtual model that was easily moveable, a drastic curvature in the side wall of the chine-girder was apparent (Figure 21). Hand measurements of the timber did not identify this curvature, and it cannot be seen unless previously known about when looking in person due to the small curve and the length of the timber.

FIGURE 21. Photo of photogrammetry model of chine-girder with white line indicating the curvature of the gunnel (Image by Alyssa Saldivar).

The second photogrammetry model was far superior to the first. This model shows minor details of the vessel that would otherwise be lost due to decay over time, as well as scaled measurements that were accurate to half an inch (1cm). This model was created using Kotaro Yamafune's methodologies that this author learned through an intensive ten-day workshop with the South Carolina Institute for Archaeology and Anthropology's (SCIAA) underwater archaeologists. The workshop focused on creating scientifically accurate models that could be used as data in place of the physical object, which was directly applicable to this study. Using Yamafune's methods, the second photogrammetry model's accuracy far surpassed the original model, which was made nearly obsolete with the development of the second.

The few advantages of having two photogrammetry models that were created from two separate photographic datasets was the ability to compare the deterioration between the models. While the first model could not be used to take accurate measurements, the photo stills that were used to create the model were a good depiction of the visual condition of the timber. The two photographic datasets were taken nine months apart, and even in that short period of time, there are differences in the cracking and decay of the timber. As a large and awkward piece of wood, the timber is exceedingly difficult to navigate around without risk of damage in its current location. Even the process of photogrammetry was damaging to it, as each time the timber needed to be flipped for a full view, small pieces of wood 1-3in (2.5-7.6cm) would be dislodged and fall to the ground. With the completion of these models, movement of the object for examination and study is needed far less, as researchers have the ability to rotate, zoom in, and examine the model in AgiSoft. Given the rare design of this timber, having a computer model of it also allows researchers to understand the construction of the timber with ease, instead of relying on photographs that do not capture the complexity of the object.

Rhinoceros 7 Models

The three models that were built in *Rhino* each gave insight into the type of construction processes that could have been used to build this vessel. Each were chosen after analyzing the historical research and determining how this vessel would have been constructed given the location, type of wood used, and its intended purpose. This section will discuss each of these models, and why they were either dismissed or chosen as a viable option of design.

Preparing the Chine-girder

Uploading the photogrammetry model into *Rhino* was a relatively simple process. Once it was placed inside the software, it could be scaled accurately to the physical measurements. The length of the timber was scaled to the actual size, and each measurement was then checked against measurements taken in-person. In nearly all cases, the difference in measurement was less than an 1/8 of an inch (0.3cm). Of course, the timber's photogrammetry model would not be what the original construction of the timber looked like, as time had taken its toll on the wood.

As previously mentioned, the chine-girder had a slight curve in the hull, where it was either pushed inwards by the force of water rushing over the site for years or a construction factor that was seen in other experimental models (Newell 1997:83). The deterioration of the vessel over time means that the experimental model could not be built off the timber as it was in the photogrammetry model. The chine-girder needed to be changed to resemble what it would have looked like at the time of construction, which could be easily completed in *Rhino*. After discussion with Mark Newell, it was decided that the original builders of this vessel would have chosen to use the imperial measurement system, so each measurement was rounded to the nearest 1/8(0.3cm) or 1/4(0.6) of an inch in *Rhino* to make the reconstruction easier. However, rounding turned out to be unnecessary in many cases, as while the sharp edges of the timber's original construction had been worn, the wood thickness, treenails and tholes, and rabbet thickness were all still exact in inches. In the cases where there was more deterioration, there were usually areas that were still relatively intact that had good measurement points. Looking at the timber in profile, the highest intact height and the widest intact width was what was used to create the new measurements for the *Rhino* model. From a plan view, the widest section of the shelf was used.

As the chine-girder has nothing but straight lines, it was easy to trace the lines of the photogrammetry model to create a strong and intact version of the timber using the line tool. Once an exterior outline was created of the timber, the lines were then extruded to create a 3D object of the appropriate thickness. The same method was used to create the inner outline of the chine-girder, focusing on the shelf thickness and rabbet height. After tracing and extruding was finished, the photogrammetry model could be hidden from view, leaving behind a rendering of what the timber would have looked like when it was originally built.

During the process of tracing and extruding the ramp angles on the timber, it became obvious that the ramps were angled differently from each other. Original measurements and even a thorough examination of the photogrammetry models did not show this, as the difference was overshadowed by the deterioration of the timber. The angles were 14° and 12°, only a 2° difference, small enough to not be noticed unless placed into modeling software like *Rhino*. Given the small difference in angles, this was probably not indicative of a certain end of this vessel being the bow or stern, rather a product of its vernacular construction.

Determining the width of the planking was a difficult process. Vessels built during this time may not have had consistently sized planks, as the planking would most likely have been cut by the builders themselves from trees available to them. As twenty-six treenails were still visible, the original plan was to measure the distance between each set to get an average plank width. However, due to erratic treenail placement, no average plank width could be calculated. It was determined that this sporadic placement could be the result of one of two options, or the combination of both. This first was irregular size planking throughout the vessel, which was understandable given the location of the vessel being distant from active cities would have supplied cut lumber. The second potential reason for the placement of the treenails was the vessel requiring repairs throughout its lifetime. If the hull planking was considered sacrificial, the replacement of the planks would, in some cases, require more treenails to be placed in different areas of the chine-girder. A combination of the two options is most likely the case, paired again with the amateur nature of the construction.

Given the research questions did not rely on the understanding of the plank width, consistency was chosen for ease of construction. The plank that was found embedded into the bank of the Oconee River was 10in (25.4cm) wide, which did match up with the few treenails that were consistently placed. Given these two factors, a plank width that was approximately 10in (25.4cm) was chosen. Given the width of the bottom of the timber, not including the ramps, was 205in (5.2m), planks with a width of 10.25in (26cm) each would mean twenty planks would fit perfectly. Using the same width, five planks would fit on each ramp, with a small space remaining that would have another, smaller-width plank added. With chine-girder and plank width determined, the rest of the theoretical models could be created individually.

First Model- Narrow Barge

The first type of vessel constructed in *Rhino* was a narrow quarter-ditch barge. This design was based primarily off the design and construction of the Conway Narrow Barge, which was found floating in the Waccamaw River in South Carolina. This vessel was studied by Mark Newell, who published an article on it in 1992 (Newell 1992:1). This vessel, unlike the other chine-girder built flats in South Carolina, had a beam to length ratio closer to 1:9. This is an extremely narrow vessel, most likely used for navigating narrow canals and or quarter ditches made in rice fields. The basic dimensions and construction design were mirrored from this vessel onto to Oconee River timber, changing only where the timber dictates.

Given the length of Oconee timber, the length and beam of the first theoretical vessel based around the Conway Narrow Flat's construction would be 25.68ft (7.82m) by 2.85ft (0.86m). The first step in the process of making this theoretical vessel was to mirror the chine-girder, to visualize where both would be sitting. The chine-girders were placed 6ft 3in (1.905m) away from each other, making the outer walls of each sit exactly 9ft (2.7m) apart, as shown in Figure 22.

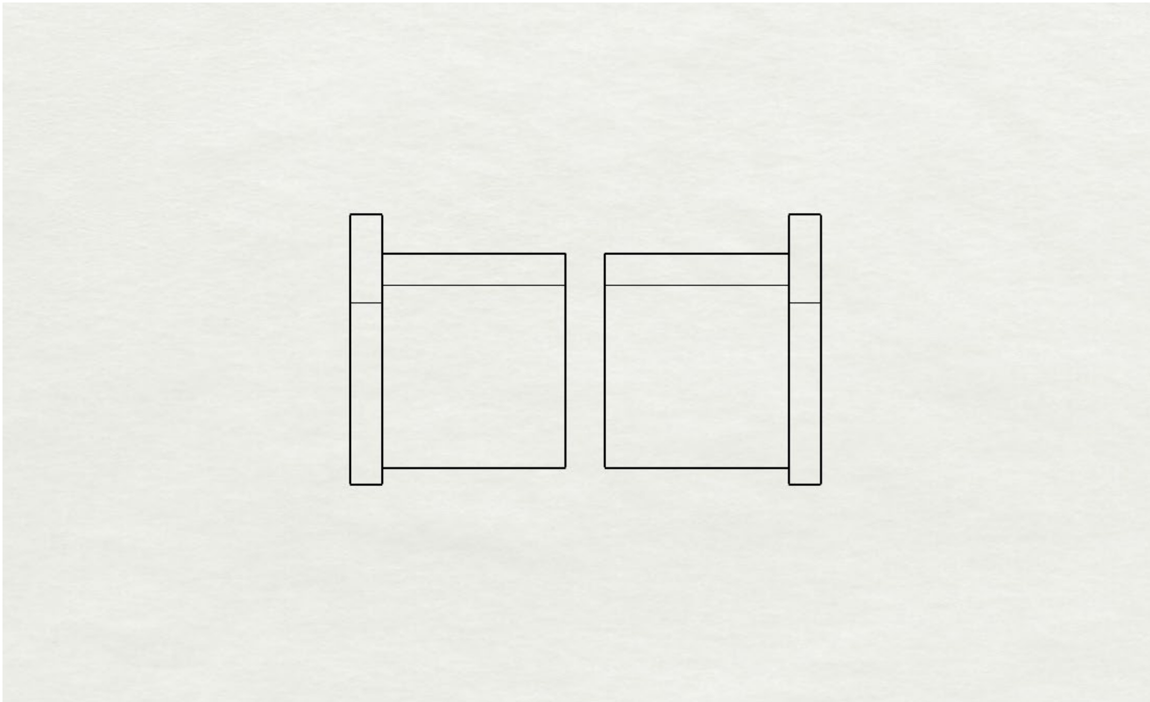

FIGURE 22. Photo showing distance between the chine-girders in the 1:9 ratio build (Image by Alyssa Saldivar).

After the chine-girders were aligned in the proper orientation, planking, knees, treenails, and header planks were added. Structural components like knees were added into this model, as they were present in the Conway Narrow Flat. However, these may be unnecessary given the vast size of the chine-girder shelf, which would easily replicate the structural integrity of the knees. If the knees are removed from the model, only the chine-girders, the outer planking, stretchers, treenails, and header planking are necessary for this vessel to be structurally sound. Once all these components were added to the vessel, a complete analysis of the first theoretical flat could take place.

The first and most obvious observation when looking at this theoretical model is the extremely narrow beam compared to the size of the chine-girders. Given the width of this vessel is less than 3ft (91.4cm), the chine-girders take up most of the floor of the vessel, the outer planking barely visible from the interior of the vessel (Figure 23 and 24). Four stretchers were chosen to provide interior structural support, placed on top of the chine-girder shelves. This would relieve some pressure from the interior of the vessel, ensuring that the chine-girders would stay upright and not tilt outwards, putting stress on the exterior planking and the treenails. With this construction, it was still very obvious that the vessel was heavily overbuilt. This size and strength of the chine-girders were unnecessary for a vessel that would have only been good as a transportation vessel in narrow rice flats.

Apart from the over-construction of this hypothetical vessel, its use as a transportation craft would not be needed in the area. During possible construction (mid-18th century), there would have been no narrow canals in this area of the Oconee River. Rice planting that necessitated such small canals and complex irrigation systems would have been over 100 miles east, in the Lowcountry of Georgia and South Carolina. The questionable construction and the location of the vessel rule out this type of vessel.

