Profitability and Production of 19th Century Composite Ships: The Case Study of the Austrian Vessel, The *Slobodna*

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PROFITABILITY AND PRODUCTIONOF 19TH CENTURY COMPOSITE SHIPS:THE CASE STUDY OF THE AUSTRIAN VESSEL, THE SLOBODNA

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The shipbuilding strategies of the late-19th century are defined by the adaptations and incorporation of new building materials that allowed for the specialization and near perfection of the sailing ship as a commerce vehicle. European shipbuilding industries began incorporating iron as a building material as its value became lower than that of timber. As the more affordable alternative, iron alleviated the pressures of decreasing timber reserves and the material's growing value. Iron was integrated into merchant ships, creating larger stronger hulls and achieving faster freighting rates. The first iron and wood hybrids were known as composite ships, which increased the economic surplus of the industries due to low production costs and increasing efficient freighting rates. As the revenue increased, industries expanded into the specialized production of iron ship parts eliminating more of their reliance of wooden craftsmanship and its costly application. The lost cost and benefits of ironworking in sailing ships gave sailing dominion over the long-distance trade while the steamship controlled regional trade.

The steamship produced only low returns on long-distance trade due to high fuel consumption and frequent repair, giving the sailing ship a specialized role for trade. With the creation of the fuel-conscious triple combustion engine in the late-1880s, the steamship became more efficient and profitable than sailing ships, which were then phased out of commercial trading. However, this trend did not happen simultaneously across Europe as the availability and level of industrial production varied. Austrian builders continued practicing traditional shipbuilding methods up to the 1880s, as it remained the most cost-efficient method of construction for long distance trade. Through an archaeological and historic study of one of these Austrian vessels, the *Slobodna*, it is possible to observe the different methods that European countries at the time utilized in order to maintain their approaches to capitalism. Through an interdisciplinary approach consisting of history, Marxian economics, and maritime archaeology, it is possible to identify and further examine the relationship between the motivation to achieve high profitability in shipbuilding and the incorporation of technological advancements in the industrial and economic situations that were present in 19th century Europe.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS……………………….………………………………….……..x

1. INTRODUCTION……………………….………………………………………1

1.1 19^{TH} CENTURY EUROPEAN SAILING SHIP…..…………………………………3

1.2 MARITIME ARCHAEOLOGY AND THE SLOBODNA……………..…………4

2. MARITIME ECONOMICS AND INDUSTRIALIZATION IN 19^{TH} CENTURY EUROPE………………………………………………………….……………....6

2.1 ECONOMIC THEORY IN 19^{TH} CENTURY SHIP PRODUCTION………………..8

2.2 A SURVEY OF SHIPBUILDING IN THE 19^{TH} CENTURY ……………..…….…9

2.2.1 Transitioning From Wood to Iron…………………………………..……...9

2.2.2 Composite and Iron Shipbuilding……………………………………....12

2.2.3 The Rise of Steam……………………………………………………....16

2.3 CONCLUSION…………………………………………………………………...18

3. THE INDUSTRIALIZATION AND MARITIME ECONOMY OF 19^{TH} CENTURY GREAT BRITAIN……………………………………………………..…….19

3.1 WORLD FRIEGHTING IN THE 19^{TH} CENTURY….……………………………..20

3.2 HIGH PROFITABILITY IN BRITISH SHIPBUILDING………..……...…………22

3.2.1 Industrialization factors…………………………………………….……..22

3.2.2 Maritime Legislation and Government Actions……………………….….…25

3.3 CONCLUSION…………………………………………………………………...27

4. THE INDUSTRIAL AND ECONOMIC SITUATION OF 19TH CENTURY AUSTRIA-HUNGARY……………………………………………………….………..28

4.1 19TH CENTURY MEDITERRANEAN AND AUSTRIA-HUNGARY ……...…….28

4.1.1 Industry and Trade in the Mediterranean……………………………….…....28

4.1.2 Industry and Commerce of Austria-Hungary……………………….…….…30

4.2 AUSTRIAN EFFORTS IN MARITIME COMMERCIALISM—ROLE OF ADRIATIC PORTS……………………………………………….……..….……32

4.3 CONCLUSION……………….…………………………………………….…...33

5. HISTORY OF THE AUSTRIAN COMPOSITE SHIP, THE *SLOBODNA*………..35

5.1 CONSTRUCTION AND EARLY YEARS………………………………………35

5.2 WRECKAGE AND SALVAGE…………………….………………….……..….37

5.3 CONCLUSION…………………..………………………………………….…..38

6. ARCHAEOLOGICAL DOCUMENTATION AND ANALYSIS OF THE *SLOBODNA*….………………………………………………………………….....39

6.1 SHIPWRECK ARCHAEOLOGY………………………………………….......40

6.1.1 Overview…..………….…………………………………………….......40

6.1.2 Maritime vs. Nautical Archaeology…………………………………...….41

6.1.3 Wrecking Process……………………………………………………....…42

6.1.4 Shipwreck Archaeology and the*Slobodna*...43

6.2 PAST RESEARCH EFFORTS………………………………………………..….44

6.2.1 Discovery and Confirmation: Indiana University (1998-2005)……………......44

6.2.2 Further Documentation: PAST Foundation (2005-Present)……………...…46

6.3 METHODOLOGY AND 2011 GOALS………………..……………......…………47

6.3.1 Site Description……………………………………………………...……..…..47

6.3.2 2011 Efforts to Locate the *Slobodna*'s Stern………………………………….49

6.3.3 2011 Methodology and Logistics...………….………………..…….……….50

6.3.4 Feature Locations……..………………………………………………….…..50

6.4 2011 FEATURE DOCUMENTATION…………………………………………….….52

6.4.1 Framing Systems……………………………………………………..……52

6.4.2 Interior Iron Structure……………………………………………….……53

6.4.3 Iron Knees…………………………………………….……………….…..57

6.4.4 Deck Structure (Supporting Knees)…………………….……………………58

6.4.5 Rigging and Spar Components………………………………………………60

6.5 VERIFICATION OF THE PRIMARY DOCUMENTS……..………………………62

6.6 CONCLUSION……………………………………………………………………...63

7. CONCLUSION: THE RELAVANCE OF THE SLOBODNA……………….……..66

7.1 THEMATIC ELEMENTS PRESENT IN THE SLOBODNA……..…..………..….66

7.2 FUTURE RECOMMENDATIONS……………….……………………………..68

8. APPENDIX A:PRIMARY DOCUMENTS……………………………………..70

9. APPENDIX B: GLOSSARY OF IRON SHIP PARTS…..…………………………..83

10. APPENDIX C: TABLE OF FEATURES DOCUMENTED DURING THE 2011 FIELD SEASON…………………………………………………………….……….87

11. BIBLIOGRAPHY...………………………………..…………………………89

LIST OF FIGURES

2.1 A Composite Sailing Ship, *Aclestis*, at the End of the 19th century……………………..…….12

2.2 Riveted Iron Ship……………………..………………………………………………….….…13

4.1 Popular Trade Routes in Europe During the Age of Sail…………………………………..……29

4.2 Map of Austria-Hungary in the Late 18th Century………………………………..………….31

4.3 Map Displaying the Geographic Locations of Yachting Ports (Marinas) on the Adriatic Coast including the Major Ports of Rijeka and Losinj, Homeport of the *Slobodna*…………………....33

5.1 Map with Red Star indicating the *Slobodna*'s Homeport Herceg-Novi……………..………35

5.2 Map of Molasses Reef in Relation to the Coast and Protected Sites of Florida Keys National Marine Sanctuaries………………………………………………………………………….…37

6.1 An outline of Muckelroy's Wrecking Process as described by Cory Retherford…………....42

6.2 Location of the *Slobodna*'s *Mast Wreck* and *Winch Hole* Sites in Relation to the Rodriguez and Tavernier Keys used to correlate the sites to the Salvage Reports…………..….………..…45

6.3 The Three Loci of the *Slobodna* indicated by the Red Stars……………..……………..…..48

6.4 Map of Buoy 13, the *Slobodna* Amidship Site……………….………………….……..…….48

6.5 Locations of Interest Surrounding Molasses Reef including the Potential Sites of *Spanish Anchor*, *Medium Anchor* and *Northeast Anchor*………………………………………………49

6.6 Divers of the 2011 Field Season trilaterating a Rider Knee Fragment………………………50

6.7 Artifact Map of Features Documented by 2011 Green Team……..…………………...……51

6.8 Artifact Map of Features Documented by 2011 Blue Team…………………………...…….51

6.9 Artifact Map of Features Documented by 2011 Red Team……………………..……..….51

6.10 Bronze Fasteners located at Ravine 2 of the *Bronze Wreck* site……………………..……..52

6.11 I-beam documented during the 2011 field season located in Ravine 2….……..…..……….53

6.12 A 19th century composite sailing ship hull structure highlighting the use of I-beams and T-beams………………………………………………………………………………..…………54

6.13 Dagger knees located in Ravine 2 matching the curvature of the vessel……………..……..57

6.14 Deadeye taken from the *Slobodna* at the *Winch Hole* site…………………..……………...61

6.15 Patent Windlass by Emerson Walker & Co……..……………………………………….62

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1. INTRODUCTION

The incorporation of iron as a building material resulted in several advantages to ships including larger hulls, increased speeds, and lighter ship weights. These advantages led to decreased freight rates and more frequent shipments. Iron with its attributes as a building material lowered the production values of transported materials and raised the possible surplus, or profitability, of ship transportation. By using iron, European countries reduced the exchange-values of their manufactured products and raise their revenues when compared to their less-industrialized competitors. This scenario can be best observed in the case of Great Britain, which lessened its iron exchange-values by means of a large labor force and widespread industrialization. Private shipbuilding firms through beneficial government legislation utilized their industrial position to acquire the highest possible revenue.

At the center of the Industrial Revolution, British shipbuilders could purchase iron at the lowest price. Great Britain was able to sell iron at a lower cost than their competition due to lower production costs brought by the availability of cheap labor. Britain opted out of the expensive shipbuilding equipment that foreign nations had to install, which by extension raised the production costs of foreign ships. Britain's industrial sectors of the country also brought down the production costs of iron. The transportation costs of the industrial fuel coal to these private dockyards were cheap, giving yet another advantage to the British as their industries were maintained at lower sustainability rates. As a result, Great Britain became an unchallenged industrial and shipbuilding force whose designs and dock personnel were highly coveted by foreign countries hoping to imitate Great Britain's success.

Using Great Britain as a model for a direct relationship between profitability and industrial advancements allows for an appropriate contextualization of the government and private maritime ventures of another industrial state, the Austrian Empire. Assessing the situation in Austria-Hungary alongside Britain conveys the correlation between profit incentives and the decision to construct in the most technologically advanced manner. Using Marxist economic theory, economic and industrial histories of both Great Britain and the Austrian Empire, and an archaeological discussion of the Austrian vessel, the *Slobodna*, this thesis examines how profitability could be achieved independently from technological advancements.

1.1 19TH CENUTRY EUROPEAN SHIPBUILDING

Iron and steam power were first incorporated into shipbuilding designs during the 1850s-1880s (Graham 1956: 74). The first generation design stemming from these innovations was the composite sailing ship, whose architectural designs were first introduced in the mid-19th century (Stammers 1999). With low-cost iron production, composite sailing ships incorporated iron in their framework, replacing traditional wooden crafted pieces. An analysis of the architecture of an iron composite sailing ship physically displays the extent of the economic and industrial situations of their countries-of-origin in a very concise manner. The production of specialized parts reflects the level of industrialization dedicated to shipbuilding. In order to produce more efficient ships, less-industrialized countries had to import many of the materials lowering the revenue that could be gained from the implementation of these vessels. These more-efficient vessels required a level of industrialization that was not present in many European countries. Instead of importing specialized iron parts, less-industrialized countries continued to produce antiquated wooden vessels, bypassing the extra costs included in the transportation of these materials. Because of the lower production costs, higher profitability could be obtained through the use of less-efficient wooden models. The decision to produce less efficient ships reflects the sway of profitability over technological advancements and one facet of the affiliation these factors shared.

The history of the transition from wood to iron in the sailing ship, the development of the steamship, and the economic and industrial shipbuilding situations in the 19th century will be further discussed in later chapters. Drawing from the standard literature in shipbuilding practices of Desmond (1919), Underhill (1988), Souza (1998), and Gardiner (1993), evolving shipbuilding methods can be tied to their economic benefits. Each change led to partitions in the industry that are best observed in the choice to utilize sailing ships or steamships. For the greater part of the century, the steamship lingered in the shadow of the sailing ship. Many of the incorporations of iron were devoted to improving the architecture of sailing. Inefficient fuel consumption of steam engines made it undesirable for longer voyages; however, dependability and speed created a more profitable scenario for the steamship on shorter regional routes. Until the triple combustion engine resolved the fuel issue in the late 1880s, technological efforts to improve cost-efficiency were aimed at improving the sailing ship. Not only was the decision to construct in timber and iron based on the profitability of the resulting vessel, but also the decision to utilize steamships or sailing ships in designated trade routes. The implementation of technological advancements raises a ship's efficiency; however, by investing in these advancements, the profitability of its usage may be lowered due to higher production costs. It is through an examination of these technological transitions that the extent that profitability dictated over these integrations can be assessed.

1.2 MARITIME ARCHAEOLOGY NAD THE SLOBODNA

In order to better assess the industrialization level and the scenario less-industrialized shipbuilders faced, an archaeological analysis of the vessel the *Slobodna* will be conducted. This survey will provide evidence that may not be present in the historical documents and shed light on the specific practices utilized by Austrian shipbuilders to successfully profit. Built for oceanic voyages, the *Slobodna,* a ship of the Austrian Empire, transported cotton for private concerns from New Orleans to several Baltic ports before its intended return to its home port along the Adriatic coast. While in transit along Molasses Reef off the Florida Keys, the *Slobodna* hit a sudden squall and ran aground on March 16, 1887, ending its short career. After salvage reports processed by the city of New Orleans deemed the ship unrecoverable, the *Slobodna* was left undisturbed for over a century. Beginning in 1995, the Florida Keys National Marine Sanctuary published the Hayes' Report detailing two sites that belonged to a previously unknown vessel. In 1998 Cory Retherford of Indiana University connected the two sites, tying them to the vessel of the *Slobodna*. Building upon the research of Indiana University and the Partnering Anthropology with Science and Technology (PAST)[1] Foundation, this thesis will incorporate an analysis of the features as well as the techniques applied to retrieving this data as the sites have already been identified as the *Slobodna*.

The methodologies of nautical archaeology will be employed in order to investigate the shipwreck site of the *Slobodna*. Shipwrecks make up a large percentage of the sites studied by this sub-field of archaeology (Gibbins et al. 2001). As ships of all cultures share common characteristics, similar methodologies and research strategies can be applied to study the various aspects of these sites. The archaeological analysis of the *Slobodna*'s remains describes the features' functions and connects several features of the vessel, relating their purposes to the

[1] For more information, visit http://www.pastfoundation.org/current-programs/slobodna/

greater economic and industrial conditions of the late 19th century. Attached appendices provide supporting primary documents, a glossary of shipbuilding terminology, and documented features taken from the 2011 field season in order to strengthen the effectiveness of the *Slobodna* as a model for the industrial and economic circumstances in Europe and Austria.

The chapters of this thesis detail aspects of the economic and industrial histories of Great Britain and Austria in order to display how industrialized countries such as Great Britain and Austria adapted differently in order to promote the growth of their economies through capitalism. Through the shipwreck of the *Slobodna*, the different approaches to obtain high profitability rates in shipbuilding and freighting in the continent can be surveyed. This thesis demonstrates that in 19th century Europe, the motivation that promoted the integration of iron parts was the drive to achieve the highest economic profitability in shipbuilding rather than the presence of these technological advancements alone.

2. ECONOMIC AND INDUSTRIAL DEVELOPMENTS IN 19th CENTURY SHIPBUILDING

Revolutionary developments in technology have always played a significant role in the rapid growth of economies. Though it is difficult to isolate the influence of technology from socio-political influence, studying innovations and economic factors in specific time periods and regions provides a clearer understanding of the motives behind change (North 1968: 953). Shipbuilding is an excellent case study to examine this interaction. Two major innovations in ship construction that largely affected the trading practices were the shift from wood to iron as the primary building material and the replacement of wind power with steam in both long-distance and regional trade (Harley 1970). The benefits of these changes continued a period of economic growth that originated in the past century with the decline of piracy, beneficial legislative actions, the availability of labor, the organization of private dockyards, the increased iron production, and economic dependencies between larger industrial countries and those lacking material or industrial resources (Pollard 1957). This chapter discusses economic and industrial organization, both international and internal, of Great Britain and Austria in a theoretical framework in the context of the technological evolution and architecture of composite sailing ships and steamships. These contextual aspects must be addressed before beginning a comparison of the relationship of profitability and technological integration in shipbuilding of the 19th century.

In the early 1800s, the growth of capitalism on a continental scale was already underway. The effect of industrialization began to impact European shipbuilding, bringing modifications to the sailing ship design that led to an increase in freighting efficiency and trade profitability. Freighting rates that had been expensive became affordable due to the benefits of using iron as a building material. Ships could reach higher speeds, carry a larger payload and had lower maintenance costs. The introduction of affordable iron caused a drop in European shipping costs that continued for decades (North 1968: 959).

2.1 ECONOMIC THEORY IN 19TH CENTURY SHIP PRODUCTION

The discipline of economics examines limited resources that are exploited to satisfy human needs (Mendel 1973). There are different approaches to this issue and its application. This thesis makes use of the Historic School of thought, which focuses on the trends and processes rather than the result of human action. One of the leading contributors to this school was Karl Marx. Marx focused his writing on labor and production theories, which are very useful in understanding the evolution of 19th century ship production. The economic theories of Marx focus on the production of *commodities*, or products whose purpose is to be sold for profit on the market. Commodities must have an *exchange-value,* or its selling value. The exchange-value of a commodity is determined by the quantity of labor necessary for it to be produced. With this understanding of production, Marx established the basis of capitalism, which he defines as the desire of every enterprise to achieve a rate of productivity superior to the national average and thereby make a surplus profit. In turn, this inclination provokes a movement that causes the surplus profit to disappear through expenditure (Mendel 1973: 23). *Surplus* is defined as the difference produced by the worker and the value of his own labor. The pursuit of higher surplus, or profitability, is the driving force behind the entire capitalist economy (Mendel 1973: 23). The examination of the shifts in technology and materials will show how the pursuit of profit does not necessarily embrace technological advances. This only occurs if the advances present a situation where the employment of such advances aligns to profitability.