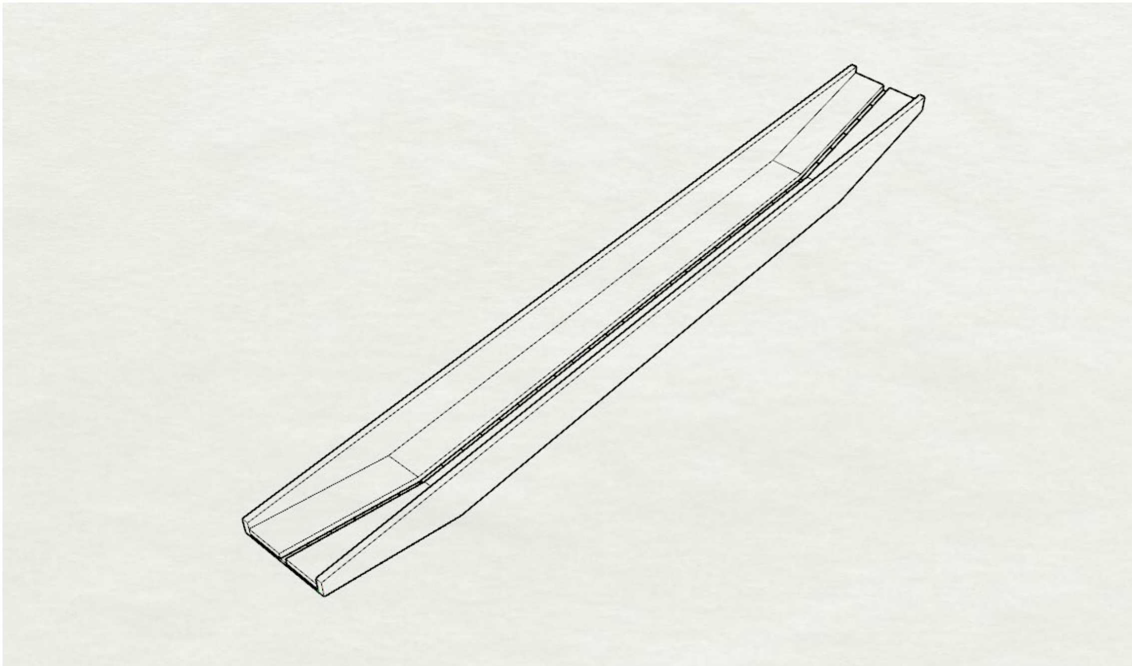

FIGURE 23. Photo showing 1:9 ratio vessel with chine-girders and hull planking in place (Image by Alyssa Saldivar).

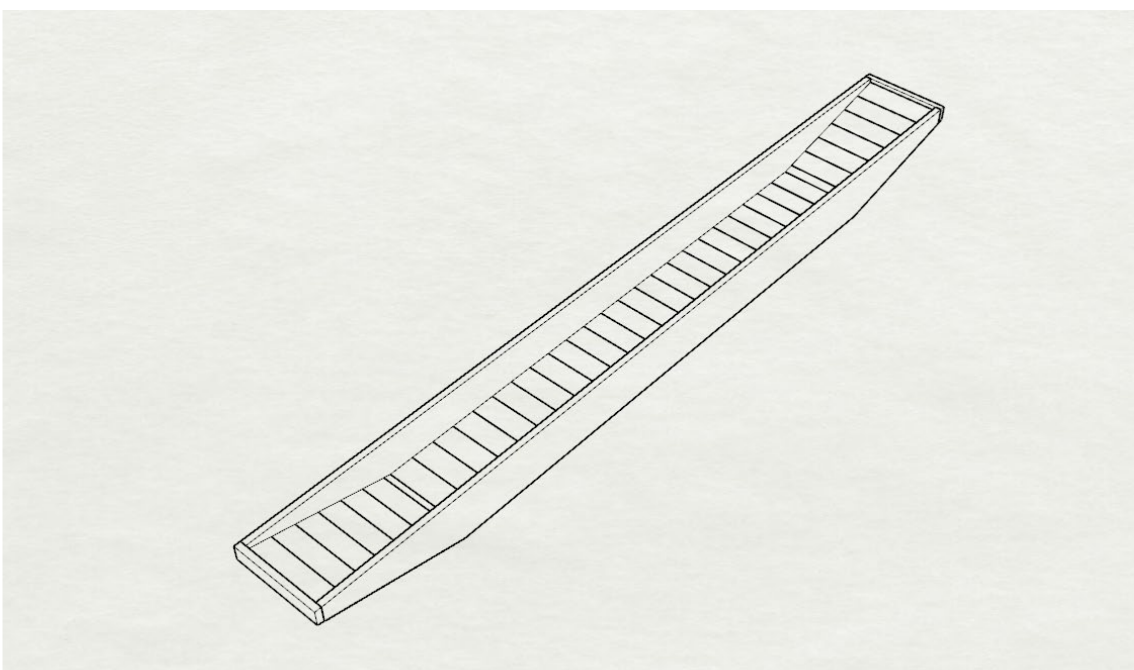

FIGURE 24. Photo showing 1:9 ratio vessel fully completed (Image by Alyssa Saldivar).

Second Model- Cargo Vessel

The second model constructed in *Rhino* was a cargo vessel that would have transported goods around the Milledgeville area on the Oconee River. This model represented a craft that was used in the riverways of South Carolina and Georgia for decades. These vessels were simple to design and could carry a large amount of cargo. While this vessel would not have been fast, it would have been easily floated down river with a full and profitable load.

Like the first model, the beginning steps were to mirror the existing chine-girder and orient them in the appropriate space based on the assumed beam measurement. Chine-girder cargo flats in South Carolina were of an average beam to length ratio of 1:3, instead of the much narrower 1:9 as seen in the first model. This beam would have been appropriate to hold cargo and would also give such a shallow vessel more balance. With a length of 25.68ft (7.82m) and width of 8.56ft (2.6m), this vessel would have been extremely stable as a simple box-shaped flat.

Once the chine-girders were placed so the outer walls of each were exactly 8.56ft (2.6m) apart, the rest of the vessel could be constructed around it. The exterior planks (Figure 25) were added to the bottom of the flat, and treenails were placed following the pattern found in the actual Oconee River timber. Stretchers and knees, a chine-spacer, and header logs were all added into the interior for heavy structural support.

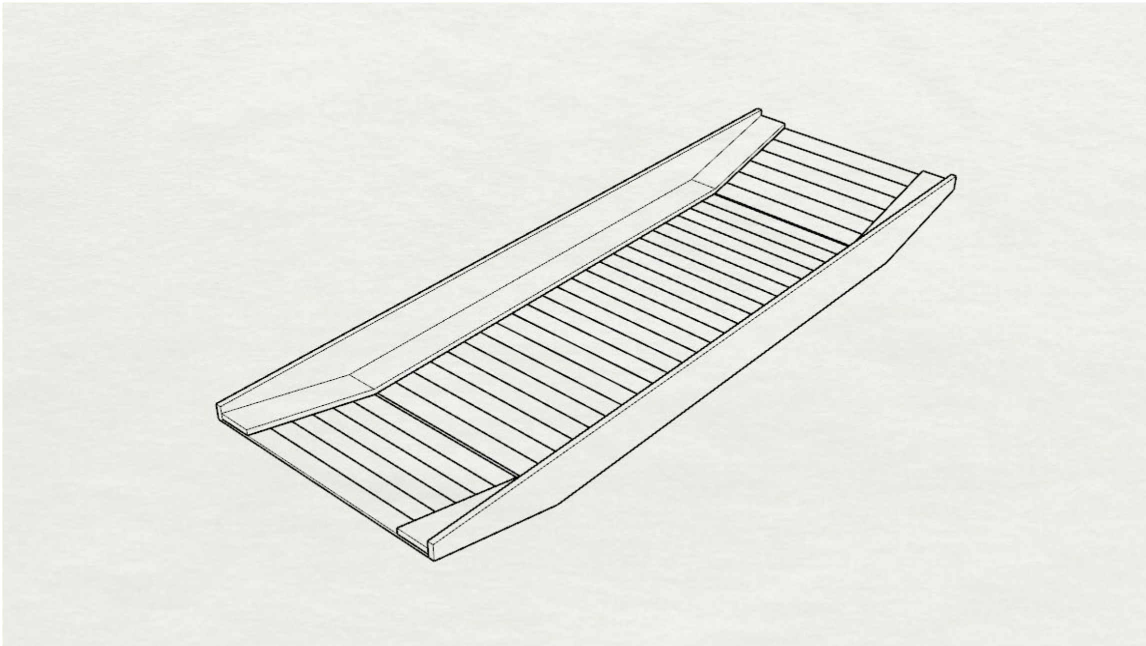

FIGURE 25. Photo of 1:3 ratio cargo vessel with hull planking (Image by Alyssa Saldivar).

When completed, this vessel had a more symmetrical and appropriately constructed design than the first model. However, it still had many of the same issues, the most apparent being that it was still relatively overbuilt for the needs of the vessel. Again, the width and longitudinal strength of the shelves of the chine-girders make the knees in this model obsolete. The stretchers that were added into the first model were also added into this one, though they were longer to compensate for the wider beam of the vessel. This vessel (shown in Figures 26 and 27) looks very similar to that found in Willam Judd's drawings, as shown in Figure 20, the largest difference once again being the size of the chine-girder shelf. While this model is more visually pleasing than the first, much narrower model, it also has problems of its own, once again, centering around the overbuilt construction design of the vessel. The chine-girder shelves are still much larger than those found on similarly built vessels of the time.

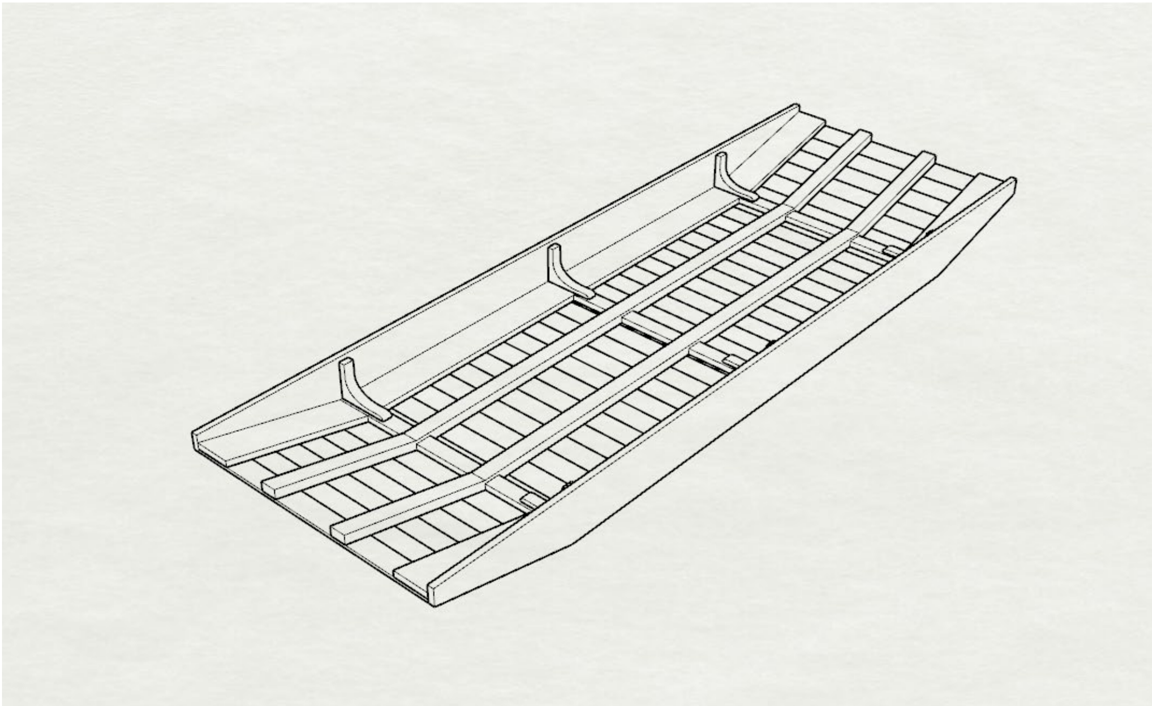

FIGURE 26. Photo of 1:3 ratio cargo vessel with knees, stringers, and stretchers (Image by Alyssa Saldivar).

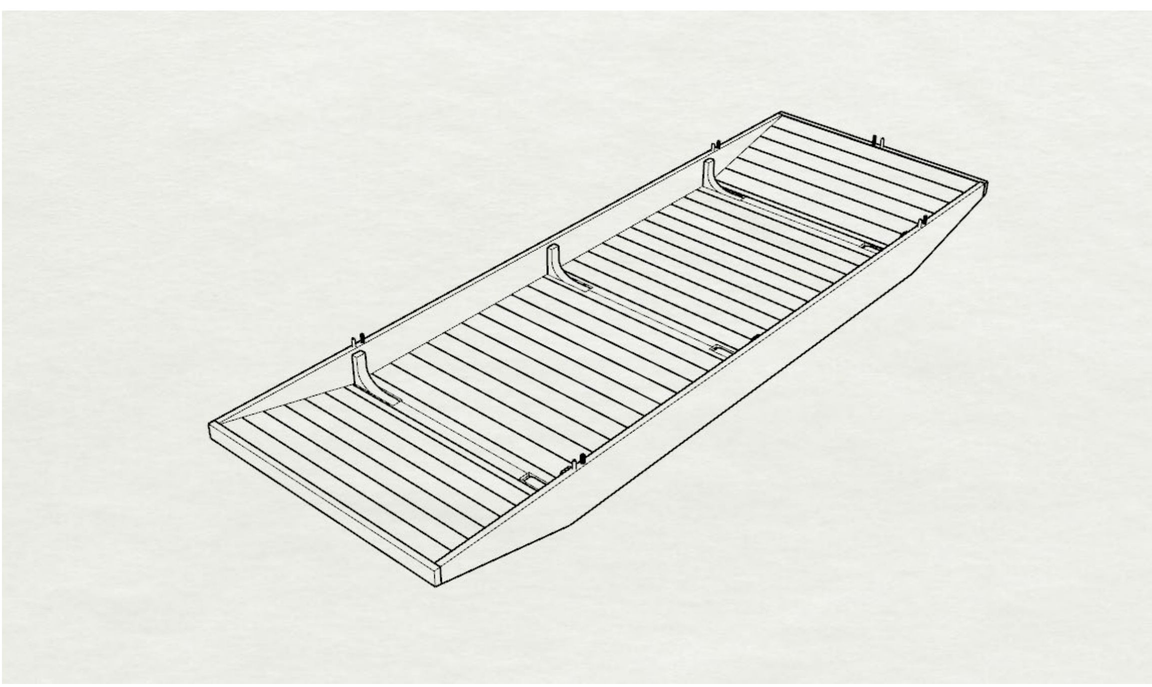

FIGURE 27. Photo of 1:3 ratio cargo vessel completed with visible knees and ceiling planking (Image by Alyssa Saldivar).

Third Model- Ferry

The third model built was a ferry flat. This would have been used for people, wagons, and cargo to cross the Oconee River. As Milledgeville was beginning to grow in the mid-18th century, transportation was paramount. A ferry craft would have been necessary for the everyday function of the small city. It was determined that this vessel's internal structure would differ from those before, as it would be large enough to support objects like wagons and animals. To ensure that the strength of the vessel was enough to transport these large and heavy objects, it was built with the approval of historian and boat builder William "Rusty" Fleetwood. In email correspondence, the exact measurements of this vessel were communicated with him, and as a skilled boat builder, he determined that given the heavy construction of the chine-girder and the added internal structural support, the vessel would have been strong enough to sustain everyday use as a ferry craft.

The construction of this vessel inside of the *Rhino* software began similarly to the other two models. The chine-girders were once again placed at a distance that was accurate to a 1:3 beam to length ratio (25.68ft (7.8m) by 8.56ft (2.6m)). Exterior hull planking was added at the appropriate length given the beam. Once the planking was all in place, two treenails were placed into the end of the plank and into the chine-girder. This happened on both chine-girders, meaning there were four treenails in each plank, for a total of 124 treenails securing the 32 exterior planks to the chine-girders. After the treenails were all placed, the interior of the vessel could be constructed.

The interior of this vessel, as a ferry craft and not a cargo or rice barge, was much different. First, no knees or stretchers would be added into this model. Instead, this model would have interior planking that sat on top of six longitudinal stringers. The stringers were placed to accommodate the average wheelbase of a carriage that would have been used in the mid-18th century, approximately 4ft (1.21m) (Hill 2013). The stringers would have been 2in (5cm) in height and 6in wide (shown in Figure 28), adding the appropriate amount of support for a carriage and any hooved animals that would be walking on the interior planking. The stringers were attached to the exterior planking with two treenails per plank, adding up to 124 treenails securing the six stringers to the exterior planking.

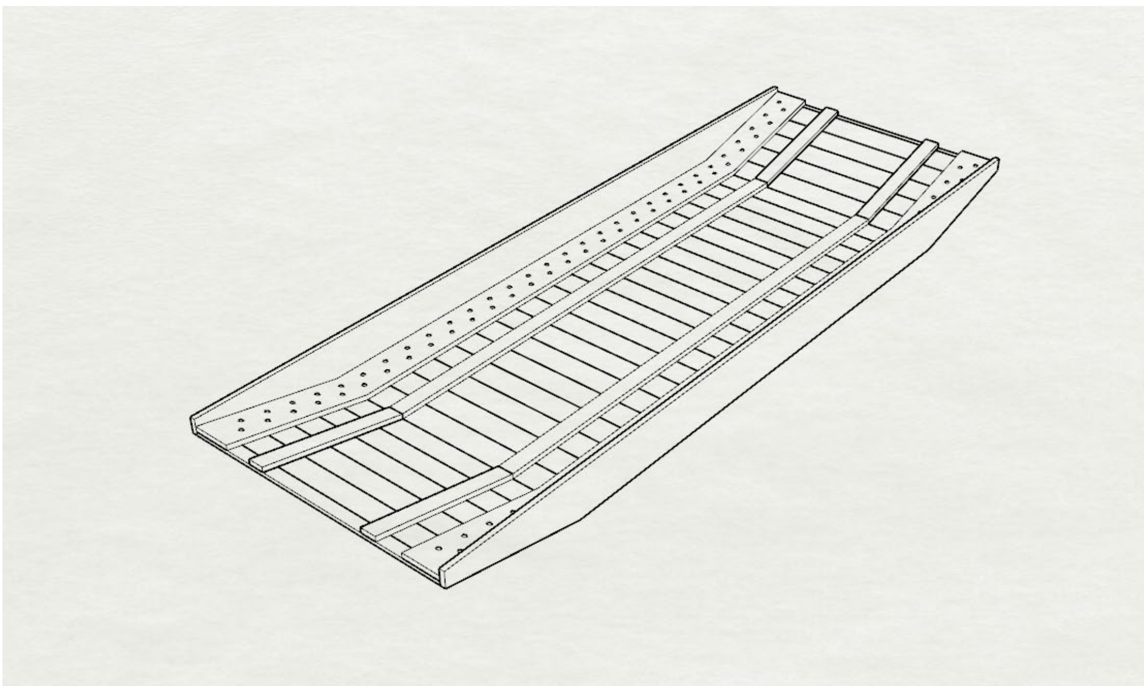

FIGURE 28. Photo of 1:3 ratio ferry vessel with hull planking held by treenails and stringers (Image by Alyssa Saldivar).

Interior planking was the next step in the process, each plank once again a width of 10.25in (26cm). Again, 20 planks would have lined the flat section of the vessel, and five more would be on each of the ramps, with remaining space for a smaller cut plank. The interior planking would not need to be as secured as the hull planking was to the chine-girders, as they would be resting on top of the chine-girders as well as the secured stringers. To secure the interior planking, four treenails were driven through the planks and the stringers sandwiched between the hull planking and interior planking, for a total 124 treenails holding the interior planking secure. After each was placed, a total of 372 treenails held the hull and interior planking to the two chine-girders and six stringers. After these steps were completed, the hull of the vessel was finished with only the finishing touches left (Figure 29).

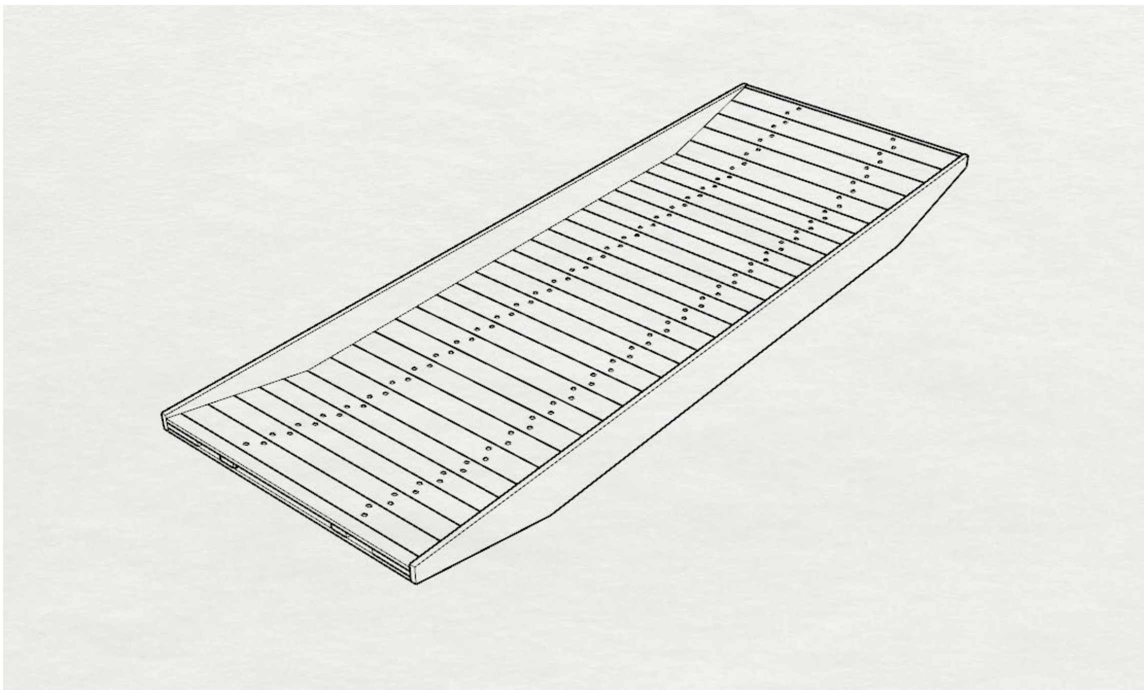

FIGURE 29. Photo of 1:3 ratio ferry vessel with ceiling planking held in place by treenails (Image by Alyssa Saldivar).

The finals steps to complete the third model included attaching the header planks and placing thole pins in the gunnels. The header planks were to cover the very ends of the vessel, as this construction would leave a two-ich gap between the hull and interior planking, where the stringers and shelves of the chine-girders resided. The plank could be a very simple addition. This author chose a 2in (5cm) wide plank that would cover only the planking without compromising the use ramps. If the planking was placed too high, carriages and animals would have a difficult time rolling and walking off the ferry. Four treenails would hold each of the header planks in place, hammered into the chine-girders. The chine-girders would also have eight more holes drilled into their gunnels. The location of each is based on the remnants of thole pins found in the original timber. The original timber had two pairs of thole pins placed at either end of the gunnel. This would have been ideal placement for oars or sweepers. These last pins marked the completion of this model. This model was officially chosen as the best choice of vessel type given the area the vessel was located in, the construction techniques, and the size of the timber itself (Figure 30).

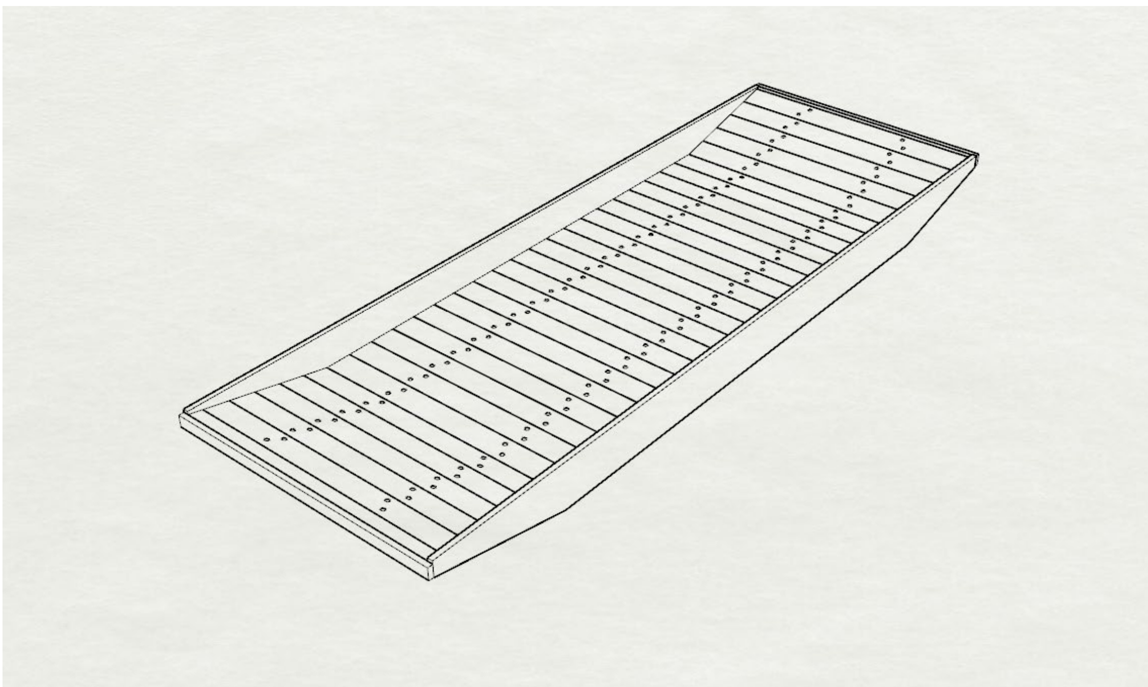

FIGURE 30. Photo of 1:3 ratio ferry vessel with ceiling planking held in place by treenails (Image by Alyssa Saldivar).