2.2 A SURVEY OF SHIPBUILDING IN THE 19TH CENTURY

North America dominated the shipbuilding market until the 1870s. The United States led production in the 1850s, but was superceded by Canada in the 1860s, until it was in turn surpassed by Europe (Harley 1970: 262). Through the incorporation of iron, Europe was able to respond to the stresses of their growing capitalist system. Europe's response was heavily influenced by the market shifts in supplies that led Northern European shipbuilders to construct with iron. Studies indicate that the shifts in iron and wood supply curves were the primary factor in the switch to iron rather than manual labor costs (Harley 1970: 264). These supply curves were exemplified through the differences in technological development in the Old and the New World (Harley 1970: 263). Price and quality were important factors in Europe's choice to switch to iron. By the 1870s, fully wooden shipbuilding only remained in Maine and portions of Canada, where large quantities of wood encouraged continuous production (Harley 1970: 262).

2.2.1 Transitioning From Wood to Iron

Iron played a critical part in the development of both the sailing ship and the steamship. As they shared a common building material, both vessels were constructed in the same shipyards (Harley 1970: 263). For the sailing ship, iron solved the problem of the dwindling reserves of European trees that had existed for centuries. Great Britain and much of Europe lost their New World wood reserves in the 18th century when the American colonies achieved independence. Facing a situation of economic Darwinism, Great Britain was left with three alternatives: consume their remaining continental reserves, purchase expensive American timber, or find a suitable material to replace timber. With iron prices dropping, Britain chose the cost-conscious option. During the

1840s, iron was a nuisance to shipbuilders who were trained to handle wood. Perfection in ship ironworking would come with more time (Graham 1956: 75). Iron strengthened the sailing ship with the innovation of the composite hull model, which blended both iron- and woodworking. With this new design, sailing ships had stronger holds and were more hydrodynamic (North 1968). In addition, iron frameworks created more spacious cargo holds as shipbuilders no longer had to sacrifice space for hull strength. This use of iron in hulls caused a 40 percent drop in freight costs (Harley 1970: 263). With composite hulls, sailing ships were able to carry a larger capacity at faster rates.

Iron also improved ships indirectly through its implementation in procedures for packing cargo. This is best observed in the handling of cotton, a significant export from the United States to Great Britain (Smith 2007). In order to increase the amount of cotton that could be carried, the process of jamming (compressing the cotton by way of an iron press) increased the pounds per square foot five-fold. This fact, along with the greater availability of cargo space, allowed Europe to import larger quantities of textile materials, providing the textile industry with ample supplies of raw materials. European iron working did not offer a sharp advantage over American shipbuilding, which still utilized its large reserves of New World timbers, but it gave Europe an alternative to increasingly expensive wooden shipbuilding (Harley 1970). It was the sailing ship's efficiency that brought a drop in freighting costs in Europe when dominating the longer hauls of trans-oceanic trips (North 1968).

The shift from wood to iron did not come suddenly. Wood had been the material of shipbuilding since its beginnings. Masters and apprentices in the handling of timber in ships had created the image of shipbuilding as an art. As iron was incorporated as a material, shipbuilding began to transition from a handicraft to an industrialized product (Ho 2004). Several iron shipbuilding yards had been established in the Clyde and Thames Rivers, two of the most populous centers for British shipbuilding. These new yards reflect the favorability of iron over wood in places where the competition promoted the use of the most profitable techniques.

It is important to note that labor cost differences had little impact on the shift to iron. Price movements in wooden and iron materials were responsible for the shifts in supply curves. Production costs for iron shipbuilding in Britain declined 1 percent each year during the mid-1860s and declined 40 percent over the period of the 1860s-1890s. These iron rates would bring down the cost of wooden shipbuilding, until the 1870s when wooden shipbuilding only continued in Maine and the Canadian Maritime Provinces (Harley 1970: 263). North (1968) observes the fluctuations, which he establishes a direct relationship between years of innovations and freight rates. The decreasing price of freight rates was part of the larger aspects of the age as decreasing mercantilist restrictions, expansion of trade and revolution of technology all were primary factors for an overall growth of the European economy of the time (Harley 1970). Even in 1873-1884, innovations in sailing ships still greatly affected the decline in shipping rates.

The implementation of iron did little to change the use of wood in commercial ships (Gould 2001). Wooden ships remained in competition with metal vessels up through the 1880s, thirty years after the introduction of iron shipbuilding (Harley 1970: 262). In the 19th century, the chief limitation of wooden shipbuilding was the lack of longitudinal rigidity in the hull. Wooden hull designs were commonly constructed with short wooden planks, which set limitations on the maximum speeds and hull space available (Greenhill 1988). Shipbuilders first used iron to form composite ships, which provided ships with increased strength, speed and durability. These vessels incorporated iron in the structural workings of the frame, while maintaining a wooden outer hull. Iron was implemented in the construction of the composite hull, especially in the pins and screws. As the strain from screws in wooden hulls took its toll, pins provided additional strength (Harley 1970). These screws were better fitted for the iron hull parts, as the tensile strength of metal-to-metal was stronger than wood-to-iron, providing additional strength to the already-reinforced structure. Iron shipbuilding was favored by the industry for shorter time-constraints when assembling a vessel, additional hull strength, elimination of unnecessary hull supports, and increases in cargo-carrying capacity (Gardiner 1993). Iron not only improved the strength and volume of ships, but also reduced maintenance costs. With iron protecting the wooden interior and parts, fewer repairs were necessary, although it did add the iron-specific problem of oxidation. Despite all of its advantages, iron did not replace wooden shipbuilding entirely. The choice to construct with iron was motivated by the supply curves of iron and wood. This fact denotes the role of profitability in the introductory stages of the chaîne opératoire of iron as a shipbuilding material. Countries such as Austria and America continued to build in partial wooden fashion either due to the lack of iron production and specialization in the country or the greater profitability of wooden shipbuilding still outweighing the advantages of iron shipbuilding.

2.2.2 Composite and Iron Shipbuilding

The structure of composite ships was similar in design to traditional wooden ships. Composite ships were still classified by wooden definitions: schooners, clippers, and barques. Iron was first incorporated into ships by replacing wooden hull support structures with iron ones. This did not represent any alteration of shipbuilding methods, only the materials. Beginning with the keel, perpendicular beams were laid with frames attached crossways. Early composite models were mostly wooden with iron supports, but later construction switched entirely to iron frames (Fig 2.1). Center keelsons were plated with iron before they were laid down. Many of the wooden components had been switched to T-shaped iron beams. Over time, ship construction of the sister keelsons, bilge keelsons and side keelsons in iron-incorporated ships replaced the stringers found on wooden models. With iron in the keelsons, several support structures of wooden ships could be eliminated due to the greater strength of iron. In addition, the various chocks, futtocks, and wales were replaced with iron structures in the floor panels, plating and stringers (Kihlberg 1972:30). In composite and iron ships, decks rested on knees attached to the perpendicular frames. This construction was first apparent in French naval ships of the mid-18th century, where iron knees replaced wooden crooks. Due to the rising costs of timber, British shipbuilders soon adopted this trend in the Napoleonic War under the supervision of Sir Robert Seppings, the Royal Navy's chief surveyor during this time (Stammers 2001). These hanging knees were a key feature in iron hulls. Decks resting on the knees housed mechanisms such as capstans and windlasses. These pieces were soon incorporated in iron, wood or composite fashions (Greenhill 1993:78). The deck was for the most part, constructed with wood until iron replaced wood entirely in commercial shipbuilding. Anchors remained unaltered on iron ships. Figure 2.2 provides a diagram of the main iron components in a composite ship.

Figure 2.1: The composite sailing ship, *Alcestis*, at the end of the 19th century (Smith 2007).

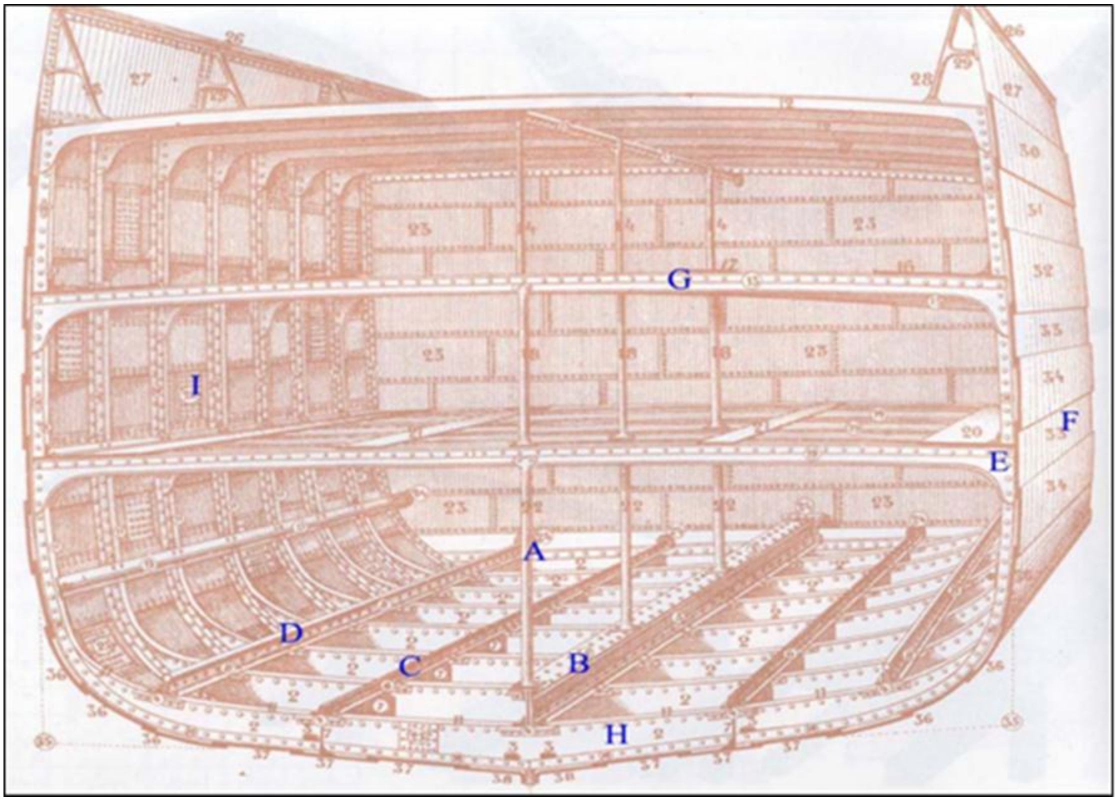

Figure 2.2: Riveted Iron ship. A: Pillar, B: Keelson, C: Sister Keelson, D: Bilge Stringer, E: Angle bar, F: Outer Plating, G: Deck Beam, H: Floor, I: Butt plate (Ho 2004: 12).

The rigging was different on iron ships as compared to wooden ships in rigging (Greenhill 1993: 79). Linked iron rods were introduced in the 19th century, which resulted in less weight, greater durability and increased strength. Compared to standard rigging, these improved properties allowed for thinner masts. Iron knees were also more convenient to incorporate in designs due to the shifts in supply curves of the early 1800s. The scarcity of timber during that time prompted shipbuilders such as Gabriel Snoodgrass to call for iron materials as an alternative. Aware of iron's strength and density, Snoodgrass began to incorporate iron structures in British East India Company ships as early as 1796 (Fincham 1851, Stammers 2001). His efforts inspired the creation of specialized structures—specifically, various types of knees used in iron sailing ships. Iron right-angle knees were manufactured in response to increasingly economical iron over the rising price of wood (Stammers 2001: 115). Right-angle knees were common and covered a broader class of knees that included hanging, lodging and standard knees. Hanging knees supported the underside of a deck beam while lodging knees were fitted alongside the deck beams. Rider knees were developed in order to provide extra strength to the lower hull, while at the same time holding support beams in place (Stammers 2001). Iron materials improved the structure, as specialized knees were incorporated into the joints between the keel and the stern and the keel and the bow.

The latter part of the 19th century witnessed a second transition for seafaring mercantilism, as the transition from wind to steam power took place. Although this transition was not consistent throughout Europe, as many states were not as industrialized as Great Britain, steamships came to dominate both regional and short-haul international trading routes by the end of the 1880s. Sailing ships took on a specialized role as a vehicle for long distance trading. The 1860s-1870s brought several economic factors supporting the commercial uses of both the sailing ship and the steamship. With the repeal of high tariff legislation such as the Corn Laws, rising British exports provided new cargo for the steamship on shorter routes (Knauerhase 1967: 616). As legislative restraints on shipbuilders loosened, private firms became increasingly specialized in iron part production. Attempts to lessen dependence on timber continued with a vertical planking design supported by iron knees. These designs resulted in less bulky frames without weakening the strength of the hull (Stammers 2001). As iron became affordable, shipbuilders switched to an all-iron frame, which increased speed, making it more profitable than wooden shipbuilding (Gould 2001). Affordable and more efficient freight rates of the steamship supported the continued industrialization in Europe. Through the affordability and specialized production of iron parts, increased profitability further encouraged technological advancement in the construction of iron sailing ships and steamships (Harley 1970, North 1958).

2.2.3 The Rise of Steam

Over the course of the 19th century, the steamship transformed from a wooden, inland vessel with a paddlewheel to the trans-oceanic, compound-engine machine, ending the 300-year reign of sailing on international trade (Brock 1973). The efficiency of the steamship was effective in regional maritime trade, but further technological developments were needed in order to compete with the sailing ship in long-distance trade. Steam power first became practical in the 1800s as its beginnings were in mining practices, gradually being incorporated into the terrestrial transportation of passengers, raw materials, and agricultural products in the form of railways. Only later was the steam engine incorporated into other venues, such as seafaring (Graham 1956). Before the Suez Canal opened, mariners relied in the Cape of Good Hope where wind currents quickly carried sailing boats at a rate the single-engine steamship could not achieve. By the 1850s, steamships could voyage across the Mediterranean and the English and Irish Channels and from South America to Africa (Graham 1956). The use of steam in long-distance seafaring began in transportation, as immigrants traveled from Europe to the United States in search of the promising new opportunities. All the while, steam engineers in Europe began to develop larger, stronger engines to transport passengers more efficiently, entering the realm of international trade (Brock 1973). The quick transition of the steam power from mining to seafaring gave way to the belief that the 19th century was the age of iron and steam. However, it was not until 1875 that the steamship began to overtake the sailing ship, as seen in the German mercantile fleet (Graham 1956, Knauerhase 1968).

Early steamships were plagued by the inefficiencies of the two basic designs: the single-engine design and the paddlewheel. The single-engine design was restricted due to its high fuel consumption, and the paddlewheel was limited to river transportation. Steamships only replaced wooden ships in private passenger transportation and experimental military ships (Graham 1956). The direct ratios of coal, cargo space, and distance made by the steamship were unfavorable and less profitable for long-distance trips. Longer voyages required that more cargo space be dedicated to coal reducing the amount of revenue possible (Harley 1970, Graham 1956). Steamships had the advantages of being flame-retardant, less dependent on weather, and able to carry more weight in proportion to size than sailing ships. Also, steamships used less capital and smaller crew sizes per mile over longer distances, indicating that the shift from sailing to steam was primarily caused by advances made by marine engineers, such as the improved triple combustion engine (Harley 1970, Knauerhase 1968). Disadvantages of steamships included the need for cargo space for fuel and higher maintenance costs as the hull of the ship was frequently damaged due to the oxidation of iron—a problem not found in sailing ships as outer wooden hulls protected their interior iron structures (Graham 1956). On longer oceanic expeditions, sailing ships were still able to provide more efficient freighting, with larger cargo-carrying capabilities at a much faster rate than their steam rivals.

Sailing was still superior on long-distance voyages because it offered almost twice as much cargo room in relation to its tonnage. Sailing ships transported raw materials such as iron, coal, jute, rice, wheat, wool, and nitrate fertilizers from the colonies of West Indies, Australia, South America and the Bay of Bengal to various harbors of Great Britain to supply their native factories (Graham 1956). By the 1870s, the incorporation of John Elder's compound engine increased the fuel efficiency of steamships, allowing more room in the hulls to be dedicated to cargo, increasing the profitability of the ship. As the more profitable transport, investors then backed the steamship, sanctioning them the control of regional routes. (Knauerhase 1967: 615).

The opening of Egypt's Suez Canal in 1869 for commercial use is commonly thought to be the start of the steamship's reign in commercialism; however, the sailing ship still prevailed for another decade (Graham 1956). Steamships significantly reduced the voyage period into the Far East, but only through this route. Due to the currents around Africa, the insignificant difference in traveling time meant that sailing ships could avoid the canal and the costs for using it entirely and still make their docking dates. This fact, along with the mechanical issues of the steamship discussed below, deterred private companies from fully embracing the steamship (Graham 1956). The Suez Canal provided an opportunity for the steamship to mature as it made smaller, quicker trips around the Red Sea and into the Indian Ocean. Iron production was still in its infancy, facing industrial problems whose answers would only come later in the century (Graham 1956).