Physical Model

With the completion of phase two, the construction and analysis of the *Rhino* models, phase three could begin. The first decision made was the size of the experimental model. Considering the time constraints, availability of tools/lumber, lack of financial backing, and heavy contemplation of research questions, the scale in which the model was going to be built was chosen at 1:9. Each measurement was scaled, and Newell procured appropriately sized wood. To find period-appropriate wood, it was sourced from a home built in 1844, the oldest lumber that could be found in the correct size for the scale chosen. Finally, on February 24, 2023, Newell and the author were able to begin building the vessel together.

Upon arrival, Newell had precut the lumber for the chine-girders. According to Doar, the ideal construction would have been both chine-girders coming from the same tree (Doar 1936:34). This would ensure that both chine-girders would be of the same grain, weight, and pliability. However, this was not an option given the wood available. Both chine-girders would have to be carved from separate pieces of wood, which unfortunately meant that the carving techniques used had to be different for each chine-girder, as the density of the wood varied vastly between the two. However, this did provide beneficial information about the differences in densities among samples of Georgia pine.

The benefits of creating an experimental model showed themselves early. The first observation was made while preparing the chine-girder lumber. Given that the Oconee timber was one piece that included both ramps, the carving technique that was mentioned in David Doar's work and shown in Rusty Fleetwood's book showing that both chine-girders were carved from the same tree was improbable given the diameter of longleaf pine. For this process to even be possible, a tree of a substantial diameter (at least 3ft 3in (99cm)) would need to be found, as shown in Figure 31. A tree with a diameter of four feet would need 100-150 years to mature, and even in the era before the logging industry ripped through Georgia, longleaf pine trees were not necessarily large enough for this process (Central City Millworks n.d.). Other vessels found in South Carolina had chine-girders carved from cypress, a tree known for its large diameter. However, this chine-girder is one of the widest seen and would stretch even the limits of cypress growth.

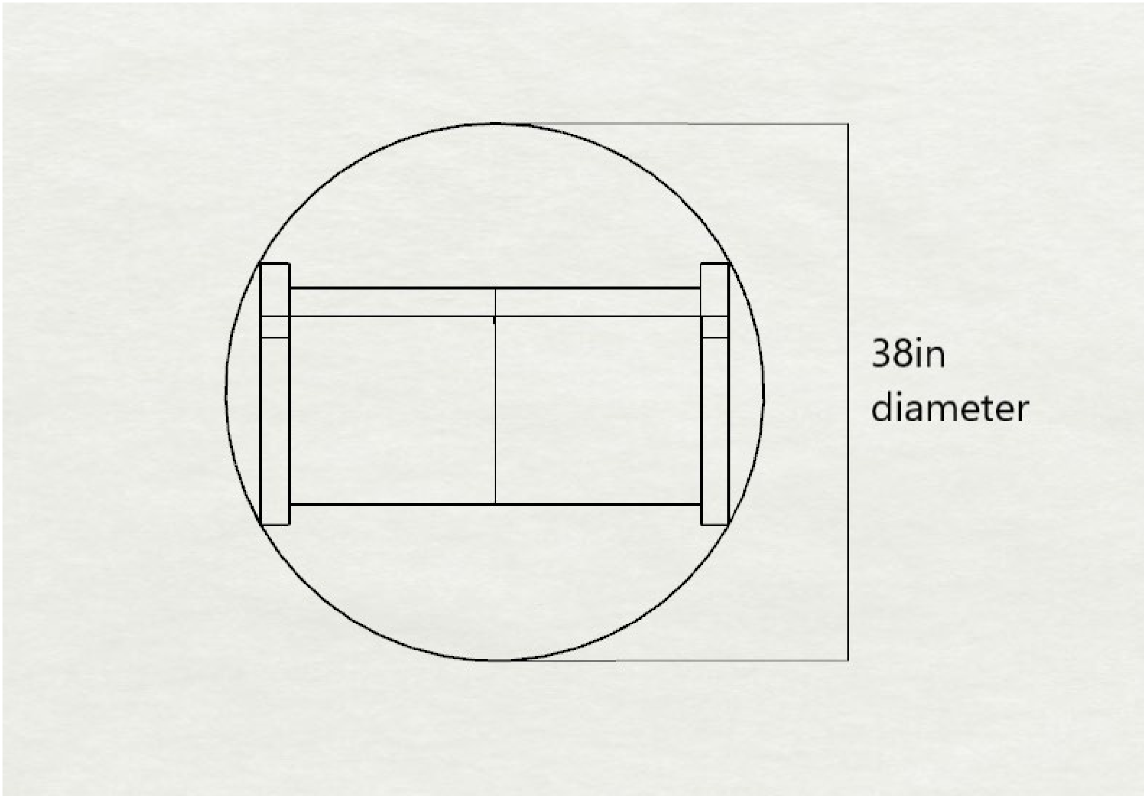

FIGURE 31. Rhino diagram showing the potential diameter of tree needed to carve two chine-girders from a single tree (Image by Alyssa Saldivar).

Regardless of whether both chine-girders were to come from the same tree, the waste of wood from carving the internal section would be significant. Given that the carbon dating identifies the construction of this vessel to be from the mid-18th century, before the development and widespread use of circular saws (Ball 1975:2), the wood carved from the interior of the chine-girder would be too damaged to be useful as planking (Figure 32 and 33). Some pieces would be able to be used for fasteners or treenails, but the carving process would leave no wood behind for planking, meaning that another source of good lumber would need to be procured.

FIGURE 32. Photo showing carving technique used for the interior of the chine-girder (Image by Mark Newell).

FIGURE 33. Photo demonstrating the large amount of waste that this technique of carving the interior of the chine-girder would lead to (Image by Mark Newell).

This waste of good material could be understood if the chine-girder's shelf was small, as seen in other vessels such as the Laurel Hill Barge No. 2 (Figure 34) but given the nearly 15in (38.1) shelf seen in the Oconee River timber, it may have been too much for a boat builder to forgive. If both chine-girders came from the same tree, there would be a significant amount of wasted longleaf pine, but if they are carved from separate trees, there would be less waste, but potential problems with changing density.

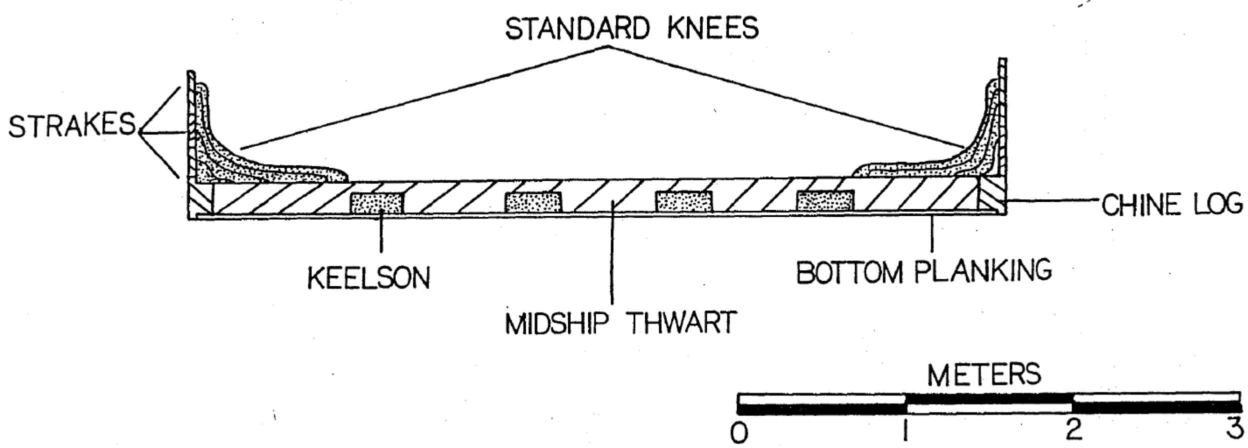

FIGURE 34. Drawing showing cross section on the Laurel Hill Barge No. 2, illustrating small shelf width of chine-girder in comparison to the chine-girder wall (Harris 1992:36).

The process of carving the interior of the chine-girders was time-consuming. The first full working day and a significant amount of the second were focused purely on carving using hand tools. The first chine-girder was carved completely using hand tools, but the second was helped along with the use of power tools to speed up the process. In hand carving the first chine-girder, many observations about the difficulty of making the interior right angle of the chine-girder were made. Even on a small scale with an appropriately sized tool, achieving a hard-ninety-degree angle where the side and shelf of the timber meet is very difficult (Figure 35). Using a hammer and chisel, small amounts of wood were pried out, but a single error in depth would injure the structural integrity of either the hull or shelf of the vessel, as a flat hole could be punched directly through the wood. As the shelf and side wall were only 2in (5cm) of easily splintering pine, a chance of damaging or cracking the hull was high at the time of vessel construction, just was it was in the replication of construction in 2023.

FIGURE 35. Photo showing the author hand carving the hard-right angle of the chine-girder (Image by Mark Newell).

The first three days were entirely consumed with the carving of these chine-girders. If too much was taken from one area, the shelf or side wall became too thin. If not enough was taken, the outer and inner planking would be placed incorrectly and would not lie flat or even above or below the shelf. The rabbet, only 3/16th inch (0.46cm) in the scale model, was difficult to carve, being almost impossible to replicate without steady hands and deep patience. However, with care, even on the small and fragile scale model, no areas of the pine split. Before construction, the team hypothesized that the wood may be too easy to destroy on such a small scale, but with delicate moves, even the thinnest of areas were able to be replicated, meaning that the Oconee River flatboat itself was possible to be carved, even with relatively unskilled hands.

Day four began with sanding the chine-girders to ensure the shelf and rabbet were smooth enough to receive the planking. After the chine-girders were thoroughly sanded, planking was cut. Taking the measurements from the *Rhino* model, 30 planks each were needed for both the interior and exterior planking for a total of 60 planks. Each of the planks were cut to meet the specifications outlined in the *Rhino* model, meaning a thickness of 1.5in (3.8cm), width of 10.25in (26cm), and a length of 104in (2.64m). Approximately 80 planks were cut to make sure that each were of the appropriate quality before they were attached to the chine-girders.

The exterior hull planking was attached first (shown in Figure 36), to replicate the steps described in Doar's work (Doar 1936:34-36). The shape of the chine-girders made this quite difficult, as standing them on their gunnels to place the planking made them very unstable. This was solved by layering scrap wood underneath each chine-girder, which provided enough support to place the planking and drill through the planking and chine-girder (shown in Figure 37). Each two holes were drilled through each side of the plank and into the chine-girder, making four treenails for each exterior hull plank (shown in Figure 38). After the 20 planks were securely attached to the bottom section of the vessel, the decision was made to attach the interior planking.

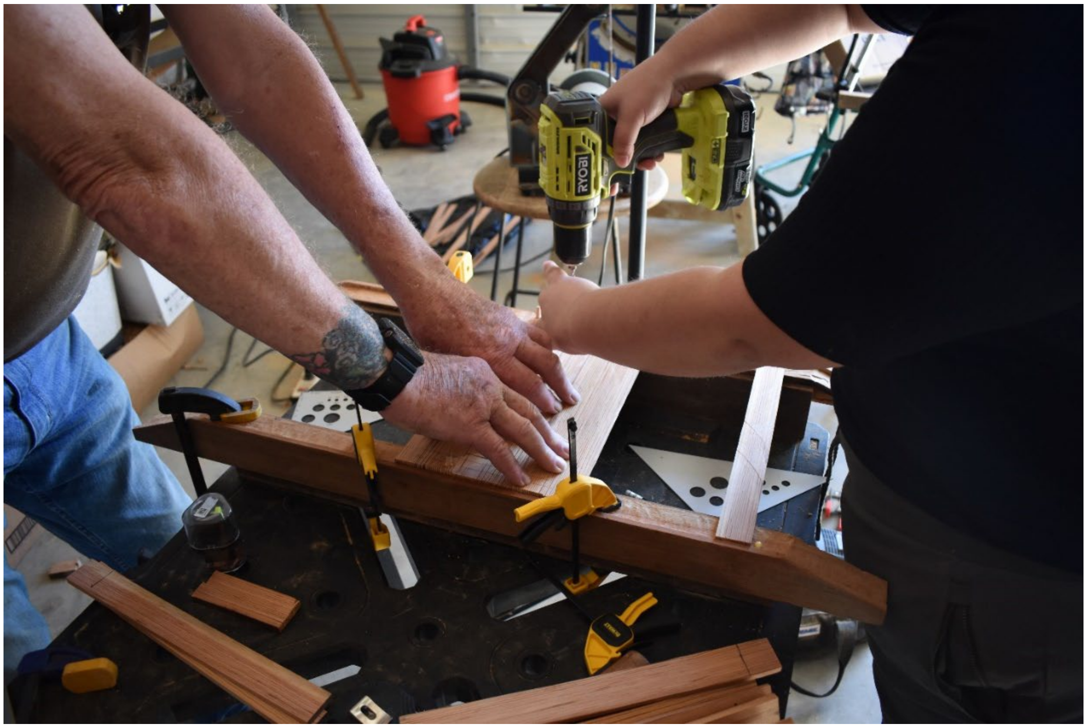

FIGURE 36. Photo showing the hull planking being placed on to the chine-girders (Photo by Michaela Hoots).