The shift from sail to steam originated in the substitutions of coal for labor and capital. In 1880, steamships entered the commercial field as steam tonnage climbed up to 2,700,000 tons compared to the 3,850,000 sailing tons, originating in the creation of new cylindrical boiler in 1878 designed to raise pressure limits (Graham 1956). Previous patents by Samuel Hall in the 1840s had already increased the efficiency of steam boilers by reusing fresh water rather than refilling with salt water which rusted the part's interior (Knauerhase 1967: 614). Marine engine innovations increased the profitability of the steamship compared to the sailing ship (Harley 1970). These improvements to the steam engine lowered fuel costs for steamships and brought down overall maintenance costs. As the steamship became a more profitable vehicle, investors and private shipbuilders began to produce long-distance steamships. The winds of change became apparent in 1881 when the *S.S. Aberdeen* traveled from Glasgow to Melbourne in 42 days, roughly the average time for any sailing ship. The S.S. Aberdeen demonstrated the steamship's ability to finally compete with the sailing ship on long-distance routes. Prices for steamship building materials reached a low in 1884, and the sailing ship was phased out of commercial use (Graham 1956). The following year, tonnage standards and regulations were adjusted in order to suit the steamship; one steamship ton became equal to three sailing tons. This came with the perfection of the high-pressure, triple expansion engine, a composite engine model that better utilized coal consumption, reducing the amount of cargo space dedicated to fuel. This innovation drove the final stake into the sailing ship, ushering in the nautical domination of the steamship in seafaring trade (Knauerhase, 1968, Graham 1956).

2.3 CONCLUSION

The 19th century saw two transitions in shipbuilding, one from wood to iron, and the other from sail to steam. It is clear in both transitions that profitability was a deciding factor of private shipbuilders to partake in the new advancements. The composite ship represents the earliest stages of industrialized shipbuilding, as it was the first hybrid of woodworking and iron production. The presence of these vessels provides a way to gauge the extent of industrial production in less-industrialized countries. These ships indicate the production of certain iron parts as they were more profitable than constructing with timber. In this study of the European practice of capitalism, shipbuilding verifies the dominance of profitability in the decision to integrate technological advancements. Marxist economic theory shows how supply and demand exerted significant, but different pressures on shipbuilders. The following two chapters will provide the specific frameworks of Great Britain, a more-industrial country, and Austria-Hungary, a less-industrial country, in order to place the *Slobodna* in context.

3. THE INDUSTRIALIZATION AND MARTIME ECONOMY OF 19TH CENTURY GREAT BRITAIN

During the late 19th century, the international markets of Europe were focused on acquiring food and raw processing materials for the ongoing Industrial Revolution. Great Britain, as the origin of the Industrial Revolution, was the unchallenged leader in shipbuilding and international commercialism. It produced the greatest amount of processed goods, such as furnishings, to be sold to foreign markets. For the shipbuilding industries, timber required for construction became exhausted, raising the construction price for vessels. However, due to the large production of iron during the British Industrial Revolution, prices for iron ship materials dropped, and iron became a substitute for wooden shipbuilding in commercial ship construction. This shift allowed private British shipyards to produce between one and a half to four times as much tonnage than the rest of the world's efforts combined, all while maintaining superior designs, and lower freight rates than foreign competitors (Pollard 1957: 426). As a leader in shipbuilding, studying Great Britain demonstrates how the profitability of shipbuilding was deeply tied to the incorporation of the latest technological advancements. As the vanguard, Britain is the measure of technological achievement to which Austrian shipping of the *Slobodna* can be compared. This comparison will show how profitability functions with and without the involvement of technological advancements.

3.1 WORLD FRIEGHTING IN THE 19TH CENTURY

Several developments decreased freighting rates in 19th century Europe (North 1968). By examining these events, it is possible to determine which had the greatest effect on freighting costs. The first factor that spurred a decrease in freighting rates was the decline of piracy a century earlier (North 1968: 953). In response to piracy, European governments established larger navies. This led to an increase in the rate of sailors, eliminating the pool of potential pirates. As a result, the percentage of full cargoes reaching their destination increased. Rising wages also deterred individuals from turning to piracy, which previously had lured recruits with better pay (Graham 1956: 78). Legislation against piracy became more aggressive, promising stronger penalties for those caught in the lucrative business, further discouraging pirate recruitment. With more patrols on the seas, private merchant vessels made it to their destinations more frequently, lowering freight rates (Graham 1956: 81). Private ships no longer had to employ larger crews, purchase expensive maritime insurance or be equipped with defense measures and protocols. Cargo space, once sacrificed for extra rations and sleeping quarters for soldiers, was now used for freighting, which increased profits. Higher cargo tons-per-man rates were established, thus, increasing the efficiency. Declining piracy in the 19th century established precedence for industries to lower production costs and create surpluses, stimulating the capitalist activities on the seas (North 1968: 960). In the early 19th century, private industries still benefited from safer international waters. Lowered freighting costs and increased profit allowed industries to increase in size, specialize in production, and participate more actively in trans-oceanic trade. Europe, especially Great Britain, began importing a wide variety of materials, the most significant being cotton, timber, and grain. Industrial companies processed these into finished and semi-finished materials (such as textiles) and shipped them out for sale to colonies such as the West Indies (North 1968: 964).

In the 1850 and 1860s, increased agricultural organization and production brought larger quantities of food on the market resulting in lower prices. Simultaneously, rising wages for the working class encouraged more spending on commodities, thus raising the public demand for various raw and processed goods (Black 2003). Industries with a large, cheap work source lowered the production costs of processed materials and heightened private industrial spending and production. The decreasing costs of agricultural and industrial products encouraged more frequent shipping; however, it was the incorporation of iron that brought the most significant decreases in freighting rates, permitting these frequent trips.

As British industries began to export more goods to the colonies and other parts of the world, these changes in ship design created more space to accommodate bulk items, such as wheat, coal, and timber (North 1958: 538). The implementation of iron vessels encouraged industrial growth in turn by reducing basic costs with greater efficiency and smoother delivery through greater trip frequency (North 1958: 540). Cargo was divided between the steamship and the sailing ship depending on the desired route. Cargoes that were transported over greater distances went to the sailing ship, whereas those that required a timely delivery over short distances went to the steamship (Hening and Hening 1990: 137). It was these factors, along with technological advances, that contributed to the ship's ability to profit.

3.2 HIGH PROFITABILITY IN BRITISH SHIPBUILDING

3.2.1 Industrialization Factors

There were many factors contributing to the success in British ship production. The first was the availability of a large skilled workforce in British private dockyards. With this surplus, Britain was not forced to succumb to purchasing expensive equipment as many foreign shipbuilders did due to lack of a labor surplus. British builders used pneumatic tools and German-built cranes (introduced to British shipyards in the late 19^{th} century), giving the workers a technological boost that was more cost-efficient than expensive equipment, like mechanical riveters. Other European shipbuilders maintained lower standards because they lacked machinery or a large, labor force. Many countries attempted to reproduce British success by employing British-trained shipbuilders and dockyard managers, who spread British ship architecture through their designs and templates. Many of the shipbuilding techniques of the rest of Europe were taken directly from Great Britain with no radical changes in design (Knauerhase 1967: 616).

The successes of Great Britain on a national scale were copied as well on the private level. German designs were more technologically focused and their institutions provided better education and more effective ship designs (Knauerhase 1967: 614). However, not many foreign orders were filled in foreign shipyards as a labor shortage made production costs high (Knauerhase 1967). France faced a different obstacle in their shipbuilding efforts. Though French companies supplied fine warships, they built antiquated vessels with higher production costs, thus requiring high wholesale prices in order to create revenue (Pollard 1952). Even though French builders managed to lower the production rates, the market for these vessels was almost non-existent, as other countries produced a relatively small amount of ships. British ships were built better and cheaper. The expanding production of Britain ships originated in the 1860-1880s before their unchallenged dominance in the late 19^{th} century. No other country, except the United States, had the steel, iron, and engineering capacity to construct ships on a global scale. British shipyards had no substantial competition in the production of merchant and naval vessels until the early 20^{th} century.

Due to the low production costs of iron and the large workforce, industries began to market specialized iron parts and ships in British yards—a trait that foreign shipyards did not exhibit (Pollard 1957: 433). Companies such as Clack & Co. would build the giant express liners, while smaller firms such as S.P. Austin, William Denny, and J.I. Thornycroft built fishing vessels, cross-channel vessels, and warships (Pollard 1957). Shipbuilding firms were made up of associated private individuals who could supply loans and an exchange of shares between them and the shipbuilder. This exchange allowed for repeat orders from contractors and cut spending costs by implementing standardized templates and designs associated shipbuilders adhered to. Marine engineers were employed to supply specialized knowledge to the private companies, which were constantly introducing newer designs to the yards. British companies benefited from having greater specialization in manufacturing of parts such as windlasses, donkey engines, and interior furnishings, creating the distinguished reputation of British artisans, shipwrights, and boilermakers. Even in later steamship production, British yards dominated (as their coal reserves were located close to the coastlines) decreasing the maritime and terrestrial transportation costs that plagued foreign yards.

British yards also had more access to the market of shipbuilders. Ship-owners who financed these vessels were located near ports so they could oversee the production. Dockyards grouped around rivers like the Clyde, had access to large pools of labor and insight into the new designs being produced by the competition. While tradition did at times hamper innovation, it was not a determining factor in British shipbuilding. As many of the private dockyards fell into bankruptcy, many others opened along other rivers. This encouraged private owners to search for the best deals without obligation to a certain dockyard (Pollard 1957).

British companies benefited from their country's advanced industrialization as they received the lowest costs of steel on the market. This continued even as foreign countries such as Austria formed their own steel industries. Though Americans held the greatest advantage in steel production with cheap rolled steel, this fact became negligible since plates were sold to Scottish and Irish companies from $8-15 USD per-ton cheaper than their home rates. The large amounts of British steel produced allowed companies to export it to foreign countries at rates 15%-20% lower than locally produced iron in other countries. One example of this is seen in Germany in the 1890s, which kept purchasing British steel until the introduction of railways in 1910. The railways lowered transportation expenses, allowing German steel production costs to compete with those of the British.

3.2.2 Maritime Legislation and Government Actions

At the dawn of the 19th century, the rise of the modern nation and subsequent changes in legislation significantly affected the maritime economy. In Britain, this process began with the repeal of the Corn Laws and Navigation Laws (Pollard 1952: 98). These laws had encouraged the citizens to purchase foods locally. However in 1815 as the United Kingdom faced agricultural hardship, these acts were repealed in order for the country to sustain itself (Pollard 1952: 115). Parallel to this growing policy of laissez-faire economics, Europe, led by Great Britain, introduced legislation reforms to organize the standardization of oceanographic mapping techniques and the education of hydro-navigation institutions. These standards were enforced in various trading powers to properly educate and certify captains and navigators. With standardization, sailing ships became more precise, decreasing the amount of sailing time up to ten days, depending on the route. Legislation not only controlled tariffs, but also the standardization of the ship proportions. Alterations to the Tonnage Laws in 1836 were added to prevent tax evasion. In consequence, the standards of ship measurements were widened. Redefining the previously strict criteria allowed more breadth, increasing the hold and quantity that ships were able to carry (Graham 1956: 78). With this adjustment, shipbuilders were no longer financially tied to a strict structure design and created ships that were more distinct and designed for specific cargo needs rather than a standardized model for all cargo.

Government involvement played a significant role in private shipbuilding and freighting rates. Due to more efficient French naval designs in the 18th century, the British government responded to the French threat with the establishment of the Society for the Improvement of Naval Architecture in 1791. Though the society eventually dissolved due to a lack of funding and poor results, it is through its existence that the influence of the British government on shipbuilding can be examined (Pollard 1952). Later in the 1860s, the Royal Navy was modernized under the guise of the newly founded Institution of Naval Architects (I.N.A.). The I.N.A. members were mostly Admiralty officers who chose to reside in proximity to the shipbuilding department of the Navy. The I.N.A. would go on to establish the College of Naval Architecture in South Kensington in 1864 (Pollard 1952: 101). When the institution was relocated to Greenwich, the facilities were further reduced. Though the schools established by the I.N.A. were eventually closed, the subject of shipbuilding began to take hold in several science and art departments. Moreover, graduates utilized their training in their careers further spreading the science of shipbuilding to private employers (Pollard 1952).

In 1873, The I.N.A. called for the introduction of steel in ships and the reorganization of dockyard government administrations (Pollard 1952: 102). The actions of the Admiralty further promoted the government's role in shipbuilding. In regards to hull structure and materials, the Admiralty brought variations to royal shipyards through contracts with private shipbuilders. The

Royal Navy was a large contract, relying on both its own yards and private ones. Acquiring one of these coveted contracts ensured private firms steady business, thus promoting the maritime economy of Great Britain.

The participation of both private and public firms introduced new naval architectural designs as well as modernization in the education of shipbuilding (Pollard 1952: 109). The government employed contracts with private yards mostly for ship repairs, which proved invaluable during times of war. Repairs to hulls were done according to Admiralty standards. The high profits of iron warship production encouraged private builders to construct these vessels and sell them to the government. After 1880, warship contracts become a necessity for large, private shipbuilding firms such as Harland & Wolf & Swan, and Hunter & Wigham Richardson. Despite the reign of the private shipbuilders, the highly involved role of the Admiralty in contracts, laws, and regulations made the government's role influential. Its strong impact on patterns trickled down from Britain to less industrial countries. The actions that the British Government took in the 19th century belie the notion that Europe was undergoing a period of strict laissez-faire. Instead, it was one where the government's role was secondary to that of private efforts.

3.3 CONCLUSION

The growth of the maritime economy in Europe greatly benefited British shipbuilders. The combination of a large labor force, advanced industrialization, and falling freighting rates encouraged shipbuilders to use the technologies available as the market favored those who presented the most efficient ships. Private companies competed to produce the best ships for the highly coveted, lucrative contracts. Thus, profitability favored those companies who could effectively employ cost-cutting technologies. An examination of British shipbuilding in the 19th

century establishes how the motivation for profitability can be strongly correlated with technological innovations; however, this is not always the case. In contrast, 19th century Austria-Hungary, where the *Slobodna* was constructed, chose to build with less-efficient materials. The country's situation will be examined as a display of the different practices in achieving the same economic ideologies.

4. INDUSTRY AND ECONOMICS IN 19th CENTURY AUSTRIA-HUNGARY

In Chapter 2, Great Britain was examined as a case study to show a positive correlation between the implementation of more-efficient vessels according to profit incentives. Here, Austria-Hungary is investigated to present how the pursuit of high revenues bypassed the use of more-efficient vessels. One of the key objectives of this thesis is to show that an Adriatic-Mediterranean ship can represent the larger European trends and economic dogma concerning profitability. It will provide an overview of the state of Austria-Hungary's economy as well as the maritime commerce of the Adriatic coastal region. The industrial and economic situations pertaining to of 19th century shipbuilding in Austria-Hungary were different from those of Great Britain. While Britain had beneficial government involvement, the interaction of private firms and government participation in Austria-Hungary proved detrimental. Despite this obstacle, private shipbuilders adapted to their situation, obtaining the highest profitability available in their specific circumstances. The contrast with Great Britain is addressed as an expression of capitalism as defined in Marxist economic theory.

4.1 19TH CENTURY MEDITERRANEAN AND AUSTRIA-HUNGARY

4.1.1 Industry and Trade in the Mediterranean

With the discovery of New World trade routes (Fig. 4.1), the former "trade-hub" of the Mediterranean faded into the background as Northern European countries dominated the global markets with trans-Atlantic ferrying (Black 2003). The Mediterranean region still had goods to

Figure 4.1: Popular trade routes in Europe during the Age of Sail. (MacNamar N.d.).

export such as Italian architectural designs, silk, Egyptian coffee, Sicilian wheat, cheese, butter, and especially salt from Alicante, Trapani, and Ibiza (Black 2003). Though these goods were valued, they did not match the demand for new exotic materials brought about by falling prices stemming from improved navigation and sailing technologies. The market for products such as Chinese tea, Indian cotton cloth, and New World sugar, coffee, and tobacco benefited from the drop in prices as the overall exchange-value fell. By the 19th century, attempts were made to compete with the New World through the production of tobacco and cotton in the Ottoman Balkans and Egypt during the American Civil War. Despite the attempt to replicate new world goods, the Mediterranean region still lacked the industrial magnitude that Great Britain possessed, forcing much of the Mediterranean to import processed products from the industrial giants (Black 2003). In response, the Mediterranean countries opened their ports to encourage free trade and lower exchange-values. Free ports such as Livorno, Trieste, and Ancona failed to greatly advance local industrial revolutions or stimulate local economies (Black 2003). The reasons for these failures did not stem from the Mediterranean. Successful ports such as the French La Rochelle increased economic enclaves rather than transform industrial practics. Production of local goods such as soap, glass, and porcelain were expanded, but the production of foreign products could not be sustained. The Mediterranean industries had to rely on Britain for their more-industrialized goods. Mediterranean mercantile fleets even had purchased many commercial vehicles from Great Britain in the form of aging ships. British influence seeped into Mediterranean dockyards as British managers were hired for their expert training and shipbuilding knowledge (Pollard 1952). Mediterranean fleets and economies attempted to mimic Britain's success; however, they were unable to match the low production costs of industrial countries, which ironically caused dependability on them rather than the industrial independence they strived for.

4.1.2 Industry and Commerce of Austria-Hungary

Bérenger states that in the late 19th century, Austria-Hungary was one of the global leaders of industry, providing 6 percent of Europe's total manufacturing (1997: 248). These efforts included silk, wool, cotton, linen, pottery & glass production (Proberts Encyclopedia 2005). Austria's steel production made up 6.3 percent of Europe's total steel production, contributing in pig iron and lumber processing. The country was divided in production goals. Hungary favored the use of its agricultural lands, while Austria was determined to follow in the steps of the industrial giants and focus on manufacturing. Following the 1873 elections in Vienna, the shift to a more monarchic government increased the influence of government over private industrial growth, putting Austria behind in the Industrial Revolution. The state intervened in railroad production and public works projects to alleviate the stresses caused by the 1873 Gründerkrach, or "Founders" crash, an economic crisis set off by hyperinflated shares of the Lemberg-Czernowitz-Jassy Railway Company (Sked 2001). In response, the monarchy order industries to operate at basic conditions limiting production and industrial growth.