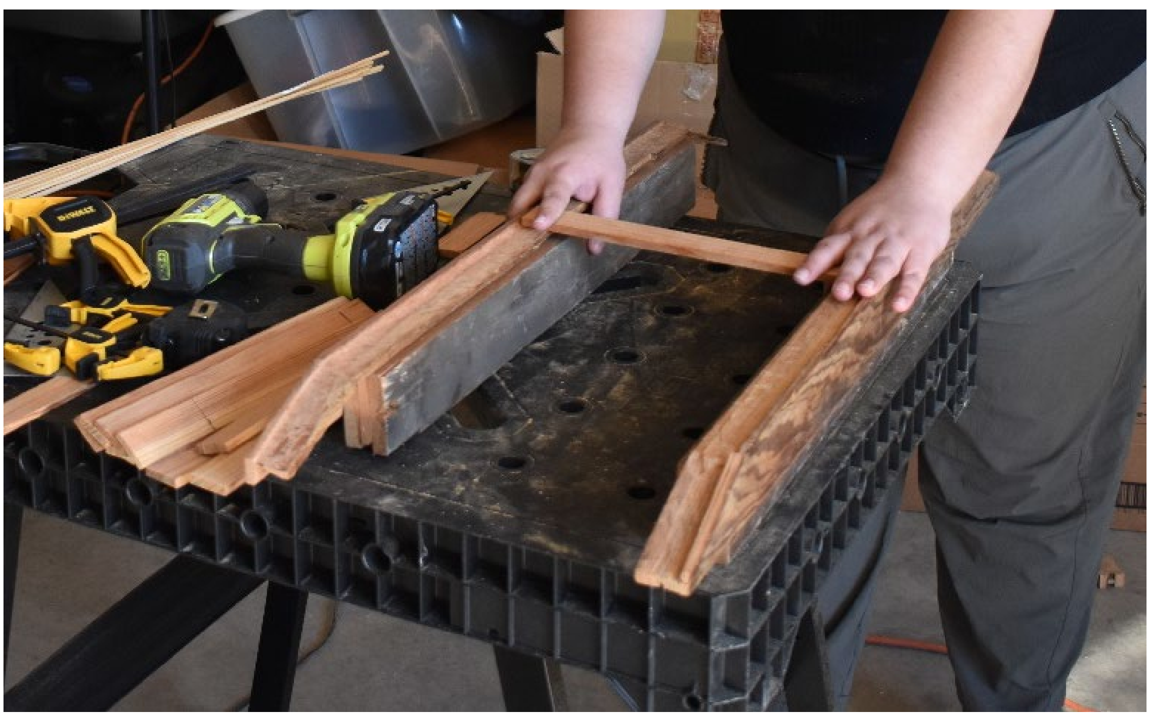

FIGURE 37. Photo showing the chine-girders placed on their gunnels so the hull planking could be laid in (Photo by Michaela Hoots).

FIGURE 38. Photo showing the holes drilled into the hull planking and the chine-girders to insert the treenails into (Photo taken by Alyssa Saldivar).

While turning a 1:9 scale model over is simple, a full-scale vessel of this size would have been very difficult to upright. David Doar outlined this process (Doar 1936:34):

> These flats were made bottom upward, so that the planks could be put on, and when finished they were pushed into the water and turned over. To do this they had an ingenious method, which was to take the flat out to the river, carry it to a deep place, fasten one end to the bank, at right angles to it, anchor or tie the other end in the stream to another flat, then throw mud on one side the whole length until that side sank and the other rose. The force of the tide would then catch and whirl it over. It was then baled and flooring put in and the head and foot timbers.

The vessel's ability to uphold during this process was heavily questioned by researchers. While completely dispelling concerns would require a full-scale model to be built and tested, the strength shown by the scale model's chine-girders, 33 planks, and 124 treenails was impressive.

Even without the stringers, internal planking, or header planking, the vessel showed no signs of shifting. Even under forced duress, the vessel showed no signs of weakness once the treenails were placed. Once wet, the treenails and wood would swell into position, making the vessel even stronger to be able to withhold the amount of pressure and weight the flipping process would inflict.

Day five began the process of adding the stringers and internal planking (shown in Figure 39). Once again following the measurements mapped out in the *Rhino* model, the stringers were cut to fit the vessel, and were added to the floor of the vessel first. Two treenails were placed in a diagonal pattern in each of the planks along the stringer, for a total of 84 treenails in the bottom planking, and 44 treenails holding the stringers to the ramps (added later). This process bled into day 6, the final day of construction. After all treenails were placed, each were sanded down to the same elevation as the chine-girders and the stringers. Once the internal structure of the vessel was sanded appropriately, the internal planking could be added to sit on top of the chine-girders and stringers.

Due to the hand carving of the interior of the chine-girders, each plank had to be either sanded or cut slightly to fit into certain sections, as no one area was as wide as the next. This technique would surely have been used for the original chine-girder as well, as the carving and the natural warping of even cut wood would require planks that fit tightly between the chine-girders. To ensure limited shift and movement of each plank, the holes for the treenails were drilled as each plank was set. Each plank was held in by four treenails placed into the stringers (shown in Figure 40), in the opposite diagonal pattern as the exterior hull planking. Five hull planks were placed on each ramp, with the same drilling process for each. The small section that was left open for a smaller plank had a plank specially cut for the perfect fit, and it was placed into the open area and attached with one treenail (Figure 41). Thirty full sized planks were used for the interior planking, with two smaller planks filling the gaps between the ramps and bottom planking.

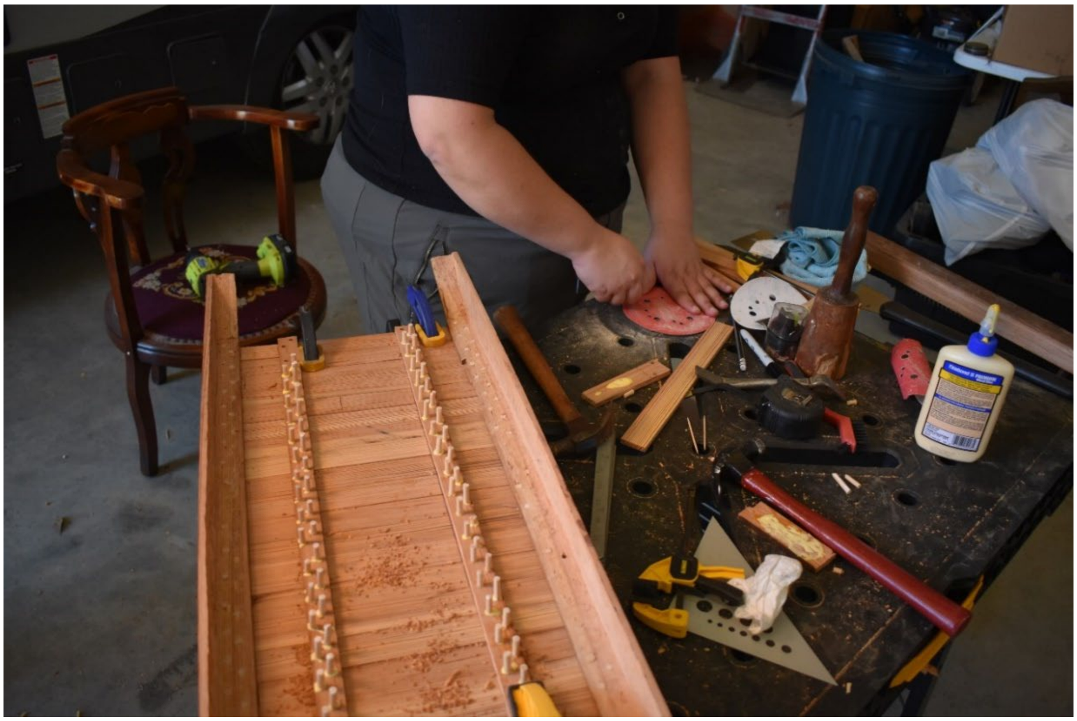

FIGURE 39. Photo showing the stringers placed on top of the hull planking, with treenails through the stringers and hull planking (Image by Mark Newell).

FIGURE 40. Photo showing the internal planking being laid into the chine-girders, and the treenails being placed as each plank was laid (Image by Michaela Hoots).

FIGURE 41. Photo showing the hull planking for the ramp attached (Image by Alyssa Saldivar).

At this stage, the main structure of the vessel was finished, with the header boards and thole pins in the gunnel the only remaining components to be built. The header boards were cut to fit on each end individually, so that the angle and attachment to the chine-girders could be adjusted for the different angles of the ramps. Each header board was attached with two treenails placed into each chine-girder. Once the header boards were placed, the whole vessel was thoroughly sanded. The interior planks were sanded so no hard edges were visible to trip on or make carriage loading difficult, and any treenails that were left with hard edges were made even with the wood surrounding them.

For the purpose of an education piece, the decision was made to leave a cutout in the interior planking so the internal components of the vessel could be seen and identified (Figure 42). If each internal plank was laid without the cutout, the chine-girder shelves and the stringers and stringer patterns would be entirely hidden. As the research questions focused on the construction techniques of the vessel, it was determined that this would be the best option for the physical model. This means that one end of the vessel is complete, while the other has been left open for educational benefit.

FIGURE 42. Photo of the near-completed scale model of the Oconee River flatboat, showing the cut-out chosen so the inside construction of the vessel could be seen (Image by Alyssa Saldivar).

Finally, the thole pins could be added to the gunnels. It was decided that due to the size and fragility of the thole pins, it would be best to only show one representation of the thole pin pairing, shown in Figure 43. One corner would be easier to protect in transport of the model. To make it appear weathered, all outer areas were lightly stained, and the vessel, as well as phase three, was complete.

FIGURE 43. Photo showing the one thole pin pairing, and the finished model (Photo by Alyssa Saldivar).

Conclusion

Each step of the model construction provided valuable understanding into the potential historic construction of the Oconee River flatboat, and was documented thoroughly through photography, as seen in Appendix C. The process of reconstruction both in the form of 3-D modeling and physical construction was extremely beneficial to understanding the steps taken by the original builders of the vessel. Without the computer models or the physical model, many clues to how these vessels were constructed would have eluded researchers. The next chapter with focus on the results of these models, and how they were used to answer the research questions originally propose

Chapter 5: Discussion and Conclusions

Introduction

By using experimental archaeology, this study provided a deeper understanding of the construction of chine-girder built flatboats. Through historical research, field work, and various forms of model building outlined in Chapter two, construction techniques used for the Oconee River Flatboats were identified and replicated. Chapters three and four both showcased the results of the research performed and what steps were taken to answer the research questions outlined in Chapter one. This chapter will conclude this study with final remarks on the construction of the models, revisit the original research question posed, and provide recommendations for the future.

Discussion of Models

The *Rhino* models of both the plank built and chine-girder built vessels will be examined to identify the differences in construction. This will include the steps involved in the construction using historical research as well as the computer and physical model building. The analysis will focus on the comparison between the separate construction techniques between the two types of vessels. After the comparison highlights the differences and similarities between the two, the usefulness of the CAD software will be analyzed so the first research question can be thoroughly answered. Then the physical model will be revisited to provide answers for the second set of research questions that involves the construction process for both plank-built and chine-girder built vessels. Here, the efficacy of experimental archaeology as an appropriate theoretical framework chosen for this study will be focused on. The results from the physical model built for this study will be compared to the plank built experimental archaeology performed by Mark

Newell described in his 1997 work. The physical construction of the models will be scrutinized for their accuracy and usefulness in answering the questions proposed in this thesis.