Figure 4.2: Map of Austria-Hungary in the late 18th century (Proberts' Encyclopedia 2005).

The chief export of the Austrian industrialized state was terrestrial transport vehicles, mostly railways, though many of the trains themselves were purchased from Britain. The Austrian-Hungarian economy suffered due to its reliance of foreign capital, effectively preventing them from becoming an industrial power like Great Britain or France. This dependency did not hinder Austria-Hungary from modernization and industrialization. It still ranked in the top four industrial countries of the 19th century, behind Britain, France, and Germany (Bérenger 1997). During the 1880s, coal production became a strong industry due to the rising use of steam engines. In international trading, the empire was split. The hinterlands of Hungary favored a free market system, while the industrial upper and lower Austria stood strong by its protective tariff policy. Despite increasing their profits over exported goods, the policy resulted in a stagnating industrial situation that would never surpass the larger industrial giants (Kahn 1974).

4.1.3 Austrian Efforts in Maritime Commercialism—Role of Adriatic Ports

Austria Hungary's ocean access was limited to the Adriatic Sea especially the port city of Dubrovnik (located in present-day Croatia) early in the 16^{th}-17^{th} centuries (Fig.4.3). In the 19^{th} century, the major port city became Rijeka. The development of iron shipbuilding on the coast began first in Rijeka and Pula in the second half of the 19^{th} century (Strazcic 1996). Following the economic crisis of 1873, the Austrian government controlled many aspects of shipbuilding such as the class and materials used in ship production. As the Austrian Government placed the iron industry under increased restrictions, the manufacture of specialized iron ship parts decreased. This situation pressed the Adriatic coastal shipbuilders to utilize the traditional

wooden shipbuilding methods, which did not require specialized iron parts. Despite these strong restrictions, evidence of successful efforts by private shipbuilders in Austria exists. One example of a private maritime commercial venture in Austria is the career of Lloyd Triestino, an Austrian from Trieste who established the Danube Steamship Company, which became the largest in the Mediterranean (Strazcic 1996: 451). By the 1880s the government used iron and steel from Austrian terrestrial industries to build steamships, as they were the more profitable and cost-efficient choice. The favorable natural conditions on the Adriatic coast naturally stimulated the development of maritime tradition. It is with good reason that the Adriatic coastline is considered among the oldest maritime regions in Europe (Strazcic 1996). Sailing in late 19th century Austria was generally limited to private shipbuilders who could afford to build in the traditional manner. The governments left much of the shipping to merchant companies wealthy enough to purchase a second-hand British vessel or construct their own iron ships.

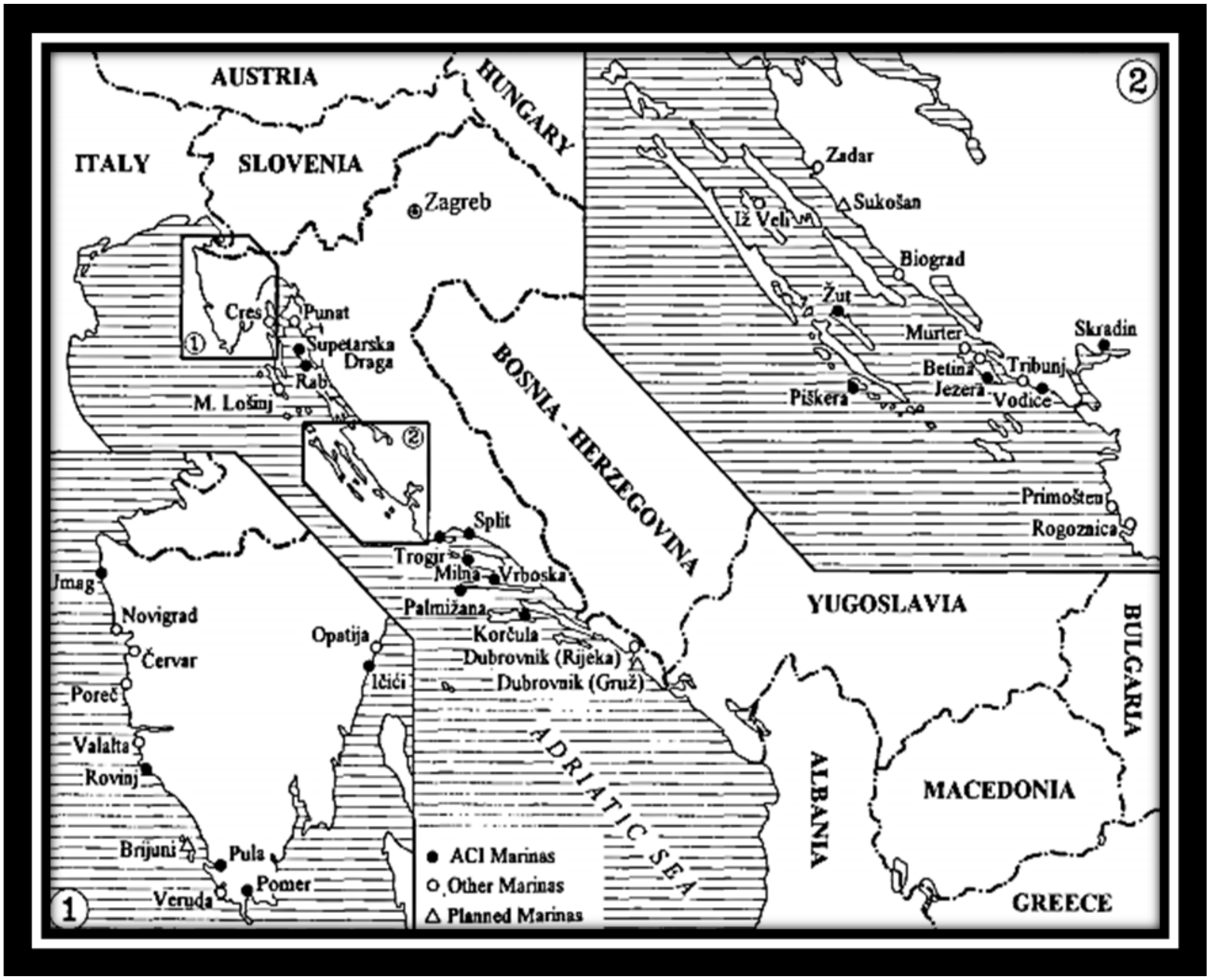

Figure 4.3: Map displaying the geographic locations of yachting ports (marinas) on the Adriatic coast including the major ports of Rijeka and Losinj, homeport of the *Slobodna* (Strazcic 1996: 453).

4.2 CONCLUSION

Austria-Hungry, as a Mediterranean country, reflects the trends and efforts of this region in imitating the economic successes of more-industrial countries like Great Britain, outlined in the previous chapter. Specifically, the opening of free ports, incorporation of agricultural products from the New World, and industrialization of Austria-Hungary's interior, affected the country's maritime practices. Following the 1873 crisis, the involvement of the government limited in the manufacturing efforts of many private industries, including those of shipbuilding, in Austria-Hungary. Nevertheless, private efforts were still successful. As shipbuilders attempted to make the greatest revenue, many opted to build with cost-efficient timber rather than technological-efficient iron. The low-production level of specialized iron ship parts in Austria indicated that iron ships could not be produced without eating into profits. The choice of Austrian shipbuilders testifies that economic gains were more important than the integration of advanced technologies or materials.

5. HISTORY OF THE AUSTRIAN COMPOSITE SHIP, THE *SLOBODNA*

The industrial and economic histories of Great Britain and Austria-Hungary clearly show that profitability determined whether technological advancements would be incorporated into ship construction. The specific history and archaeological analysis of one composite ship, the *Slobodna*, will illustrate its place in these historical frameworks. The next two chapters will address the primary documents and archaeological documentation of the shipwreck. From a discussion of the archaeological features and historic accounts, the economic and industrial history of the country can be elucidated. Furthermore, this case study provides a better understanding of the experience of the private shipbuilders and how the profit motivations of private entrepreneurs drove the decision to incorporate new advancements in shipbuilding technology.

5.1. CONSTRUCTION AND EARLY YEARS

The history of the *Slobodna* begins in Losinj (Fig. 5.1), an island in the Cres-Losinj archipelago known for its ship construction (Stallaerts et al 1995). In the 19th century, Losinj was under the rule of Austria-Hungary. In light of the country's limited production of specialized iron shipbuilding parts, the industries of Losinj

Figure 5.1: Map with Red Star indicating the *Slobodna*'s home port, Herceg-Novi (Retherford 1995).

utilized the available timber reserves of Austria to construct in both iron and wood. The vessel was constructed in 1884 by Nikolo Martinovich, a regional expert in shipbuilding. Normally, his ships were small and lighter than those produced by Great Britain. Martinovich's vessel was a special order for Captain S. Milinovich. Primary documents indicate Milinovich was both owner and master of the *Slobodna*, with Castelnuovo (Herceg-Novi), where Milinovich was based, listed as the ship's homeport. The *Slobodna* was most likely the last composite ship Martinovich ever built (Smith 2007). These unique circumstances allow the ship to accurately reflect the changing times that private Austrian shipbuilders encountered when she was built.

The *Slobodna* had three masts and was listed at 1199 tons, typical of the rigged vessels of the time (Fengar 1877). The dimensions given were 52m in length, 10.8m in breadth and a cargo hold depth of 7.7m (Fengar 1877). Average-sized vessels produced by the more-industrial countries weighed in around 2,000 tons and reached a length of 60 meters. The salvage records indicated that when loaded, the ship drew 5.1m forward and 5.5m aft (Smith 2007). The *Slobodna's* maiden voyage departed from Herceg-Novi in Montenegro in 1884. Three years later, Milinovich and his special-order ship left New Orleans on March 9th, 1887 to sell American cotton in Baltic ports. By this time, recent innovations in steam engines had given the steamship dominance in Europe's freighting industry. Aware of his sharp disadvantages, Milinovich remained determined to make a profit, taking all shortcuts possible. Unaware of the oceanic terrain of the Florida Keys, he sailed too close to the eastern reefs of Florida, where he was caught in a sudden squall that eventually pushed the *Slobodna* onto Molasses Reef on March 16th.

5.2 WRECKAGE AND SALVAGE

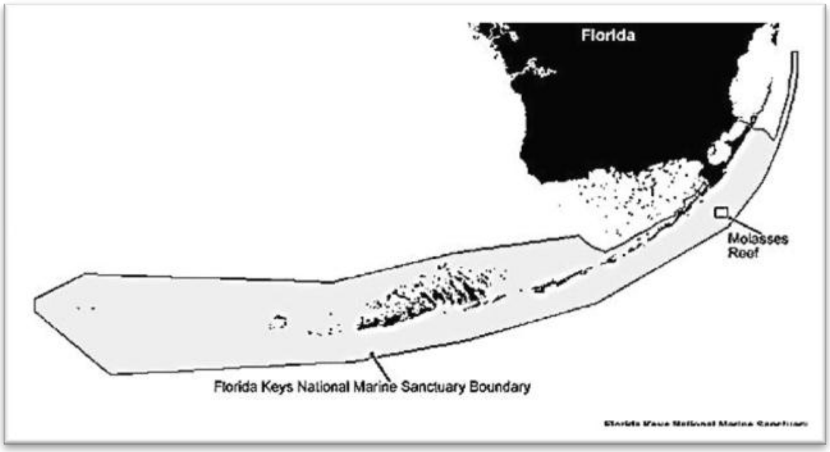

Figure 5.2: Map of Molasses Reef in relation to the coast and protected sites of Florida Keys National Marine Sanctuaries (NOAA n.d.).

At the time of the wreck, the *Slobodna* was jammed with 4,500 bales of cotton, weighing 500 pounds each, for a total weight of 1,125 tons. Milinovich knew the value of American cotton in the Adriatic and Europe at the time would make him very wealthy (Smith 2007). With profit incentives, Milinovich attempted several times to free his ship with the rising tides. The ship was spotted by Libellant Baker about 9:00 am that morning on the Florida Reef zone, known then as French Reef, now referred to as the Molasses Reef zone. Due to the overpricing and corruption that was rampant in the salvaging business, Milinovich avoided salvaging offers from the *City of Key West*. In this business, captains often lost much of their cargo value, barely recovering their initial investment. With no hope of freeing *Slobodna*, Milinovich gave in to the salvaging offers. The *City of Key West* and the *Rapid* conducted the salvaging operations of Milinovich's ship with 335 men and 41 vessels continuing for 30 days (Retherford 2001). During the cargo-recovery mission, a squall came alongside the ship again complicating any salvaging attempts made. Only 29 bales of cotton could be recovered. With all the attempts made, the salvagers claimed they only removed 1,208 bales of cotton, leaving roughly 3,300 in the hold, but later surveyors reported only 400 bales remaining after the April 6th report. Though the discrepancies in the reports between the court records provided by the salvagers and the records of the surveyors of the loss of cotton, it is certain Milinovich lost 2,700 tons of cargo, whether to the sea or to corrupt salvaging practices (Smith 2007: 11).

Continuing squalls and inclement weather led to poor recovery results and increased damage to *Slobodna*. By April 14th, salvage had been completely abandoned. Following the end of salvaging, two surveys were conducted on *Slobodna*. The first took place on April 6th and another on April 20th 1887, to address whether full salvage was possible. These reports would be the last work ever conducted on *Slobodna* until excavations began in 1998.

5.2 CONCLUSION

The *Slobodna* was a product of its time, a result of the industrialization and economic situation of Austria-Hungary. The historical analysis of the vessel shows why the vessel had the specific construction characteristics it did. The unique historic past of Martinovich only reinforces the greater historical context. It is only though this context that the *Slobodna* can be examined to explore the relationship of profitability and production in Austria-Hungary. The next section will amplify this relationship through the archaeological record. The features of the *Slobodna* will highlight the technical aspects that display the level of the integration of industrial products as they provided the highest possible revenue for shipbuilders in 19th century Austria-Hungary.

6. ARCHAEOLOGICAL DOCUMENTATION AND ANALYSIS OF THE *SLOBODNA*

A refined study of the *Slobodna* would not be possible with a review of the historical background alone. It is the interpretation of its physical remains of the ship and its original components that provide a framework of the historical context (Catsambis 2011). Archaeology offers insight that extends beyond the written record to provide additional information that strengthens the claims of this thesis. Though shipwreck and maritime archaeology, further examination of the wreckage reveals the *Slobodna*'s role in the industrial and economic developments in 19th century Europe. From a discussion of the *Slobodna*'s features, it is possible to observe the level of industrialization present in Austria and how native shipbuilders constructed with timber rather than iron for long distance trading vessels. Despite the fact Austrian shipbuilders continued to build with the more affordable wooden reserves, their choices show the influence to increase profitability rather than build with a more technological superior material.

Beginning with a history of archaeological research conducted at the *Slobodna* wreck site, the discussion focuses on the recent 2011 field season as it holds the largest amount of available data. Through a discussion and analysis of the documented features, it is possible to draw conclusions about the incorporation and affordability of iron in relation to its profitability as a shipbuilding material in Austria and Europe in the 19th century. It is only through the interpretation of its features and the ship's preserved structure that a discussion of the function and technical characteristics of the ship can be provided (Catsambis 2011). This information will be compared to several other contemporary composite ships such as the *Vicar of Bray* and composite architecture from vessels mentioned in the works of Michael K. Stammers (1999, 2011). A list of shipbuilding terms and definitions can be found in Appendix B while a list of the measurements taken from the documented features from the 2011 field season are found in Appendix C.

6.1 SHIPWRECK ARCHAEOLOGY

6.1.1 Overview

In order to conduct a proper analysis of the *Slobodna*, a definition of a ship must be established with attention to the technical and socio-economic aspects. Keith Muckelroy in *Maritime Archaeology* establishes the most generally accepted definition of a ship:

> The ship is a machine. It is, however, a complex machine that floats and moves in a way that is both autonomous and controlled, and constitutes an architectural system coupled with a technical system….The ship is an instrument adapted to a function. The instrument is designed to respond to precise needs arising from a political, economic, or military system. This instrument constitutes a functional system….The ship is the living and working environment of a micro-society. It is, however, a closed society whose hierarchy, beliefs, rules, rhythms of life, and tools make up a particular social system (1978: 12).

Underwater archaeology attempts to define all aspects that a ship presents. It is through the remains uncovered by archaeology that these traits can be documented and interpreted to the fullest extent. With these submerged remains, archaeologists implement a wide variety of scientific sources that ensure proper preservation and substantial data acquirement (Gould 2000: 7). Like its land-based predecessors, the results drawn from nautical archaeology serve to confirm historical accounts and establish theories concerning pre-history (Gibbins et al. 2001). Richard Gould classifies submerged archaeology as a sub-field of the science whose primary objective is to "present a clear-picture of the socio-cultural processes that produced the patterning observed in the archaeological record" (2000: 48). This specific sub-field of archaeology frequently encounters the type of site that is rarely encountered on land: event-based sites. Shipwrecks act as “time-capsules” where all the artifacts on board are culturally related and contemporaneous, offering a clear picture into the historic, or pre-historic, time period of a specific culture. (Gould 2000). Theoretically, underwater archaeologists and terrestrial ones are the same. The difference comes in the sources, types of artifacts and the different taphonomic forces that act on the remains..

6.1.2 Maritime vs. Nautical Archaeology

Underwater archaeology is typically broken down into two fields: maritime archaeology and nautical archaeology. While maritime fieldwork falls under the broader aspect of archaeology, it considers scenarios in which the cargo, dockyards, and the ship itself reflect socio-economical spheres via transportation, consumption, and ship technologies (Gibbins et al. 2001: 279). Gibbins et al best defines maritime archaeology as “the study of material remains of human activities on the seas and interconnected waterways”. Nautical archaeology focuses more on the preservation and retrieving of artifacts (2001: 280). In regards to artifact recovery, much of the remains found in aquatic environments take heavy damage from interior decaying agents such as the teredo worm (*Teredo navalis)* in addition to being encrusted with coral concretions (Allen et al 2005). Such preservation issues and difficulties of recovery in marine environments ensure that there is a high cost attached to underwater archaeology. Despite the poor conservation of these artifacts, underwater archaeology can be integrated with other forms of archaeological evidence providing, not a specific or isolating examination, but one that is mutually beneficial for strengthening interpretations as well as crafting new theories (Gibbins et al.). Using the established processes of materialism and archaeological interpretation, water-based archaeology is capable of impacting the sciences in the same manner as terrestrial archaeology.

6.1.3 Wrecking Process

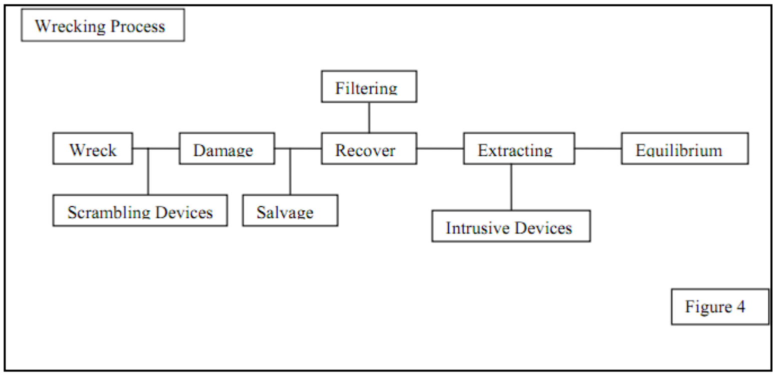

Figure 6.1: An outline of Muckelroy's wrecking process as described by Cory Retherford (1995: 8).

One of the most interesting and unique processes that shipwreck archaeology deals with is the wrecking process of ships. The Keith Muckelroy model best outlines the process (Fig. 6.1). It follows the shipwreck process from a human-organized vessel to an equilibrium state with the underwater environment. The wrecking process varies in every case study, but many undergo the larger aspects of the model. The initial organization of the ship is disrupted once the wrecking process begins. Human interaction in the processes of recovery, salvage and extraction may occur at anytime from the initial wrecking to equilibrium. The natural forces of the environment then proceed to naturally filter and dissipate many of the remains. With the sudden introduction of the ship to the location, the local currents may be altered for the time being as the ship exists in its unstable state. Taphonomy begins to take place as chemical and biological agents continue to act upon much of the structures and artifacts until the vessel gains a state of equilibrium. Equilibrium is reached when the shipwreck is incorporated into the marine ecosystem, which then provides protection by sedimentation and further decay of perishable materials of the ship through chemical deterioration (Beeker 1995). Throughout this process, human intervention may proceed at different intervals through salvaging or archaeological documentation and this also has the potential to further decay or preserve the structure. The *Slobodna* currently exists in an equilibrium state with much of the biodegradable materials already decomposed by the environment. It is in this state that the archaeological documentation and research for the ship have been carried out since the first investigations in 1997.

6.1.4. Shipwreck Archaeology and the *Slobodna*

A case study such as the *Slobodna* requires both nautical and maritime archaeology to present a strong case for the ship as a model of the techno-economic situation of the 19th century. Using Muckelroy's definition (1978), the analysis of the *Slobodna* continues with an exploration of the physical features of the related sites. With modern technology and proper techniques, it is possible for archaeologists to examine the site of the *Slobodna* with attention to the remaining details of the vessel. Though much of the vessel has been lost to the erosion, deterioration, and displacement processes of the wrecking model, archaeologists are able to investigate the areas where the remaining structural fragments of the ship have been found, while searching for the remaining artifacts. Through the model of the *Slobodna*, archaeologists may now uncover more information about the technology that came about with structural and material advances of composite sailing ships and their designs during their submission to the power of steam. As Austria was greatly influenced by Great Britain in the 19th century, the *Slobodna*'s design will be compared to those stemming from British-built composite ships such as Stammers' *Vicar de Bray*. This vessel, along with the *Catharine*, *Loftus*, and the Pulaski site, make up the few existing examples of iron shipbuilding in Europe and the Mediterranean in the 19th century (Stammers 2001, Souza 1998, Ho 2004, Burns 1999). It is through maritime archaeology that the case study of the *Slobodna* is capable of providing insights into the economic and industrial circumstances surrounding the integration of iron and how the architecture of a Mediterranean vessel depicts the larger economic motivations of Europe in the 19th century.

6.2 PAST RESEARCH EFFORTS

6.2.1 Discovery and Confirmation: Indiana University (1998-2005)

Since 1998, the *Slobodna*, along with hundreds of other shipwrecks, has been under the protection of the Florida Keys National Marine Sanctuary (FKNMS) and the organization of the National Oceanic and Atmospheric Administration (NOAA) (Terrell 2003). The sanctuary encompasses the Molasses Reef zone as well as a group of shipwreck sites known as Shipwreck Trail. Here, nine documented shipwrecks lie with several unidentified artifact deposits in the sanctuary's boundaries. Two of these deposits were tied to the *Slobodna* (Allen et. al. 2005). Though the site had been protected since the sanctuary was first established in 1997, it has become a favorite destination of recreational divers since the 1970s. The prelude to the archaeological work on the *Slobodna* began with the Hayes Report of 1995, which first identified two wreck sites, the *Main-Mast* site and the *Winch Hole* site (Indiana University 2001). In 1998, Cory Retherford of Indiana University conducted historic analyses of the Admiralty Records and several maps, both provided by the city of New Orleans, which linked the two sites to that of the *Slobodna*. Retherford's correlation study was further determined through an artifact comparison focusing on similar qualities and characteristics found at the two sites (1998). Through continuing efforts many of the artifacts at the *Main-Mast Wreck* site have been documented and allow for reconstruction of the *Slobodna*'s bow. Figure 6.2 shows the relation of the *Slobodna*'s sites to the neighboring Tavernier and Rodriguez Keys.

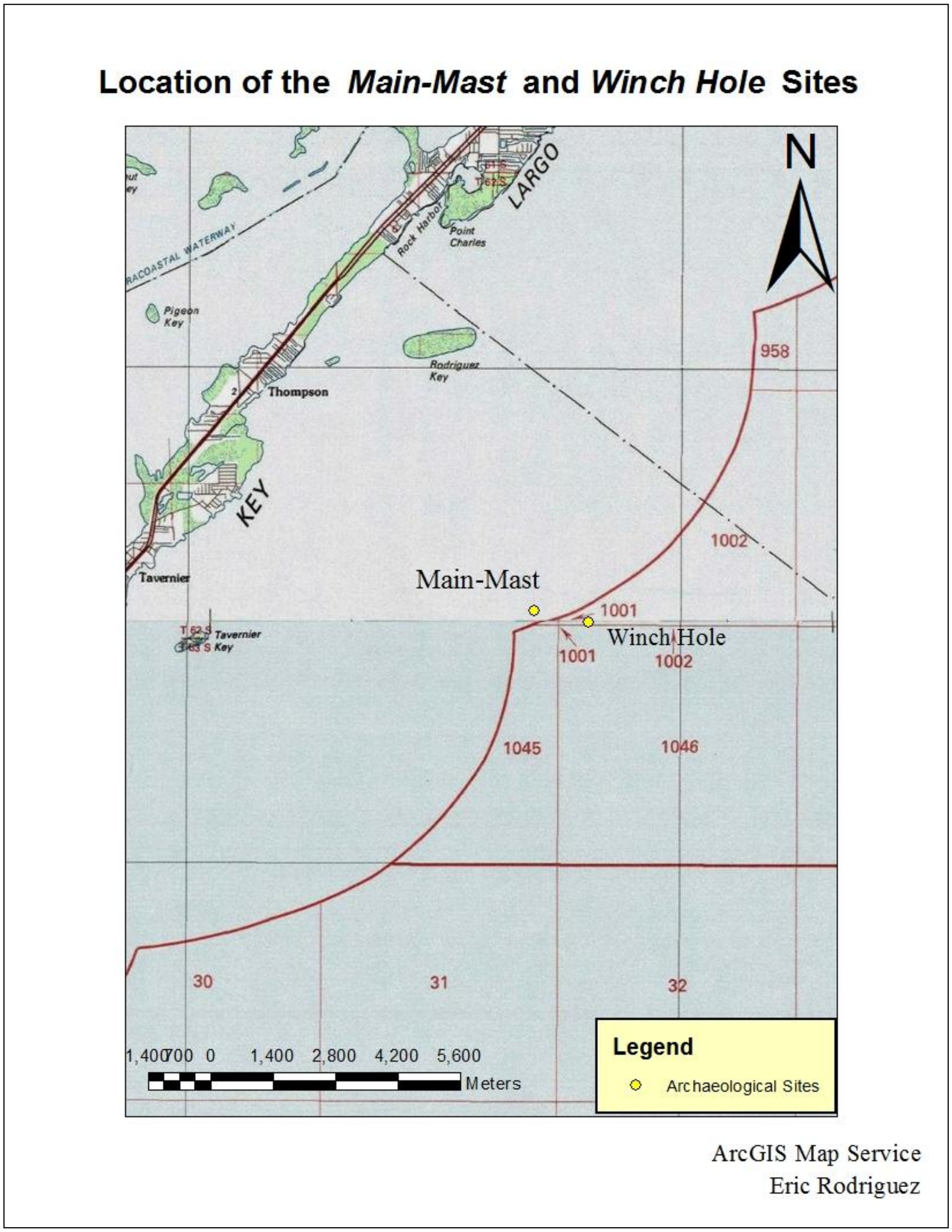

Figure 6.2: Location of the *Slobodna*'s Main-Mast Wreck and Winch Hole sites in relation to the Rodriguez and Tavernier Keys used to correlate the sites to the salvage reports (data supplied by ArcGIS Map Service)

6.2.2 FURTHER DOCUMENTATION: PAST FOUNDATION (2005-PRESENT)

Beginning in 2005, and continuing in 2006, 2010, and 2011 the PAST Foundation has focused on the *Main-Mast Wreck* site and the *Winch Hole* site documenting the iron framework and mechanical workings of the ship. The director of the program, Dr. Sheli Smith, oversaw the publication of site reports for each field season cumulating in one archaeological study in released in 2007. For the initial season in 2005, the team divided their project into five phases: familiarization, site preparation, artifact documentation, site cartography, and further suggestions. From the 2005 season, the teams were able to identify five first futtocks taken from the ship's hull; two masts; hanging, lodge, and dagger knees, clamps, strapping, bitts, and various deck beam fragments such as brackets (Allen et al 2005: 2). The team encountered and confirmed the rigging features, first noted in 2001 by Cory Retherford. The location and status of the features of the masts, tanks, and bitts all hinted that the portion of the *Main-Mast Wreck* site belonged to the forward half of the vessel (Allen et al 2005: 5). Measurements taken from this season matching the salvage records provide conclusive evidence that the ship is the *Slobodna*. The 2005 surveying methodology was divided into four phases where the team familiarized themselves with the site; dividing the region into quadrants; implementing triangulation, angle distance, and direct artifact measurements; and finally constructing a drawn-to-scale model of the site, highlighting the artifact locations (Allen et al 2005: 4).

In 2006, the PAST Foundation returned to the site to continue documenting the site of the *Slobodna*. Due to inclement weather and the effects of Hurricane Wilma, the *Main-Mast Wreck* site had acquired around 3 feet of deposited sand, limiting the efforts of the 2006 team. With very limited access to the site, the project began to focus more heavily on the *Winch Hole* site, unearthing a boiler from a donkey engine, standing rigging deadeyes, upper mast couplings, several pieces of the winch, spar rings with lots of fragmentary cable rigging, as well as miscellaneous rigging fragments. The 2006 team constructed a digital exhibition for the *Slobodna* pulling the data from the collected archaeological information, historical documentation of the salvage reports, artifact databases, and using an artifact collection from the 19^{th} century ship Adelaide Baker to create a comparison[2]. Through the combined efforts of the 2005 and 2006 teams, 60% of the *Main-Mast Wreck* site and 80% of the *Winch Hole* site had been documented (Arnold et. al: 10).

In 2007, drift snorkeling uncovered several new sections of hull close to the *Winch Hole* site, similar to that of the *Slobodna* motivating the PAST Foundation to continue research beginning in August 2010. Through a snorkeling survey, artifacts were seen scattered throughout the *Main-Mast* site. The teams designated datum points and recorded the artifacts located in the sand pit region (see Figure 6.4) (Anderson et al, 2010). The 2011 team continued the documentation efforts near the *Winch Hole* site, while simultaneously attempted to locate additional fragments of the *Slobodna*. Through continuing research, more information about the *Slobodna* can be unearthed and added to the general knowledge of the nature of composite ships and mercantile affairs of the 19^{th} century.

6. 3 METHODOLOGY AND 2011 GOALS

6.3.1 Site Description

Since wrecking, the remains of the *Slobodna* currently occupy 2 distinct loci along Molasses Reef (see Figure 6.3). The maximum depth of the sites is 25 feet. Due to the proximity to the equator, the site's temperature ranges from 62.0^{o}F to $+100^{o}$F. Ideal diving conditions allow up to

[2] For more information, visit: http://www.pastfoundation.org/2006Slobodna/History.htm

50 ft. of visibility. The portion of the *Winch Hole* site that the 2011 team worked on was an expansion from the 2010 site that focused on the sandpit near Buoy 13 on Molasses Reef. The focus of the 2011 documentation efforts were in the ravines, which are numbered in Figure 6.4. The mainmast documented in 2011 stretches roughly 102 feet. The purple cross indicates an indentation in the coral shelves. During the wreckage, it is speculated that the keel repeatedly crashed into the shelves. With this interpretation, the initial spot of wrecking can be determined. Adding to this hypothesis, the team found several sections of the keel in their area, which could have been severed during the initial contact with the shelf. The indentations in the reef run at a 250° heading. As mentioned earlier, Molasses Reef is located inside the boundaries of a government-protected sanctuary. As seen in Figure 6.4, the large unshaded regions

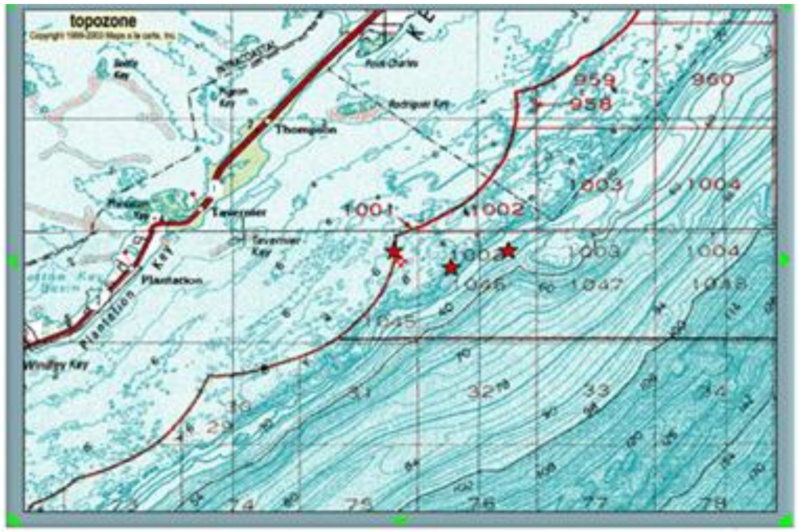

Figure 6.3: The two sites of the *Slobodna* indicated by two red stars with an additional star referencing the probable location of the still-missing stern (Smith 20: 14).

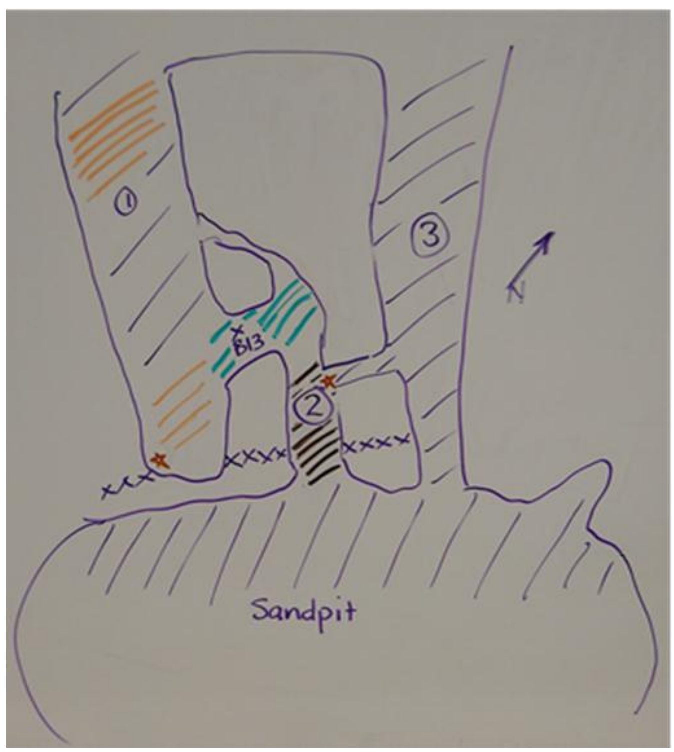

Figure 6.4: Map of Buoy 13, the *Slobodna* Amidship Site. The two orange stars indicate the location of the Main Mast (Bendig et al 2011: 5).

represent coral reefs. According to Muckelroy's wrecking outline (1978), the site has not yet obtained an equilibrium status, creating time constraints to document the continuously degrading artifacts.