This study relied on the construction of multiple computer models to determine how the Oconee River flatboat was built. Each model that was built provided insight into the possible construction of the vessel, and deeply informed how the physical model construction took place. The photogrammetry models provided details that would have been otherwise missed if the *Rhino* models were based solely on measurements taken by hand. While this process cannot be continuously replicated in environments where conditions do not allow, it benefitted the final results and understanding of the Oconee River Flatboat. Without the detailed accuracy presented by the photogrammetry model, the *Rhino* models would have not been nearly as accurate, as they would have been based on hand measurements that cannot capture minute changes as a photogrammetry model can.

The *Rhino* modeling made the reconstruction of the Oconee River Flatboat based on the remnants of the vessel and the historic and archaeological research a smooth process. While a similar result could have been accomplished using hand drawings, *Rhino* modeling was able to showcase the differences in the three potential constructions of the Oconee River Flatboats side to side in 3-D. *Rhino* software was also the perfect environment for quick changes to each design as the reconstruction (both the computer and physical) developed. The final *Rhino* model that the physical reconstruction was built from will be a helpful resource for future archaeologists and historians that research chine-girder flatboats.

A physical model constructed through experimental archaeology was built using the *Rhino* models as a reference. The process of experimental archaeology used by the Viking Ship Museum, as shown in Figure 13, was closely followed to produce the best results. Excavation and study of archaeological remains, historical research, building reconstruction models, and constructing a physical model based on all past research is all outlined in this thesis. The physical model combined all the research done on the Oconee River Flatboat, and then focused on the steps of construction itself. The *Rhino* models could be built from any point and manipulated as if another section was not there, but the physical model had to follow a specific constriction pattern to produce a vessel that mirrored the final computer model. The physical construction of the vessel provided insight into how each step of the process took place and in what order. Without a physical model construction, researchers would not know how much of the vessel was assembled. While the small scale of the model meant that the full burden of construction cannot be known until a full 1:1 scale model can be built, the construction steps could still be identified.

Research Questions Revisited

Fortunately, this study could answer most of the research questions originally proposed. The Oconee River flatboat could be reconstructed thoroughly based on archaeological remains and historical research, and the construction events and techniques were identified. However, the determination of advantages and disadvantages of pine construction versus cypress construction could not be made. Due to limited resources, the model could not be built on a scale large enough to compare it to the construction of the Magnolia flat that was built by Mark Newell. While this question remains unanswered in this study, it does highlight an excellent avenue for future consideration and research.

Suggestions for Future Research

While most of the research questions were answered, more questions presented themselves as the project progressed. First, the research question that was not answered could be taken on as a subject of its own, as it would potentially require two flatboats of a 1:1 or 1:2 scale to be constructed to truly identify the construction advantages of pine versus cypress. Without recreating the construction process side by side for each type of wood, the results of a study would likely fail to answer the question. This is a task that would require an enormous amount of time, space, and financial resources to undertake.

Other avenues of research include the question of where this construction originated from. As shown in Chapter three, chine-girders and timbers that resemble them can be found in boat building from many regions such as Africa, France, and North America before colonization. A project that focused on where this type of vessel construction originated from would require the researcher to travel to these regions to work with locals, gathering oral histories and identifying construction techniques that are used to produce vessels such as the Oconee River Flatboat.

Finally, a larger field project could also be undertaken to explore the Oconee River in the area where the Oconee River timber was found. Locals like Gary Fowler report other vessels and artifacts in that area frequently, but the state lacks the resources to thoroughly investigate these reports. With a team of archaeologists, the area could be surveyed to find the remains of the missing “other half” of the Oconee River flatboat, as well as locate and study other vessels of potential importance to the maritime history of the area.

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Appendix A: Archaeological Research Permit

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
STATE PARKS & HISTORIC SITES

MARK WILLIAMS
COMMISSIONER

JEFF COWN
DIRECTOR

Archaeological Research on DNR Lands Checklist and Memorandum of Understanding

This document will serve as a checklist for the Permit Applicant's use, and as an outline of the agreement between the Applicant (who will sign as and for the Applicant and the Principal Investigator) and Georgia Department of Natural Resources (GDNR, under signing authority of the State Archaeologist) for the specific project listed. It is agreed by the parties that this document, along with the Permit Cover Letter and the Protocols for Archaeological Research on DNR Lands, constitute the entire agreement between the parties. The GDNR is authorized but not required to consider any future changes to any of these documents that may be requested by the Permit Applicant. By affixing their signatures hereto, the parties expressly acknowledge the following Permit requirements, and agree to comply with same:

Project Information:

Project Title or Description:

Oconee River Flatboat Project

DNR Property/County:

Baldwin and Wilkinson Counties

Permit Applicant(s): Alyssa Saldivar and T. Kurt Knoerl

Date: 26 June 2022

1. ***Research Design will include:***
   a. Discussion of proposed research
   b. Topographic map showing project boundaries
   c. Procedure for handling the discovery of burials & notifying State Archaeologist
   d. Discussion of field methods and extent of work to be performed
   e. Discussion of previous research, to be integrated into proposed project
   f. List of all project personnel
   g. Project timeline
   h. Detailed project budget, including funding for conservation and curation
   i. Documentation of institutional support
   j. Graduate student's thesis or dissertation chairperson letter indicating supervision of the project

2. ***Proposal review process will include:***
    a. *Three months before start date* - complete proposal submitted to GDNR
    b. Review by GDNR, appropriate outside experts, local GDNR land manager
    c. *Within 30 days of start date* - Applicant notified of proposal acceptance/denial
    d. *After acceptance and before start date* - Applicant and State Archaeologist meet to sign documents and issue permit
    e. *If not approved* - GDNR comments returned to Applicant

3. ***GDNR Project Coordination:***
    a. (After acceptance) GDNR Project Coordinator is appointed; Applicant notified
    b. (Before start date) Coordinator will contact local land manager regarding project
    c. (Before start date, and after Coordinator contact with land manager) Applicant will make access, logistical, and other arrangements directly with the local land manager. Applicant will maintain regular contact with land manager as appropriate.
    d. Every 90 days applicant will submit a succinct report on activities to Project Coordinator
    e. Applicant will maintain regular contact with Project Coordinator during project

4. ***Required Products***
    a. Every 90 days - interim reports emailed
    b. Within 30 days of fieldwork completion - field report in letter format submitted
    c. Within 1 year of fieldwork completion - draft technical report submitted
    d. Within 90 days of receiving comments on draft - final technical report submitted
    e. Within 30 days of submitting final report - documentation regarding curation arrangements submitted
    f. Within 1 year after final report is completed - abbreviated journal article submitted

5. ***General Terms***
    a. It is understood by both parties that no funding is available from GDNR for this or other projects subject to this permitting process.
    b. Applicant agrees to submit a Research Design that complies with details set forth in Protocols under "Required Components of Work Proposal," and specifically agrees to adhere to the limitations in both time and physical area of investigation set forthfor the project.
    c. Applicant agrees to undertake responsibility for properly handling the discovery of human burials, as described in the Protocols paragraph titled "Burials."

d. The parties agree that all media communication of any kind will be made through and at the discretion of the State Archaeologist. The Applicant agrees to immediately refer any media contact s/he receives to the State Archaeologist for response, and further agrees not to initiate any contact with media without first receiving authorization from the State Archaeologist.

e. The parties agree that failure to comply with the measures presented above without timely consultation with GDNR will result in refusal of future permit requests to the Applicant, Principal Investor, and any sponsors.

f. The parties agree that all reports, data, analysis, and documents developed pursuant to this contract shall be deemed to be a product of a “work made for hire”as defined by the Copyright Act, 17 U.S.C. § 101 et seq., as amended, and are therefore owned exclusively by GDNR upon creation. If any such reports, data, analysis, or documents are deemed by law not to be a “work made for hire,” any copyright and other intellectual property ownership interests are hereby assigned completely and solely to GDNR. Applicant shall execute and deliver to GDNR and cause others it may hire under this contract to execute and deliver any transfers, assignments, documents or other instruments which GDNR deems necessary and appropriate to vest complete title, ownership and interest in and to GDNR. It is understood and agreed that this provision shall survive termination of this contract, howsoever caused.

Signed in the presence of all parties, on the date first above written.

State Archaeologist:

X

Applicant:

X Alyssa Saldivar

Co-applicant(s):

X T. Kurt Knoerl

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
STATE PARKS & HISTORIC SITES

MARK WILLIAMS
COMMISSIONER

JEFF COWN
DIRECTOR

July 11, 2022

Dear Applicant:

The Office of the State Archaeologist issues this permit under the *Official Code of Georgia (OCGA) 12-3-52. Archeological exploration, excavation, or surveying; administrative appeal of department orders* for the purpose of authorizing Alyssa Saldivar, under the supervision of Dr. Kurt Knoerl, to conduct archaeological investigations on the remains of a flatboat on the Oconee River. Investigations on site will consist of partial hand excavations, non-invasive survey techniques, and wood sampling. As per 12-3-52[d](2) a research design has been submitted, reviewed, and approved by the Office of the State Archaeologist and must be adhered to by the researcher. Deviations from this plan must be approved in writing by this office. This permit is valid for 3 years from the issue date, after which a new research plan must be submitted.

Sincerely,

Rachel Black
State Archaeologist
Parks and Historic Sites Division
Georgia Department of Natural Resources

DIVISION HEADQUARTERS | 2600 HWY 155 SW | STOCKBRIDGE, GA 30281
770.389.7286 | FAX 770.389.7402| GASTATEPARKS.ORG

Appendix B: Measurements of Oconee River Flatboat Scaled

Measurement	**Full Scale**	**1:12 Scaled**	**1:9 Scaled**	**1:6 Scaled**
Thickness of side	2	3/16	4/16	5/16
Thickness of shelf	2	3/16	4/16	5/16
Overall length	312	26	34 11/16	52
Length of bottom (no ramps)	205	17 1/16	22 12/16	34 3/16
Rabbet	1.5	2/16	3/16	4/16
Planking	1.5	2/16	3/16	4/16
Height of chine	18.5	1 9/16	2 1/16	3 1/16
Width of shelf (at widest)	14.5	1 3/16	1 10/16	2 7/16
Planking width	10.25	14/16	1 2/16	1 11/16
Planking length	104	8 11/16	11 9/16	17 5/16
Overall beam	108	9	12	18
Stringer (bottom)				
Stringer length	205	17 1/16	22 12/16	34 3/16
Stringer width	4	5/16	7/16	11/16
Stringer height	2	3/16	4/16	5/16
Stringer (ramps)				
Stringer length	57	4 12/16	6 5/16	9 8/16
Stringer width	6	8/16	11/16	1
Stringer height	2	3/16	4/16	5/16
Treenails	1.5	2/16	3/16	4/16
Stringer far edges apart	48	4	5 5/16	8
Between stringers interior	42	3 8/16	4 11/16	7
Stringer placement	25	2 1/16	2 12/16	4 3/16

Appendix C: Photos from Physical Model Construction

PHOTO 1. Saldivar cutting the ramp angle into a piece of pine (Photo by Mark Newell).

PHOTO 2. Newell using a table saw to cut down the raw pine (Photo by Alyssa Saldivar).

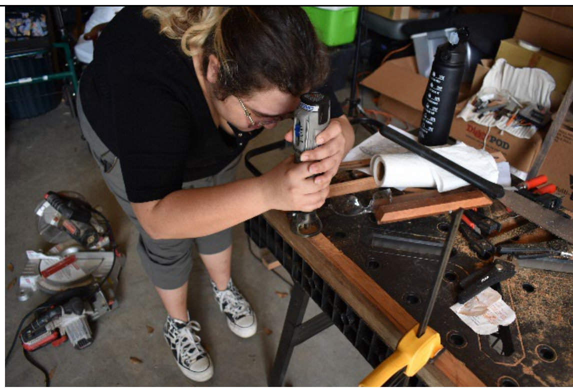

PHOTO 3. Saldivar using a Dremel to cut the rabbet into the bottom of one of the chine-girders (Photo by Mark Newell).

PHOTO 4. Saldivar using a hammer and chisel to cut the rabbet of the chine-girder (Photo by Mark Newell).

PHOTO 5. Saldivar using a hammer and chisel to cut a hard-right angle into the rabbet of the chine-girder (Photo by Mark Newell).