6.3.2 2011 Efforts to Locate the *Slobodna*'s Stern

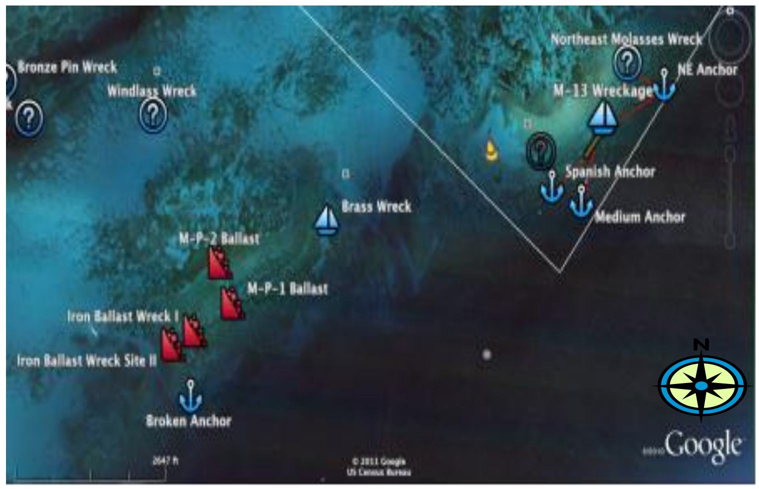

Figure 6.5: Locations of interest surrounding Molasses Reef including the potential sites of *Spanish Anchor*, *Medium Anchor* and *Northeast Anchor* (Bendig et al 2011: 3).

The first research objective of the 2011 field season was to locate the stern of the *Slobodna*. Lead by a dive safety instructor, the teams rotated daily investigating locations along the 1888 hurricane's path. During the first two days, the teams searched the locations based on higher prevailing winds of hurricane patterns of the 1888 and 1887, which would have pushed the stern eastward in the sites of *Northeast Molasses* wreck, *Spanish Anchor*, *Medium Anchor*, and *Northeast Anchor* (see Figure 6.5). The days following would focus on the sites based on the lower prevailing winds of the same hurricane patterns that would have pushed the stern towards a 210^{o} heading. The sites in this direction were *M-1 Ballast* site, and *M-2 Ballast* site, going out as far as the *Bronze Pin Wreck*. At these sites, both snorkeling and scuba diving were employed at depths ranging from 10-45 ft. Team members would start from the designated buoys found at the sites and scour the cardinal directions for 20-30 ft. then begin to circle in a clover-leaf shaped pattern. For larger area investigations, a towing survey was employed where two members were attached by ropes spread apart by ~10 feet at the edges of the boat's stern.

6.3.3 2011 Methodology and Logistics

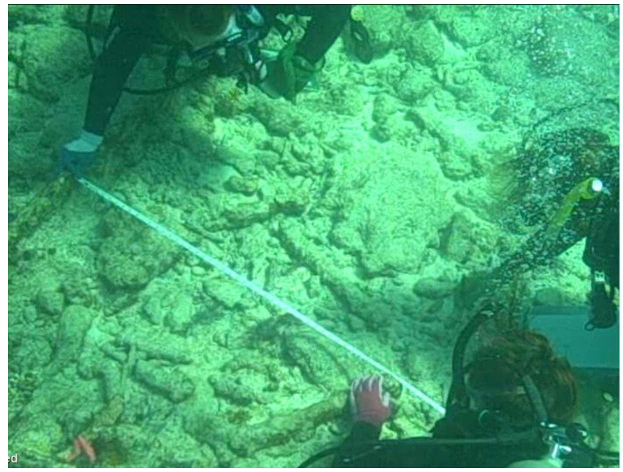

Figure 6.6: Divers of the 2011 field season trilaterating a rider knee fragment (Bendig et al. 2011: Electronic Appendix).

The second research objective of the 2011 field season was to map and describe artifacts at the *Main-Mast* site (Bendig et al. 2011). These objectives were accomplished by breaking the participants into three teams assigned to the colors red, green, and blue. The methodology for examining the amidship section involved trilateration and underwater surveying, which are low-tech in nature but effective in achieving the goals of the project. Trilateration is the most-widely used two-dimensional method for underwater mapping, by taking distances between known datum points across the site, and then measuring distances from those datums to artifacts (Smith 2006). It begins with gathering three legs (or distances) that will make up the triangle. These legs are pre-established as baselines or datum points. By choosing widely placed points, chance of error was reduced and the accuracy of the location of the artifact points was increased (Smith 2006).

6.3.4 Feature Locations

The primary goal of the Red Team was to document Ravine 1, represented by the orange sections located on Figure 6.4. The Green Team and the Blue Team split the documentation efforts of Ravine 2, leaving Ravine 3 undocumented for future field seasons

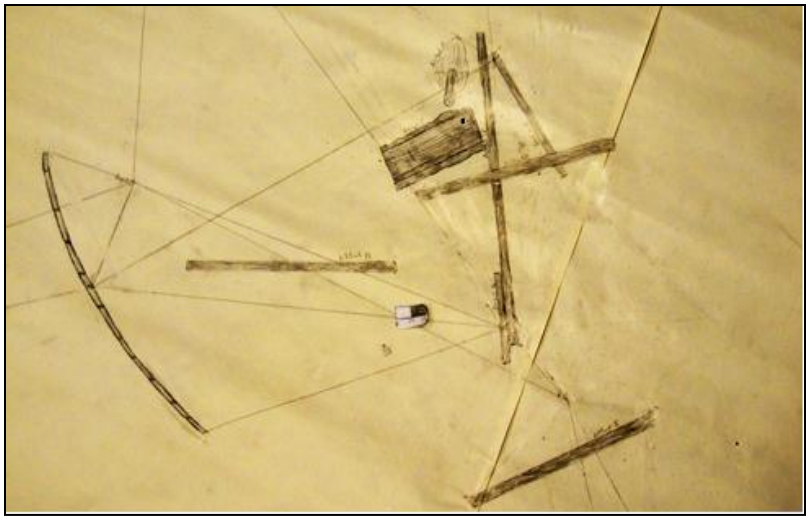

Figure 6.7: Map of documented features in Ravine 2 during the 2011 field season, including several I-beams and T-beams of its iron hullwork. Features described by the Green team included three I-beams that averaged 16’ 8” in length, 5.83” in width, and 5.2” in height; four T-beams that averaged 9’ 4.5” in length, 5.75” in width, and 6” in height; and two larger sheets of metal that might have comprised part of the ship’s mainmast. (Bendig et al 2011: 6).

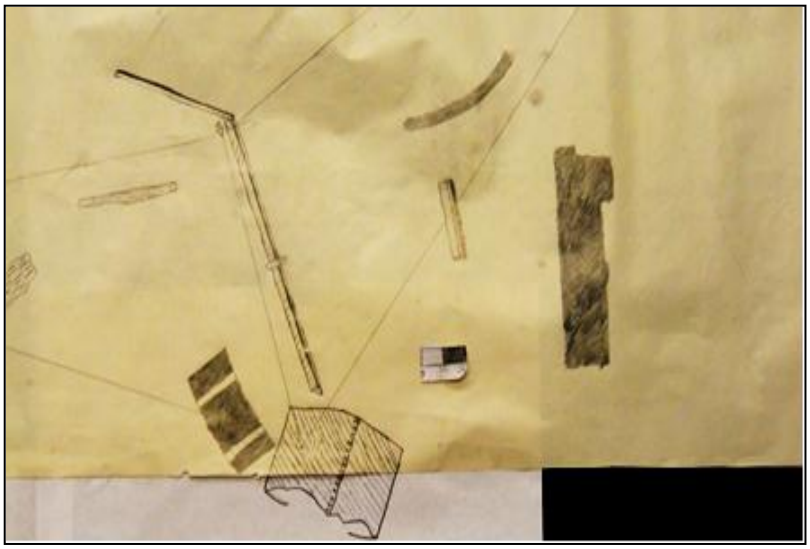

Figure 6.8: Feature map constructed by the Red Team. Scattered across Ravine 2, several knees were documented including hanging and lodge. Lodge knees were recorded at ~4’ in length and supported the deck (horizontal) beams. (Bendig 2011: 8)

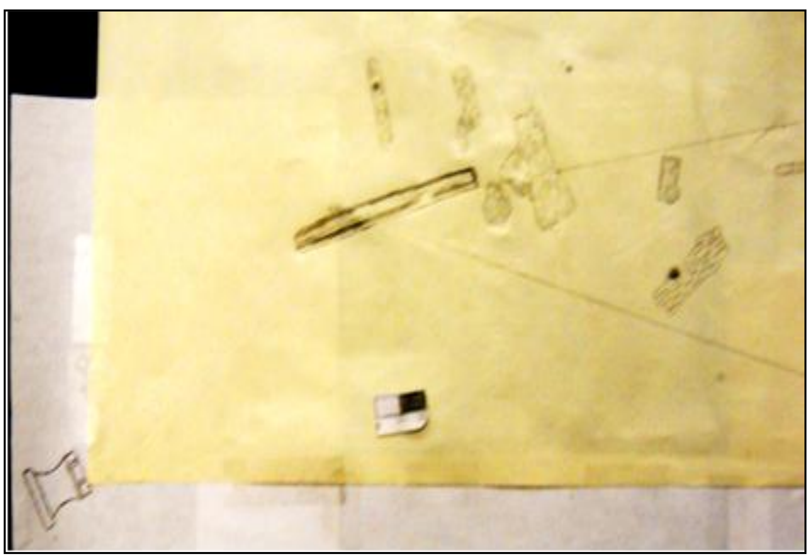

Figure 6.9: Map composed by Blue team, including the capstan, five keel fragments, four T-beams, a square beam, and three larger portions of the mainmast. Each of the five pieces that were discovered had a thickness of 4 inches. By refitting these pieces together, the keel is approximately 3 feet thick. The diameter of this mainmast section measured 5’1” and was held together by 1” rivets connecting the iron sheets. These beams were quite large in length ranging from 2’10” to 10”11 (Bendig et al 2011: 6)

6.4 2011 Feature Documentation

The second research objective of the 2011 *Slobodna* Project was to map the artifacts located at the *Main-Mast* site. Overall, thirty-two artifacts were measured and described before being plotted on a map portraying the amidship region of the *Slobodna*. The scale used was 0.5 inches per foot allowing the teams to place the artifacts proportionally on the map in a reasonable amount of space.

6.4.1 Framing Systems

Figure 6.10: Bronze Fasteners located at Ravine 2 of the Bronze Wreck Site (Bendig et al. 2011: Electronic Appendix).

One of the first features documented by the Retherford expeditions and the 2005-06 field seasons were bronze pins. The large quantity of pins (fasteners) at the site had led to being first termed as the *Bronze Wreck* site, now referred to as the *Main-Mast* site (Fig 6.10). These bronze pins are the last remnants of the framing system and can be used to determine the width of the hull and the amount of timber a given point in the hull. Pins have been found to reach upwards of 1 meter signifying the fact they were directly utilized in assembling the bow, usually reaching a thickness of the same measurement (Smith 2007). The longest pins would have been used for attaching parts of the stem deadwood together. These points in the bow relay the size of the composite structure hull. Large breast hooks fastened the two sides together at the forward apex of the ship. Together this piece weighed ~454kg, with their thickest point reaching 0.3 meters. The length of the bronze pins at the breast hooks, reproduce the sum of the thickness of the wale, the frame and the breast hook (Smith 2007). The length of the pins at the forward deadwood, reflect the thickness of the deadwood, the keelson, the frame, and the keel. The longest deadwood pins are located both the bow and the stern. Unfortunately, due to public diver salvaging, many of the pins have been removed. A study of the remaining pins provides an adequate range of lengths indicating the thickness of the vessel. Bronze pins were initially used in ships since 1783, a watershed date for all metallic fastenings (McCarthy 2005). Bronze pins in the hull were commonplace among all ships, especially in the composite ship designs, following the patent of iron fastenings by J. Purnell (McCarthy 2005). Those found at the sites of the *Slobodna* reflect the level of industrialization able to produce these pieces at affordable rates in Austria-Hungary.

6.4.2 Interior Iron Structure

The *Slobodna* sites contained large structural beams, mostly T-beams and I-beams (Fig 6.11). These beams were documented at the *Winch Hole* site during the 2011 season. The documented I-beams recorded were larger than the T-beams indicating the

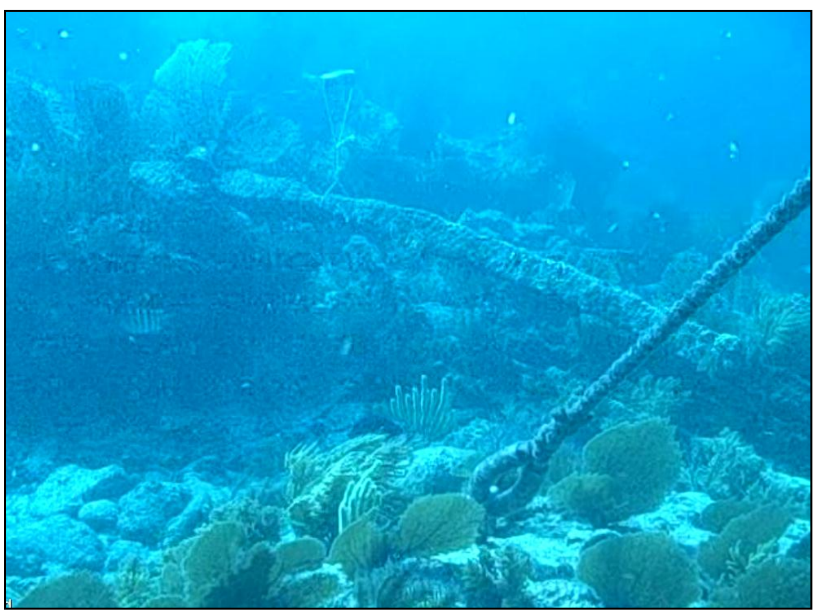

Figure 6.11: I-Beam documented during the 2011 field season located in Ravine 2 (Bendig et al 2011: Electronic Appendix).

differentiation in function between the two types. I-beams were designed to prevent bending of the hull, while typically running across the bow. T-beams ran horizontally (Fig 6.12). T-beams were typically inverted to allow joining of beams. The *Slobodna* was composed of wooden hull beams and transverse deck iron beams, providing joining strength between adjacent horizontal hull beams. This cluster of I-beams and T-beams indicate the ship's site formation processes. These types of features make up the initial wrecking site where the majority of the hull came to rest. T-shaped fittings acted as part of a deck support system and reinforce the area of the bow where a lodge knee could not fit (Paasch 1890). Flat iron bracing and U-shaped angle iron were spread around the T-shape areas and reflect diagonal and/or horizontal reinforcement along the longitudinal run of the hull. Because of the dwindling remains of wooden framing, it is problematic to assume the structural context of the braces. Iron tresses were regularly applied and appear throughout the 19th century and into the 20th century (Desmond 1919:62, 99). The amount of iron hull pieces in comparison to the amount of rigging related pieces reflects the overall makeup of the hull (Smith 2007).

Figure 6.12: A 19th century composite sailing ship hull structure highlighting the use of I-beams and T-beams. (Histarmar Foundation 2011)

The *Slobodna* was overwhelmingly wooden in construction with an iron infrastructure. This fact indicates which components of regional shipbuilding were difficult to manufacture with the available wood along the Adriatic coastline. The use of iron in knees and masts reveal the extent of the depleted forest reserves on European shipbuilders and part of the reason for the switch to composite iron sailing ships. The fact that the *Slobodna* is a composite ship indicates the industrial situation in Austria and how the country's shipbuilders utilized the level of iron production incorporating local iron for the benefits and the increase in profitability it brought. Due to the 1873 crash and the lack of specialized manufacturing of iron parts, private builders opted to construct ships with local timber, rather than import specialized iron parts from foreign sources. However, these iron beams indicated that the industry production in Austria was able to manufacture these beams for shipbuilding. Furthermore, it shows that though the technology for completely iron shipbuilding was present. The restrictions placed on Austria's industrialization limited the production of specialized iron parts, forcing Austria to build with timber in these areas rather than succumb to additional costs for importation. The importation costs were too high or not reflective of the benefits of a fully iron vessel. The interior iron structure of the vessel reflects this scenario. As only larger industrial beams are present, shipbuilders chose to construct more specialized parts in timber due to the large reserves present and surplus that was attainable due to low production costs of partially iron ships.

Five pieces of keel were also discovered in Ravine 2 adjacent to each other with pieces over lapping one another. After initial exposure of the keel three years ago, these wooden pieces have decomposed significantly. Today, these pieces are no longer connected as one keel piece. Each of the five pieces that were discovered had a thickness of 4 inches. By refitting these pieces together, the keel is approximately 3 feet thick. The location of these five pieces correlates with a depression running on a heading of 250^{o} found in the top of the coral heads at the site. This bearing suggests the location where the *Slobodna* initially impacted the reef. The remains of the keel prove vital to determining the wrecking process and size of the *Slobodna*, while simultaneously verifying the dimensions and wreckage claims of the 1887 salvage reports. Like the iron interior structure, the keel reveals the level of woodwork in the *Slobodna*. Even with the structural frames available in iron at the time, the low costs of timber drew shipbuilders to this material rather than the efficiency of iron usage.

The mainmast at the amidship was constructed of metal sheets riveted together to form a hollow mast supported by T-beams bracing each metal sheet (Bendig et al 2011). The largest documented piece of mast still retained its cylindrical structure. The diameter of this mast section measured 5’1” and was held together by 1” rivets connecting the iron sheets. The large diameter of this mast section implies this section would have been a lower portion of the mainmast nearest to the keel. Two other mast sections lay close to the largest section; these iron sheets have been severely damaged and flattened by years of damaging wind and sea currents. The T-beam braces are still visibly attached to the inside of each of the sections. Throughout the site, nineteen different pieces have been identified as part of the mainmast, spanning from datum point 7 to datum point 13. This is a distance of approximately 102 feet, suggesting an approximate size of main mast at this site. Three wooden fragments not associated with the keel were also discovered in Ravine 2, within the same general location. The dimensions of these fragments ranged from 4’4” to 1’5” in length. These pieces are speculated to be associated with the hull of the ship. In the same ravine, four T-beams and a square beam were recorded. These T-beams can be connected to the support braces found in the mainmast sections. This can be determined by the location of the beams in relation to the largest section of mast documented. A 10’11” section of T-beam protruding from the bottom of the largest mast section is evidence of the direction and length of the mainmast in this area. All of these features provide vital information about the construction and wrecking process the *Slobodna* underwent. The structure of the ship agrees with the general architectural trends that were typical of the composite ship design while expressing the unique situation that Austrian privateers faced in the 19th century. Like the keel and beams, these features support the notion and display that Austrian industries produced iron yet its incorporation depended on the profitability attained through its integration.