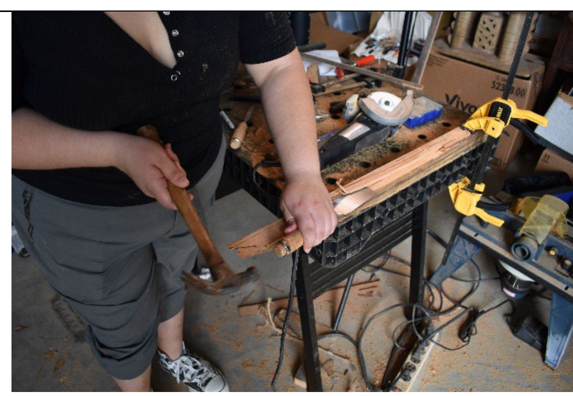

PHOTO 6. Saldivar using a hammer and chisel to carve out the interior shelf of the chine-girder (Photo by Mark Newell).

PHOTO 7. Saldivar using a hammer and chisel to carve out the interior shelf of the chine-girder (Photo by Mark Newell).

PHOTO 8. Saldivar using a Dremel to carve out the interior shelf of the chine-girder (Photo by Mark Newell).

PHOTO 9. Newell using a hammer and chisel to carve out the interior shelf of the chine-girder (Photo by Alyssa Saldivar).

PHOTO 10. Saldivar using a carving tool to carve out the interior shelf of the chine-girder (Photo by Mark Newell).

PHOTO 11. Saldivar using a carving tool to carve out the interior shelf of the chine-girder (Photo by Mark Newell).

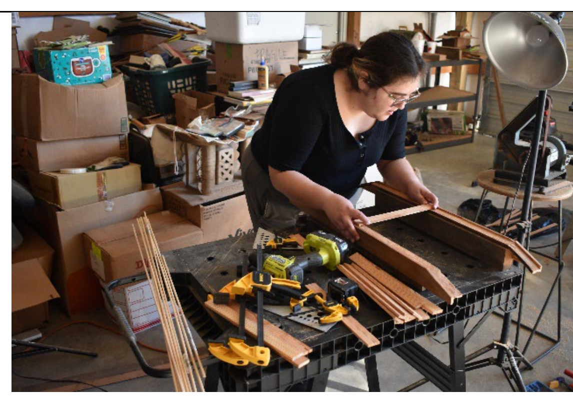

PHOTO 12. Saldivar setting the hull planking into the rabbets of each chine-girder (Photo by Michaela Hoots).

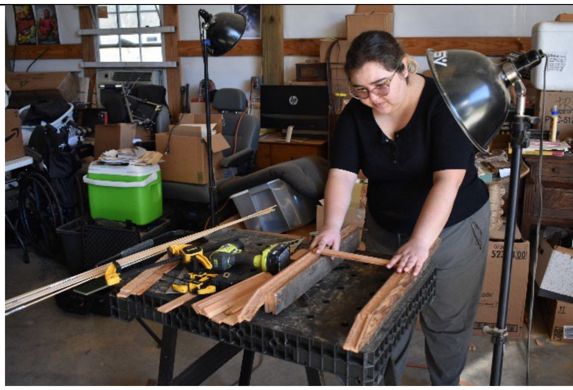

PHOTO 13. Saldivar setting the hull planking into the rabbets of each chine-girder (Photo by Michaela Hoots).

PHOTO 14. Saldivar and Hoots setting the hull planking into the rabbets of each chine-girder (Photo by Mark Newell).

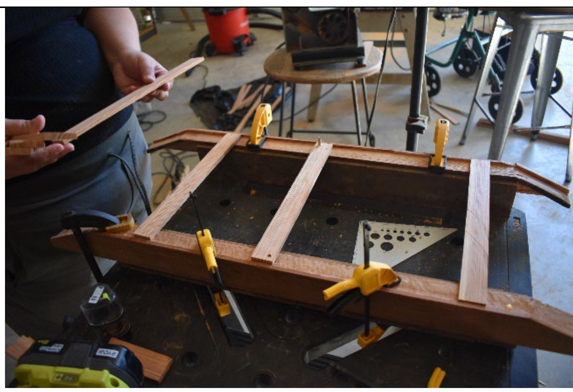

PHOTO 15. Saldivar setting the hull planking into the rabbets of each chine-girder (Photo by Michaela Hoots).

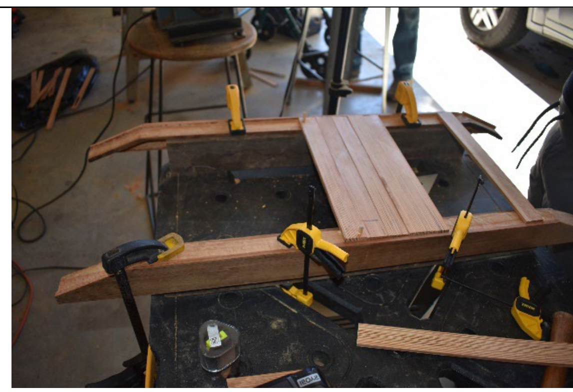

PHOTO 16. Scale model upside down showing the exterior planking being added (Photo by Michaela Hoots).

PHOTO 17. Saldivar and Newell drilling into the exterior planking and chine-girder to add treenails (Photo by Michaela Hoots).

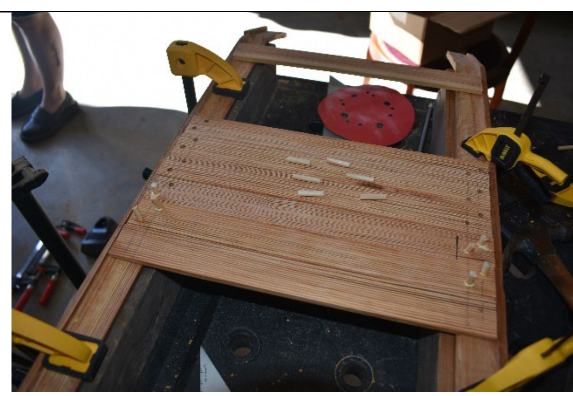

PHOTO 18. Scale model upside down showing treenails being driven into planking and chine-girder (Photo by Alyssa Saldivar).

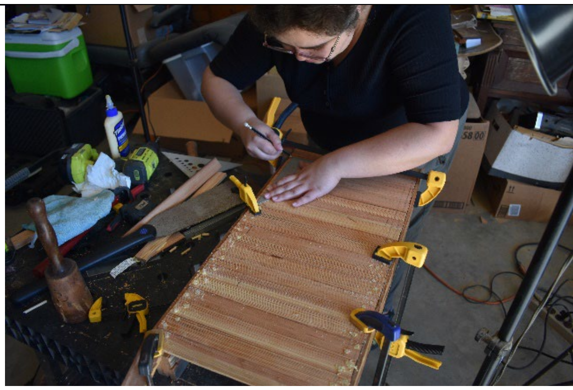

PHOTO 19. Saldivar marking the location of where holes will be drilled for treenails (Photo by Michaela Hoots).

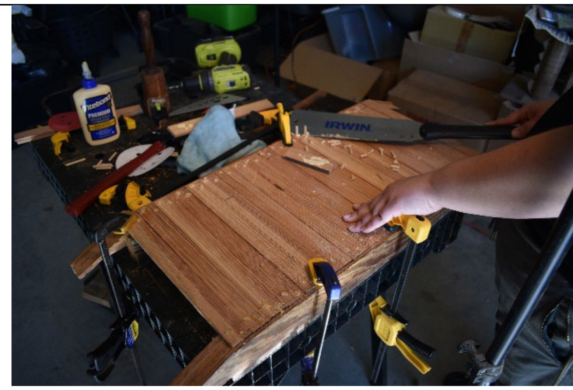

PHOTO 20. Saldivar cutting away excess treenail length (Photo by Michaela Hoots).

PHOTO 21. Chine-girder resting on its bottom, exterior planking for ramps not added (Photo by Michaela Hoots).

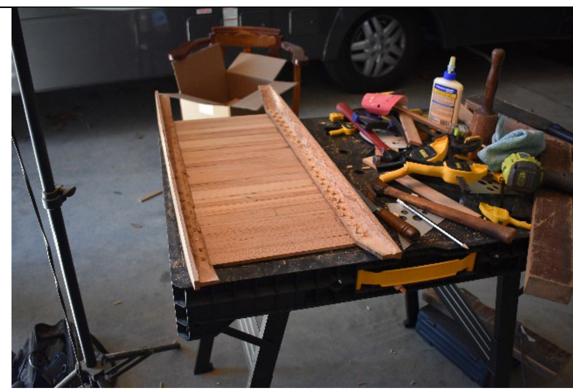

PHOTO 22. Chine-girder resting on its bottom, exterior planking for ramps not added (Photo by Michaela Hoots).

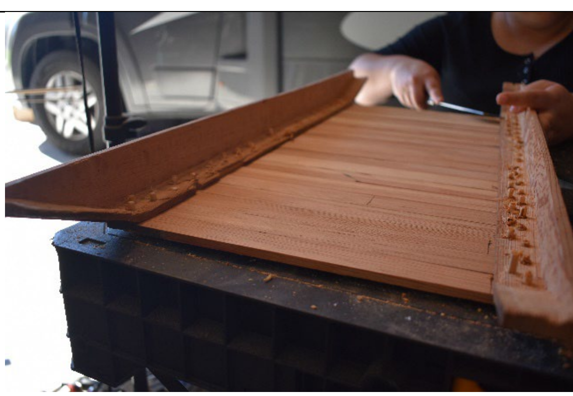

PHOTO 23. Chine-girder resting on its bottom, Saldivar trimming treenails (Photo by Michaela Hoots).

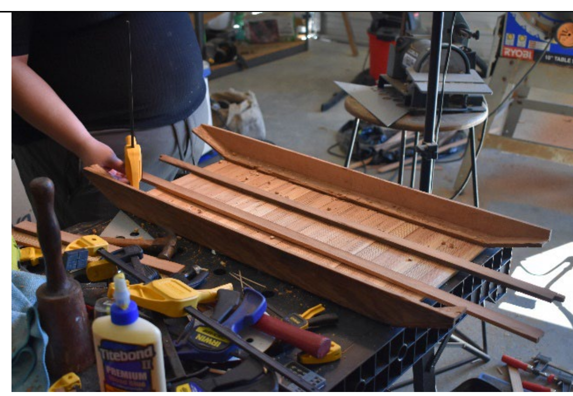

PHOTO 24. Stringer pieces being measured to be fastened to exterior planking (Photo by Michaela Hoots).

	
PHOTO 25. Saldivar measuring a marking where the stringer pieces should rest (Photo by Michaela Hoots).	PHOTO 26. Stringer pieces in place and fastened to exterior planking with four treenails for each plank (Photo by Michaela Hoots).
	
PHOTO 27. Stringer pieces fastened by treenails (Photo by Michaela Hoots).	PHOTO 28. Saldivar sanding down excess treenail stubs so interior planking can lie flat (Photo by Michaela Hoots).
	
PHOTO 29. Photo showing difference between sanded treenails on stringers and un-sanded (Photo by Michaela Hoots).	PHOTO 30. Interior planks being laid into flatboat, resting on chine-girder shelves and stringers (Photo by Michaela Hoots).

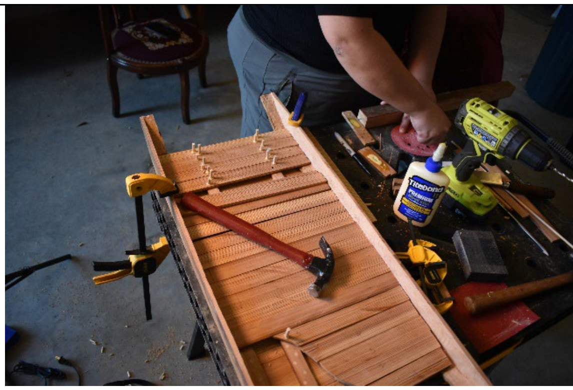

PHOTO 31. Saldivar sanding treenails to inset into interior planking and stringers (Photo by Michaela Hoots).

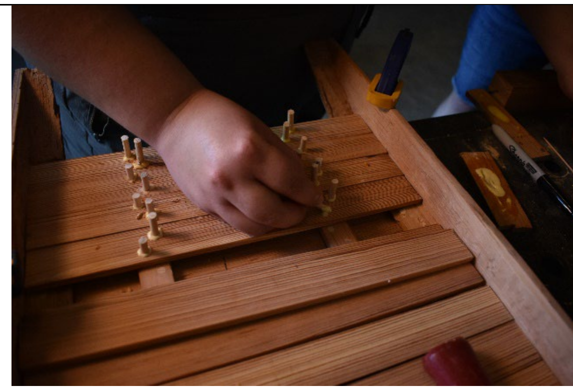

PHOTO 32. Saldivar inserting treenails into interior planking and stringers (Photo by Michaela Hoots).