6.4.3 Iron Knees

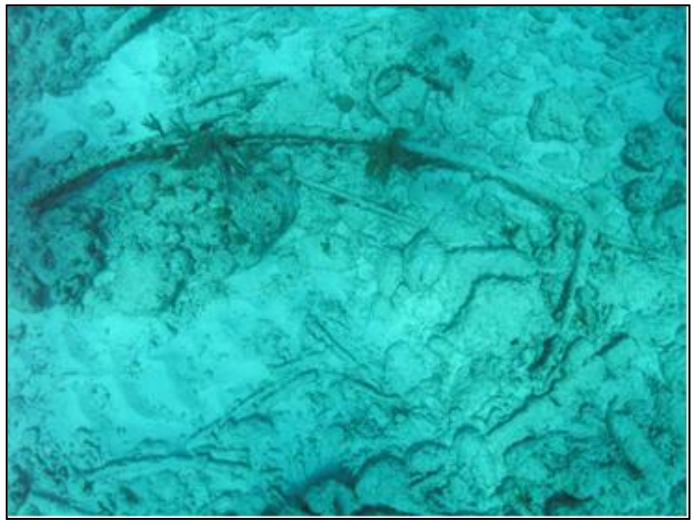

Figure 6.13: Dagger knees located in Ravine 2 matching the curvature of the vessel (Smith 2007).

One aspect of the efforts of the 2011 season focused on groupings of knees of hanging and lodge located at the amidship. Knees were documented in both sites of the *Slobodna*, with a majority coming from the *Main-Mast* site (Fig 6.13). Knees were among the most frequent fragments of the ships found in the upper portions of Ravine 1 throughout the field seasons. Knees are vital to illuminating information on the construction patterns of the hull. Perhaps the most important piece of information the knees provided is the distance between the *Slobodna'*s deck beams, which measured 4' apart. Multiple pieces of hanging knees and I-beams were found attached, giving a direct model of the configuration to the hull. Lodge knees recorded were ~4' in length and supported the deck (horizontal) beams. The length of the lodge knees is proportional to the distance between the hull ribs, making them ~4' as well. The spacing of the rivets in the lodge knees (on average six inches) is also suggestive of the spacing of the hull ribs. All five of the knees, three hanging and two lodges total, were broken. The knees in situ can be seen in Figure 6.8.

Iron knees found in composite vessels are capable of reproducing the underpinning structure of ships and describing the shape of the hull (Smith 2007). Three lower deck rider knees highlight the distinctive lower curvature, which would have been typically placed in the forward run of the hull (Desmond 1919). Hanging knees were longer, crafted over 5', and typically associated with I-beams (Desmond 1919). These knees make up the last section of curving in the bow. These classes of knees are distinguishable by their overall length. The best-documented knee is 11 feet long, defining both the lower curve of the bow hull and the minimum height of the lower orlop deck. Following the definition of Stammers, the rider knees found at the *Main Mast* site suggest that the *Slobodna* was similar to the composite vessels of the *Vicar of Bray* (Stammers 2001: 115). Its determined length-to-beam ratio of 4.8:1 equals that of an average cargo ship (Smith 2007). In a 1855 issue, the editors of the US Nautical Magazine and Naval Journal described the ideal cotton ship to be broad of beam and deep hulled for stability, with a length around 200 ft. and a hold around 15 to 17 ft. (Smith 2007). Dimensions approximated by the 2005-06 teams found that the *Slobodna* fits the model roughly as its bow and length to beam ratio were similar to this model. Though it was an idyllic ship design, the *Slobodna*, was still slower than that of the steamship, an added incentive for Captain Milinovich to move to an earlier departure time from Louisiana.

6.4.4. Deck Structure (Supporting Knees)

The deck structure of the *Slobodna* reveals the presence of terrestrial materials that were not commonly used among the whole of Europe. Austria-Hungary still had its large forest reserves, which were utilized to a large extent by the shipbuilders off the Adriatic coast, expressed in the building of the vessel. Pulling the structural I-beams and T-beams along with the deck supports documented in previous seasons does not relay much information concerning the architecture of the ship, but they do tell much about the *Slobodna*'s construction and the similarities it shared with British built composite ships. This information is then compared with other composite vessels and portrays the circumstances surrounding the Austria-Hungary shipbuilding situation. Martinovich used metal lodges and hanging knees to back its wooden decks, an uncommon practice found throughout the class of composite ships.

A ship of 1100 tons would require a minimum of 78 hanging knees for both the hold and upper deck beams (Desmond 1919). Only a dozen hanging knees and lodge knees have been documented at the *Main-Mast* site. Examples of the use of staple knees have been documented in Falkland Island shipwrecks such as the *Vicar of Bray* (1841) and the *Acteon* (1838). Both had staple knees at the narrower hull section beneath the poop deck (Stammers, 2001:119-120). The use of a staple knee in the narrowing bow underneath the *Slobodna*'s foc'sle strengthened the deck beam on the aft side of the breast hook and in front of the water tank. The longer drift pins in the piece are necessary to attach the knee through all the large bow timbers. Through both the rider and deck knees it is possible to correlate the *Slobodna* to English designed vessels that were designed as a result of the architectural changes in shipbuilding occurring in Europe.

The British Navy started employing iron knees during the Napoleonic War and in merchant ships of the time (Stammers 2001). The use of iron deck knees and rider knees in composite shipbuilding reflect the shift from wood to iron in European shipyards. Archaeological evidence for these "rider knees" appears in both the British merchant vessels, the *Vicar of Bray* (1841) and the *Jhelum* (1849) (Smith 1983; Stammers 2001), The *Vicar of Bray* is a fine example of the use iron hooks, crutches, and knees both rider and hanging. The *Jhelum* and the *Vicar of Bray* both share longitudinal timbers in their hulls. These vessels also had lodging knees and several beams matching those documented at the *Slobodna*. Shipbuilding architecture and structural materials are indicative of a country's level of industrialization. Great Britain in the 1840s did not produce the specialized parts later incorporated in shipbuilding. However, Great Britain did manufacture structural beams for profitable composite shipbuilding. These composite ships, though of different origins, share similar economic motives as they incorporated iron parts into their designs.

The decision of Austrian shipbuilders to construct composite ships suggests that the level of industrialization in Austria-Hungary in the 1880s was similar to a less industrial Great Britain in the 1840s. Austria was unable to manufacture the specified iron parts to create fully iron ships and with the steamship already in production, sailing ship production was virtually discontinued. The *Slobodna* is able to reflect the industrial trends of Great Britain's composite shipbuilding in the 1840s due to the similar industrialization and manufacturing of Austria in the 1880s. It is also reflective of the contemporaneous situation in Europe, as most states were undergoing shipbuilding troubles resorting to foreign influences and older models as seen in France. The *Slobodna* reflects the alternative shipbuilding methods in less-industrialized countries while simultaneously conveying the larger economic trends and industrial circumstances Austria-Hungary faced in the 19^{th} century.

6.4.5 Rigging and Spar Components

The Slobodna's capstan was located just east of ravine number two near the edge of the sandpit. The size and dimensions of the capstan relay important information about the rigging system that the *Slobodna* had been outfitted with. Since the Hayes Report, fragments of the *Slobodna*'s rigging and running have been listed in every field season with the exception of the 2011 team. Hayes noted the presence of chains, davits, parrels and numerous deadeyes (Fig 6.14) scattered throughout the wreckage indicating the extent of the initial wrecking process. The *Winch Hole* site contains features linked to various components of the mast and deck (Hayes 1995). The site's chain had a diameter of 2 inches and the recorded deadeyes were 7-8 inches in diameter. The winch itself was identified as a halyard winch, which would be involved in the raising and lowering of the yards. The 2005 team recovered additional deadeyes, chain plate straps, rigging cable and chain, spar hoops, couplings, parrels, and a stay hoop with a 35° angle forward edge. The 2006 team recorded additional fragments hinting at the site of the initial salvaging operations (Arnold et al. 2006). Overall the 2006 field season at the *Winch Hole* site yielded 4 other deadeyes, fragments of a winch (chains, gear, hub), an unidentifiable triangular support, iron spar rings, and several mast couplings all partially buried and clustered around the *Winch Hole* site. (Arnold et al. 2006). These parts and basic components and rigging gear present on the *Slobodna* after wrecking indicate the level of archaeological documentation conducted at the site. The origin of the specialized parts could not be identified from these features, as no maker's marks were located. If the stern of the *Slobodna* is located, the new site may hold more rigging pieces, some of which may have discernible maker's marks. With these, the origin of the industrial parts may be determined, providing insight into the industrialization of Austria and how private shipbuilders acquired these parts for the construction of composite ships.

Figure 6.14: Deadeye taken from the *Slobodna* at the *Winch Hole* site (Smith 2007: 27).

6.5 VERIFICATION OF PRIMARY DOCUMENTS

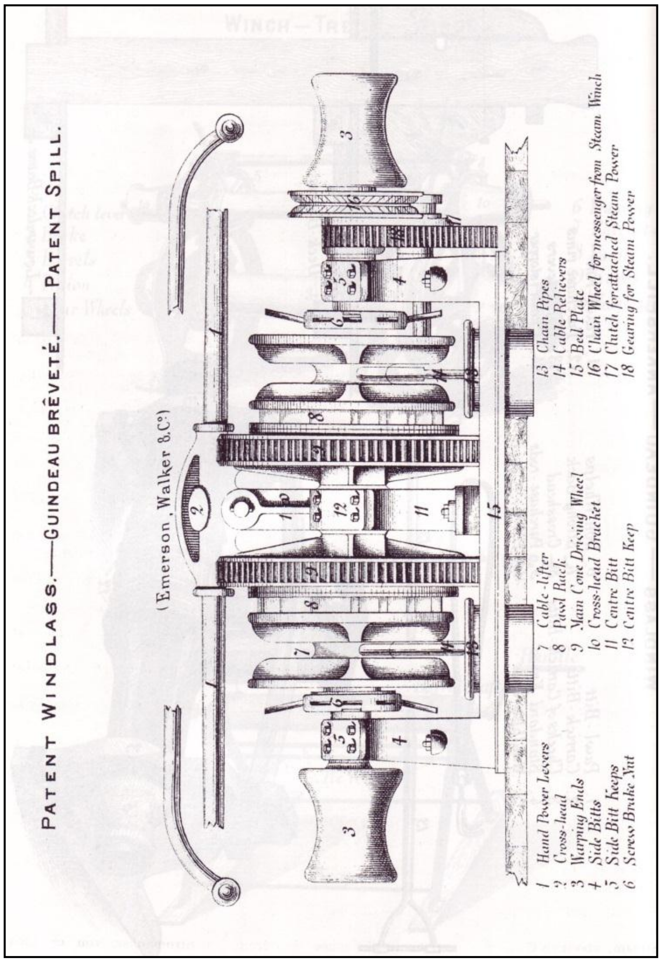

Figure 6.15: Patent Windlass by Emerson Walker & Co. (Smith 2007: 18).

The remaining knowledge of the *Slobodna*'s design is available from primary sources. Using the US Revenue surveys, Captain Fengar reports the knees breaking at the shoulders as the interior structure was torn apart (Fengar 1877: 143). Iron knees found at the site verify this claim. Iron knees, unlike their wooden predecessors, are weakest at the shoulder. Fengar mentions the cargo ports, which allow for the reconstruction of the wrecking formation and the hull configuration. Given that the wales (wooden planks surrounding the hull) were no more than 4' apart, the cargo ports were less than 4' tall. The room and space of the frames determined the width of the cargo port. The salvage survey finally communicates that the ship's steering gear was salvaged unlike the rudder. A ship of the *Slobodna*'s dimensions would have gudgeons measuring 3' long with pintel (a pin that holds up the rudder) diameters at two to three inches (5-8cm). Using the recovered gudgeon from the *Adelaide Baker*, it is possible to see similarities with the *Slobodna*. Both pieces are three feet (0.9m) in length.

The remaining cast iron components divulge more about how configuration and shipbuilding were conducted in Europe in the 1880s. Two iron bitts along the western edge of the *Bronze Wreck* site reflect that fragments of the upper, wooden deck that accompanied the mast as it tumbled toward its final resting place. Both are single bitts and lie in close proximity to what may be a fragment of a fairlead (Smith 2007, Paasch 1890, Desmond 1919:158). The distance between the two plates reflects the three-inch (7.6cm) thickness of the upper decking. The removable steering hints that it was a compact patent-style steering apparatus. The winch (Fig 6.15) is a patent-style, iron windlass similar to those produced by Emerson Walker & Co. (Paasch 1885; Souza 1998: 50). Along with the bitts, the main driving wheels and cable relievers are still fairly complete (Smith 2007). The 10-inch (25cm) stud chain that fit the description mentioned in the depositions outline the attempts to drag the ship off the reef using the starboard bower anchor. The chain dimensions also easily fits through the central hole of the chain pipe. Pertaining to the winch, an iron artifact with a distinctive shape could not be identified. However, using comparative photography of a similar winch, the artifact was determined to be an iron brake handle due to the resemblance to the iron brake handles from the barque *Elyssa*. This is further proof that the two sites are connected and that the *Main-Mast* site is indeed the bow of the same ship (Smith 2007).

Lastly, there remain artifacts that are not readily identifiable as hull parts. All artifacts are approximately 4'6" (1.3m) long and 8' (20.3cm) wide. The backside of the iron pieces is flattened with a cast indentation at one end with dimensions approximately 8" (20.3cm) long and 4" (10cm) wide. The front side of this object is cast with a mild curving foot at the same end as the indentation, while the backside is straight (Smith 2007).

6.6 CONCLUSION

The labors of past field seasons established an archaeological foundation that provided a more detailed discussion of Austrian shipbuilders and their attempts to capitalize on their industrial and economic situation by constructing with a less-efficient material. By sacrificing faster speeds, larger capacities, lower maintenance, Austrian marine merchants made higher profits by assembling wooden ships with lower production costs. Using the site description, methodology, and the documentation results from the 2011 field season, features of structural components range from beams and knees to rigging equipment such as deadeyes and couplings can be analyzed in order to assess the industrial and economic situations present in Austria-Hungary. Relying heavily on the documentation of the 2011 field season, the remains were analyzed for this thesis and then compared to the existing literature of composite ships in order to assess whether the *Slobodna* is capable of reflecting how the pursuit of profitability can bypass efficient innovations.

Looking at the interior structure of the *Slobodna*, it is possible to see a physical representation of the industrialization of 1880s Austria. The presence of specialized iron parts reveals the industrial advances in shipbuilding. However even if these parts were available, the presence of timber in the keel and hull show that wood was the more cost-efficient choice for Austrian shipbuilders. When compared to other composite vessels such as the *Vicar of Bray* and *Jhelum*, it is clear that the *Slobodna* imitates the older composite shipbuilding models as composite shipbuilding was the most efficient manner of ship construction.

The use of iron reflects the same economic factors that inspired its first incorporation in Great Britain. With its position as an inexpensive building material, iron was incorporated in the shipbuilding production, but did not increase the non-specific manufacturing of ship parts. Rather, it focused on the structural aspects that brought the greatest benefits as iron became affordable and more profitable. It was the advantages of iron structures in the hull that allowed the hold of the *Slobodna* to carry the large payload that Milinovich had hoped to cash in from

Louisiana. For Austrian shipbuilding, the continued use of wood as an affordable materials persisted due to the large timber reserves of Austria. The *Slobodna* reflects the incorporation of technological advances according to their cost-effectiveness and ability to establish high revenues in shipbuilding. The choice to construct in the composite ship manner mirrors the rationale and economic principles behind British shipbuilding in the 19th century. Through an archaeological examination, the *Slobodna* proves to be a strong model for strengthening the industrial and economic motivations that were present in shipbuilding. The archaeology of the *Slobodna* reveals the accommodations Austrian merchants made to building strategies to maintain competitiveness and quality in a cost-effective manner.

7. CONCLUSION: THE RELEVANCE OF THE *SLOBODNA*

This thesis has shown that the *Slobodna* was a model composite sailing shipwreck for examining the how motivations for profit directed the incorporation of technological advances in the less-industrial parts of Europe. The vessel shows how the Austrian shipbuilders integrated several, but not all, of the available advances. Though ship production does not reflect the same technological advances as Britain, the profit incentive in the capitalist system is clearly displayed in both countries. The *Slobodna* clearly reflects the economic position of Austria-Hungary, a less-industrialized country, as it implemented a technological alternative that catered to the capitalist motivation to profit.

7.1 THEMATIC ELEMENTS PRESENT IN THE SLOBODNA

The European shipbuilding industry in the mid-19th century began to incorporate iron as a working material as a response to the diminishing wood reserves in Europe. When iron parts replaced many of the specialized pieces of wooden shipbuilding, ships had greater hull capacities and faster speeds to deliver payloads. Faster, cheaper transportation stimulated the economy and industry through increasing availability of raw processing materials from around the globe carried by these composite ships. This trend first started through the control of piracy, falling freighting rates, and the abolishment and amendment of trade-limiting legislation, but the greatest strides in these rates in the incorporation of iron.