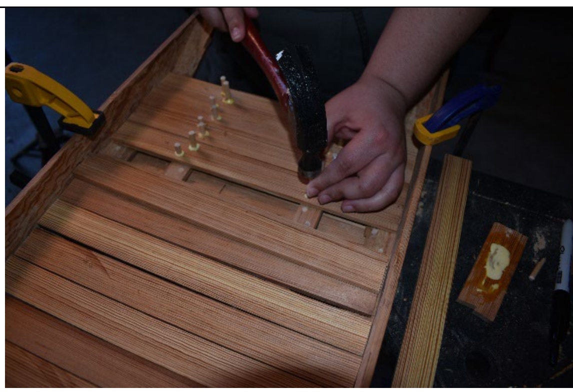

PHOTO 33. Saldivar hammering treenails into interior planking and stringers (Photo by Michaela Hoots).

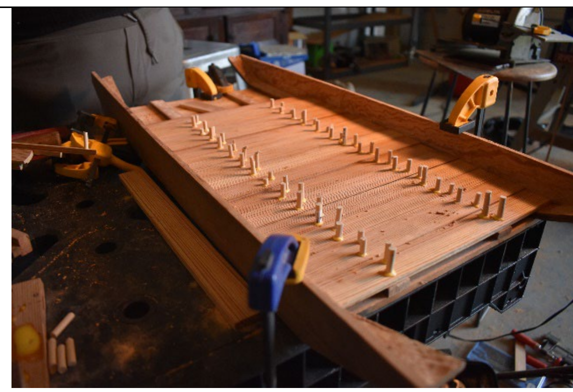

PHOTO 34. Photo showing treenails inserted into interior planking and stringers (Photo by Michaela Hoots).

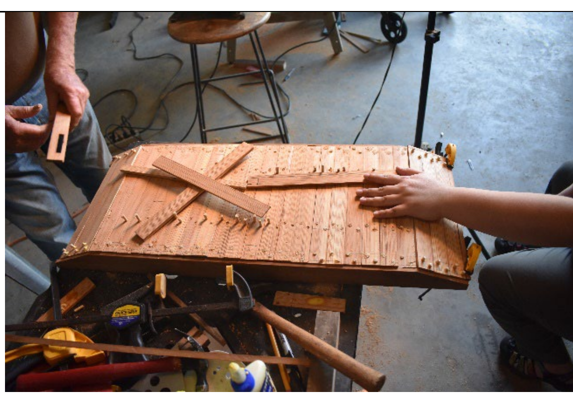

PHOTO 35. Saldivar and Newell fitting exterior ramp planking to the vessel (Photo by Michaela Hoots).

PHOTO 36. Photo of finished exterior planking (Photo by Michaela Hoots).

PHOTO 37. Saldivar and Newell sanding down treenails on exterior planking (Photo by Michaela Hoots).

PHOTO 38. Photo showing completed exterior planking (Photo by Michaela Hoots).

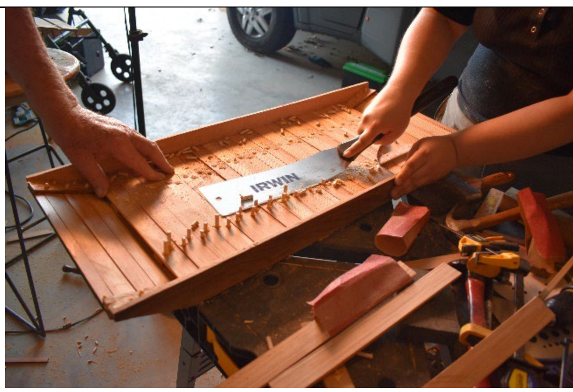

PHOTO 39. Saldivar and Newell trimming excess treenails from interior planking (Photo by Michaela Hoots).

PHOTO 40. Photo showing the bottom interior planking, the ramp planking still unfinsihed (Photo by Michaela Hoots).

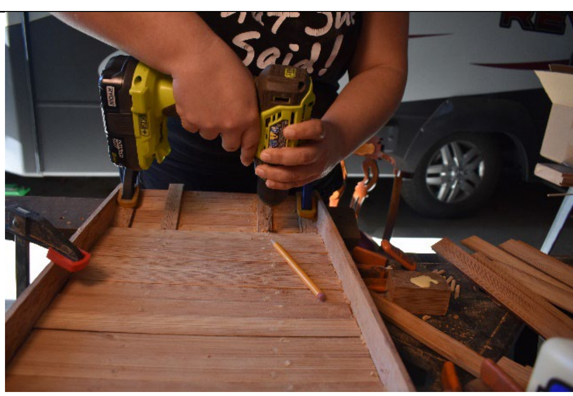

PHOTO 41. Saldivar drilling holes into the ramp stringers to add the interior ramp planking (Photo by Michaela Hoots).

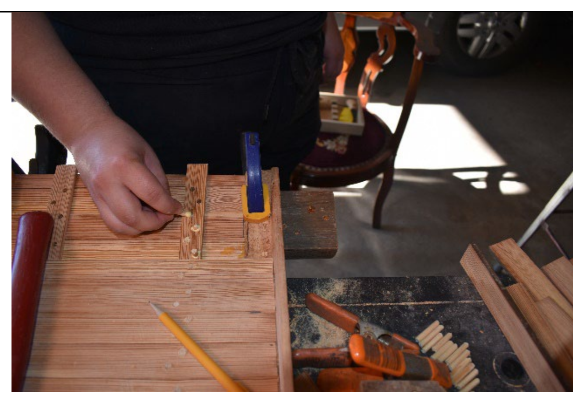

PHOTO 42. Saldivar inserting treenails into interior stringers (Photo by Michaela Hoots).

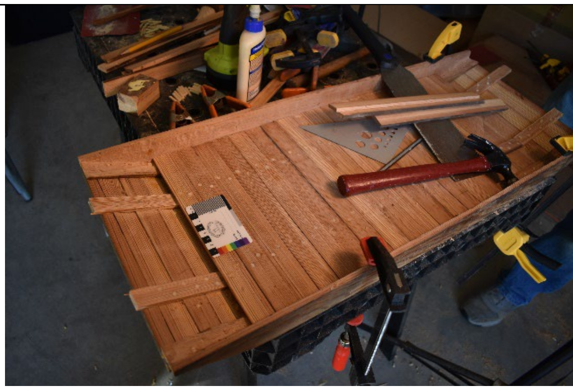

PHOTO 43. Photo of nearly complete interior planking (Photo by Michaela Hoots).

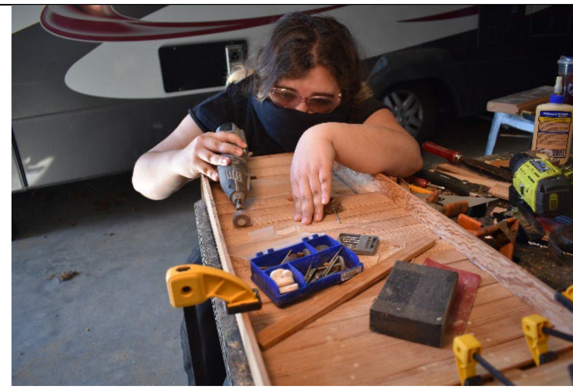

PHOTO 44. Saldivar sanding down interior hull planking with Dremel so other planks would fit flush (Photo by Michaela Hoots).

PHOTO 45. Dremel with sanding tool attached resting on nearly complete model (Photo by Michaela Hoots).

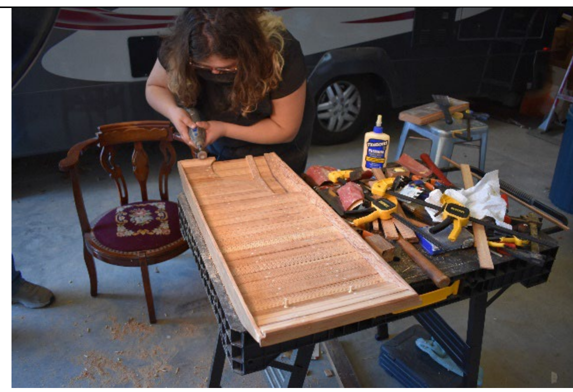

PHOTO 46. Saldivar using Dremel to sand hard edges on header near cut out (Photo by Michaela Hoots).

PHOTO 47. Saldivar using fine sanding paper to finish the bottom of the vessel (Photo by Michaela Hoots).

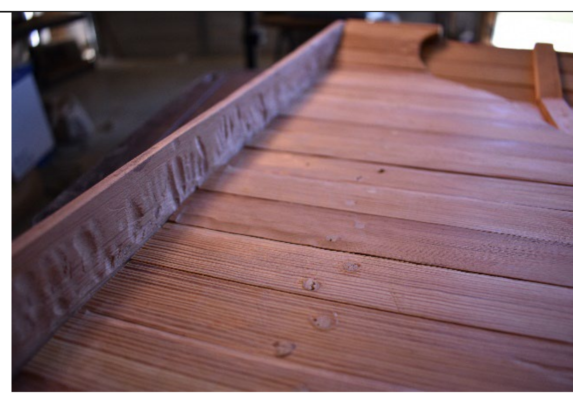

PHOTO 48. Photo showing interior of vessel, where the chine-girder comes into contact with interior planking (Photo by Michaela Hoots).

PHOTO 49. Photo of completed hull of flatboat model (Photo by Michaela Hoots).

PHOTO 50. Photo of vessel resting upside down with photo scale to show the angle of the ramp (Photo by Michaela Hoots).

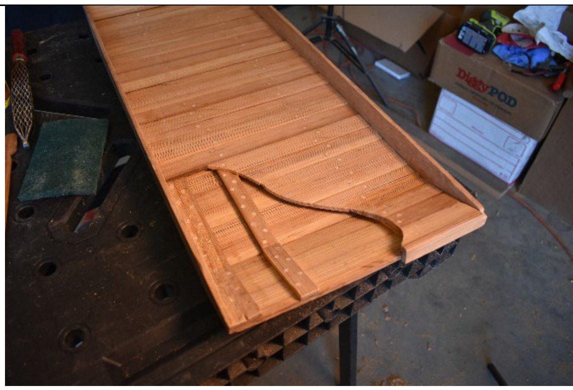

PHOTO 51. Photo showing the cut out (Photo by Michaela Hoots).

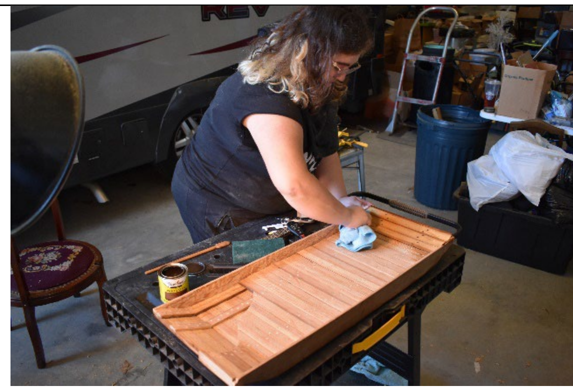

PHOTO 52. Saldivar using towel to stain the model to highlight construction features (Photo by Michaela Hoots).

PHOTO 53. Photo of the tholes in the gunnel of the vessel (Photo by Michaela Hoots).

PHOTO 54. Photo showing the completed vessel, with sweeper added (Photo by Alyssa Saldivar).

	
PHOTO 55. Photo of the completed vessel, highlighting the cut out where the interior construction can be seen (Photo by Alyssa Saldivar).	PHOTO 56. Photo of the completed vessel, highlighting the thole pins and the sweeper (Photo by Alyssa Saldivar).
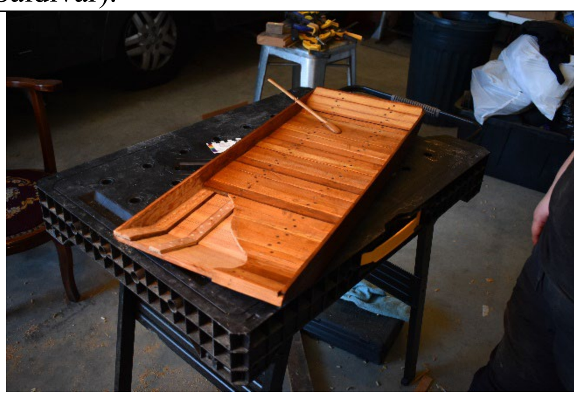	
PHOTO 56. Photo of the completed vessel (Photo by Michaela Hoots).	