The Industrial Revolution resulted in cheap iron to be integrated into sailing ships. The resulting composite sailing ships, like the *Slobodna*, were more efficient in ferrying cargo and cheaper to produce and maintain than their wooden predecessors. More-effective designs and construction methods were transferred from the British shipbuilders to Mediterranean merchants hoping to make the same economic gains that countries aimed at trans-Atlantic markets had obtained. In the case of Austria-Hungary, the government had very little industrial involvement until the economic crash of 1873. Thereafter, the Austrian government limited production to basic needs, greatly affecting maritime commerce. As the Austrian government began to produce the more affordable and more effective steamships, the construction of sailing ships was left to private builders who could afford to construct in this fashion or purchase older models from the more industrialized countries such as Britain. Austrian composite sailing ships of the 1880s such as the *Slobodna* reflect that advances in shipbuilding technology were not all incorporated simultaneously in Europe. The iron parts incorporated in Austrian vessels convey the shipbuilders' profit-conscious decisions in post-1873 Austria. The limited factories produced standardized iron parts without specialization, indicating that the level of production and technological adaptation did not reach the same extents seen in Great Britain. These specialized products were more costly to produce in Austria and expensive to import, raising the production cost of new technologies. Thus, iron parts reflect the continental technological, economic, and political trends that had been present in Europe. Despite lagging behind technological advances in shipbuilding, Austrian seafaring functioned under the same capitalist systems as Great Britain in the 19th century.

Through an evaluation of the documented artifacts and the archaeological interpretation of ship's features performed in Chapters 4, the unique circumstances surrounding the *Slobodna* are clear. Despite being of Adriatic origin, the *Slobodna* is able to mimic the designs of the European ship architecture while reflecting the industrial and economic situation in 19th century Austria, specifically that of its private companies. The *Slobodna* reflects the Austrian solution for balancing quality with cost. The presence of iron parts in the ship's structure suggests that these parts were manufactured and available at costs that adequately reflected the benefits of iron shipbuilding. The wooden aspects of the vessel conversely suggest that specialized parts were relatively cheaper to construct locally with Austrian timber rather than import the iron parts from more industrial countries. Also the choice to construct with wood may highlight the fact that specialized iron parts did not significantly increase the efficiency of the ship to the same degree as structural iron in the hull, The mere fact that sailing ships were still produced after the 1880s indicates the role of tradition among local Adriatic shipbuilders, which belies common conceptions about European shipbuilding. The archaeological work of *Slobodna* is one of the only archaeological sites that provide insight into the distinct situation that Austrian merchants found themselves in the late-19th century. It is for this reason that archaeological work on the vessel should continue as it holds the promise of furthering knowledge of the experience of private entrepreneurs and the utilization of shipbuilding materials in order to profit in the 19th century.

7.2 FUTURE RECOMMENDATIONS

With only 60% of the site recorded, the *Slobodna* still has much to offer in terms of information. As of the 2011 field season only the sandpit, Ravine 1, and most of Ravine 2 were documented leaving the latter portions of Ravine 2 and the whole of Ravine 3 to be documented in future field seasons. Though many features were mapped at the *Main-Mast* site, investigation of this section of the *Slobodna* wreck is far from completed. Additional feature plotting and description have great potential to yield additional information on the ship's iron components, indicating the level of specialization and industrialization of Austria. Equally as important, the site relays the experience of Austrian entrepreneurs as they modified their shipbuilding strategies to fit their own specific economic situation.

The attempts to locate the *Slobodna*'s stern during the 2011 field season revealed a newly discovered section of 40 additional feet of hull materials that lies among the sites that held high prospect of being the location of the stern. More diving surveys are needed at this site in order to verify whether it belongs to the *Slobodna*. If verified, the additional hull fragments of the new site will supply more insight pertaining to sailing ship production trends of the late 19th century of Austrian and Europe. Additional reconnaissance dives for the location of the stern along the 210^{o} bearing should be conducted as this bearing has the greatest chance of indicating additional artifacts pertaining to the *Slobodna*. As these sites are continuously documented and additional ones discovered, the resulting information will reinforce the importance of the shipwreck and yield additional artifacts that will continue to strengthen the claims of this thesis. The *Slobodna*'s still missing compartments make up a great deal of the ship. If found and properly documented, the features will allow for a stronger case for the importance of the *Slobodna.* As the shipwreck lies, it acts as a representational model of the experiences of Austrian entrepreneurs and the relationship of affordable iron integration and shipbuilding that occurred in late-19th century Austria and Europe.

APPENDIX A:

PRIMARY DOCUMENTS

Slobodna Federal Admiralty Records "Mast Wreck"

Florida Keys Admiralty Records of Key Largo FL

Slobodna 1887 SHIP NAME: SLOBODNA (SLABDONA)

SHIP TYPE: Austrian Ship

DATE OF LOSS: 1887/03/16 SITUATION: .Stranded/bilged

LOCATION - REEF: Molasses Reef ZONE: 3

LAT/LONG; LORAN: SOURCE: KW/ADM r14/p123

COMMENTS: Written in record as "Slabdona". Captain T. Milinovitch, master. Bound from New Orleans to Revel (?) laden with 4,500 bales of cotton. (p. 131) "Libellant Baker ... discovered from on board his schooner, then off Conch Reef, a ship ashore on that part of the Florida Reef known as French Reef (reported by others as Molasses Reef) she had gone ashore about 9 a.m. that morning. Second. The ship lay upon the southern or outer part of the reef, heading, N. by W. the wind blew fresh from the westward with a very heavy under tow, the master at the time having all square sails backed on the ship." (p. 137) Salvors were engaged for 30 days in performance of service; several days they worked night and day. Most of the cotton was saved; much was recovered by diving.

KW/ ADM r14/p124: From case of Harry Strenge et al. vs. " 456 bales and a lot of loose cotton saved from the ship 'Slobodna'": "The ship lay upon the outer side of what is known as Molasses reef with her lower hold full of water and slightly careened over on the port side and partly stripped of her rigging and all of her sails.”... Enoch Baker was principal of the salvors then engaged to assist in rendering service - offer to assist declined - 3rd. Tues. March 22nd, 1887 part of the ship's spars were cut away by the first salvor and on Wed. 23 March, libellants were invited to assist. (Pg. 124): "...assigned to them for that purpose the space from the fore hatch to the forepart of the ship in the lower hold.

"Fourth. In this space thus assigned to libellants all the cotton lay under water, that is, the top of the tier on the starboard side was even with the water's edge and that on the port side lay about six feet under the water.

"Fifth. Libellants began work on that day the 23rd of March by taking cotton out of the space afresaid and continued from day to day including Sundays until Tuesday the 7th day of April, at which time their vessels were loaded and the divers reported that it was impossible to obtain any more cotton if any remained because of the loose cotton which lay some ten feet deep in the bottom of the ship.

"Sixth. That all of the cotton was taken out of the water and as the work progressed it became necessary to dive for same and this necessitated the making a special contract with those willing and able to perform that service, whereupon (Pg. 125) an agreement was entered into, with the divers that they should receive twenty-five cents for each and every bale of cotton dived up, and by this means two hundred and forty six (246) were saved." "Sixth. [Repeated] Libellants took cotton to Key West. Seventh. "...they have worked arduously and honestly in the performance of the aforesaid service, that all of said cotton was taken from the water and portions of it dived up from water twenty feet deep ...they are unable to ascertain the value of said cotton in its present condition"- asked for an appraisal.

(Pg. 131) Enoch Baker testimony: "...on Wednesday morning the 16th March A.D. 1887 at about 9 A.M. he discovered from on board his schooner, then off Conch Reef, a ship ashore on that part of the Florida Reef known as French Reef. He immediately proceeded to said ship, and on boarding her at about 10 A.M. same day learned from the master, that it was the Austrian ship Slobodna, laden with 4500 bales of cotton and bound from New Orleans to [blank] and that she had gone ashore about 9 A.M. that morning.

"Second. The ship lay upon the southern or outer part of the reef, heading N. by W. the wind blew fresh from the westward, with a very heavy under tow, the master at the time having all square sails backed on the ship, and his crew employed moving and taking the chains from forward to aft.

"Third. Libellant Baker then offered his services to the master which was not accepted until about 4 P. M. when the schooner City of Key West was hauled alongside, and under the starboard bow of the ship and the ship's starboard anchor weighing 3,000 lbs. with 30 Fathoms of chain and 85 fathoms of a new 8 inch Hawser, were placed on board of her, a warp was then run out in a S.S.E. Direction from the ship, and a small anchor let go, the end of the warp carried to the schooner City of Key West, where she was hauled out to the small anchor, and the ship's starboard anchor let go in 8 fathoms of water, a strain was then hove on the hawser, with a four fold purchase, from the stern of the ship.

"Fourth. That while a portion of the salvors were engaged in carrying out the anchor, others were employed at the pumps, the ship having 6 feet of water in her hold, your libellant making the soundings around the ship, and at high tide, (finding that the ship had under her bows on both sides 18 feet, and under her stern 24 feet, the master informing the said libellant that the ship drew before going ashore 17 feet forward and 18 feet aft.

"Fifth. At 11 P.M., the tide rising, a heavy strain was kept on the hawser until the tide

began to fall, the pumps being attended to with both pumps going during the night except the starboard pump which gave out several times during the night and had to be repaired up to which time they had reduced the water in the ship, the water gaining on them with only one pump working.

"Sixth. At 9 A.M. the 17th the schooner Rapid was hauled alongside for the purpose of lightening the ship when they were obliged to haul her off on account of the weather, having placed on board of her only 29 bales of Dry Cotton, the other vessels except the *Nonpariel* being obliged to leave the ship, and make a harbor, leaving about 60 men on (Pg. 133) board of the ship, who were engaged in pumping, and breaking out cargo, and shifting it aft, getting ready for the next high tide.

"Seventh. At 2:45 P.M. a heavy squall came up from the S.S.W. with a very heavy sea, when the ship started [unclear word] with her stern swinging to the Northward and Eastward, and at the same time bringing the anchor home(?) continued to swing in that same direction until she headed to the S.W. laying broadside to the reef, the ship striking and pounding heavily upon the bottom while swinging, after the ship had swung broadside to the reef, put a stopper on the hawser, then led the end of the hawser forward to the capstan, by this time the wind had jumped to the north west and blew very hard, when the jobs were twisted, the stopper cut, and the slack. of the hawser taken in, when a heavy strain was placed on the hawser, but could not move the ship, taking sail again, sounded the pumps, and found that the ship had 15 feet of water in her hold, libellant then informed the master that it was useless to pump any further as he was satisfied that the ship had bilged, at the same time calling the master's attention to the fact that the men were pumping up articles of grounded plank, sand and coral, the master requesting libellant to pump one hour longer which was done, but without gaining on the leak.

"Eighth. At the time of the ship starting, libellant sounded the pumps as the ship had pounded heavily upon the bottom and found 4 ft. 1 inch of water, 10 minutes later, again sounded and found 4 feet 3 inches, 10 minutes later again sounded and found 6 feet 1 inch, 10 minutes later and at the time the ship had gone broadside to the reef, again sounded, and (Pg. 134) found that the ship had 15 feet of water in her, it being about 5 P.M. of the afternoon of the17th."

Commenced loading vessels with bales of Dry Cotton. (Ninth, Tenth, Eleventh, Twelfth. Mon. 21st - "Before the salvors could finish loading the Eliza Bennett the wind came up from the S.E. blowing fresh, causing a heavy roll, and swell upon the reef " The Salvors were obliged to haul her off till morning. From the thirteen entry through the twenty-fourth (Pg. 135 and 136) on Saturday the 9th of April, the Salvors were working continuously saving cotton from the lower hold. They recovered 1,157 bales of wet cotton. The weather was again bad on the 9th and it was too rough to bring vessels alongside until Wednesday, April 13th, when they again began loading.

(Pg. 136) Only 22 bales were saved, "...the divers being exhausted and the condition of the ship making it entirely too dangerous to work in the lower hold." Then on Thursday the 14th they abandoned the work after saving the rest of the ship's materials.

"Seventeenth. Libellants would further give the Court to understand that they saved 3,540 Bales of cotton, out of which number they have saved Dry 1650 Bales, partly wet 584 Bales and 1306 wet bales, That 1081 bales were saved by actually diving for which they have paid from 25 to 50 cents per bale, that the divers were subject to severe pain from their eyes, a number of whom had to give up diving, That several of the salvors were injured by falling blocks, and being struck by bales of cotton, that several of the vessels were damaged while alongside of the ship, having their bulwarks (sic) stove in." (Pg. 137) The salvors stated that they were engaged for 30 days in performance of the service and for several days they worked night and day. They estimated the value to be $175,000.00.

(Pg. 139) On April 4, 1887 a letter was written by F. R. Maloney, Notary Public, informing Capt. A. A. Fengar of the U. S. Revenue Service, Commander of the U. S. ,Revenue Cutter Crawford Lieut. T. S. Smythe, Ex-officer of the U. S. Rev. Cutter Crawford; and Wm. H. Pierce, Mast shipwright:

"You are hereby appointed a board of survey on the Austrian ship Slobodna now lying ashore on Molasses Reef where she struck on Wednesday March 16th with a cargo of cotton while bound from New Orleans to Reval. “You are requested to proceed to that point and hold a strict and careful survey in said vessel making a close examination of her condition and a statement of the damage she has received and of the probabilities of saving the ship, you will make such recommendations regarding her condition and disposition as may seem best to you for the interest of all parties, concerned and for the purpose of advising the master as to his future course. In case you find it impossible to come to any determination about the ship's bottom without the aid of a submarine diver you are authorized to engage one who will make his report to you." (Copy certified in text).

(Pg. 140) Reply to F. R. Maloney, Dated April 6th 1887:

"We the undersigned having been appointed a board of survey on the Austrian ship Slobodna ashore on the Florida Reefs, have the honor to report that we have this day repaired alongside and on board said ship and made a thorough examination of her hull spars, rigging and apparel, as requested and find as follows:

"The Slobodna is stranded on an outlying reef equidistant between Pickles reef beacon and French reef beacon, and is lying in fifteen feet of water on hard but rocky bottom, Rodriguez Key bearing by compass N.W. by W. 3/4 west about 4 1/2 miles distant. Tavernier Key bearing W. by S. 1/8 S. about 6 5/4 miles. The ship is listed off-shore and lying on her port bilge and is heading about S. W. Her cargo of cotton consisting of about 4500 bales has been nearly all removed there remaining but about 400 bales at the time of this survey with every probability of nearly or quite all of it being saved. The ship's hull as far as can be seen is in fine condition, not a butt or seam started or the least show of starting visible anywhere except that a water tank under the forward house has been raised some 14 or 15 inches, as this tank rested on the (Pg. 141) keelson, it is not probably that it has been lifted from its bed by any other cause than from swelling of cargo, "From testimony obtained among the wreckers it is evident the ship has never moved from her bed since swinging into her present position. Her bilges may have chafed more or less and it is reasonable to suppose they have from the swell occasioned by the breezes of several days ago. But the ship having very little dead rise an examination of her bottom where she now lies is impossible.

"The wreckers have removed the steering gear, but the rudder is intact and working freely, ten (10) lower deck beams have been cut to remove the cargo and one (1) Carlene have been cut for like purposes. A thorough inspection of the ship between decks does not show in a single instance any starting of knees either hanging or on [unclear word] or any weakening of fastenings. "Her topmast have been cut away to enable wrecking vessels to get alongside, but her lower masts, bowsprit, lower and topsail yards are intact, her lower standing rigging is also in good condition, the sails and running gear have been saved. "The wreckers have in our opinion prematurely removed the metal from the starboard side as far down as it could be reached otherwise they have not damaged the vessel or appurtenances more than the circumstances would admit. Two (2) cargo ports are out on the port side in order to admit a free flow of water, for the purpose of working the cargo, but can be secured when necessary.

"We are of the opinion that the value of this ship warrants extreme efforts to release and bring her into port. We recommend the procuring (Pg. 142) of powerful steam pumps and after closing the cargo ports now open under water and removing as much of the 150 tons of stone ballast as possible (which is now in the bottom of the vessel) that an attempt to free the ship of water be made and if successful (which at present looks feasible) she be towed to a place of safety for further examination. If the pumps or other means of freeing the ship are not available or cannot be procured at a reasonable cost, compared with the value of the ship, we recommend the sale of hull and apparel as she now lies, for the benefit of whom it may concern.

Signed by the Board of Survey: A.A. Fengar, Captain U. S. Rev.

Percy W. Thompson 3rd Lieut. U. S. Rev.

William H. Pierce Master Shipwright

(Certified to be a correct copy in the record.)

(Pg. 143) "And an April 22nd A. D. 1887 report of survey was filed as follows:

Key West Fl. April 20th 1887

"Hon. J. W. Locke, Judge of U. S. District Court &c. &c.

"Sir:

"We the undersigned having been appointed by your honor a board of survey on the Austrian ship 'Slobodna' stranded on Molasses Reef, Florida Keys have the honor to report in obedience to the instructions contained in your order, that we have this day repaired on board said ship 'Slobodna' and have made a careful and thorough survey as the circumstances of the case would admit. We found the ship lying on her port bilge (Pg. 144) with her head to the southward and westward, in about 23 feet of water aft, 18 feet of water amidships, and 15 feet of water forward. The ship is water logged, her back is broken, and she is badly [unclear word] the deck is lifted fully a foot amidship, Deck houses and batch combings started. Water nay? Butts and deck seams open. The hanging knees to the second beams as far as can be seen are broken at the shoulders and the beams as well as the lower deck beams are adrift.

"The stern post is started; the mainmast has been unstopped by force of the sea and cut away to prevent further damage and is now lying alongside with wire rigging attached.

"The fore and mizzen masts are still standing. The ship's bottom is without doubt badly stove on the port side, from the fact that she has settled so deep that the front? Plank shear is covered amidship at high water. The ship has so heavy a list to port as to make it difficult to walk the deck. The 'Slobodna' is a complete wreck and beyond help. We recommend the sale of the ship as she now lies for the benefitting fit of all concerned. "

Board of Survey: A. A. Fengar, Captain U. S. Rev.

Wm. Black, Ship's Master

William H. Pierce, Master shipwright.

[There is no certification of this document and no explanation why it differs so from the previous report filed.]

KW/ ADM r14/p157: Judge's Decree: Case of Enoch Baker et al vs. Cargo. "This vessel laden with 4500 Bales of cotton, from New Orleans bound to Reval, went ashore on a projecting point of rock between French and Pickles Reefs, on the Florida Coast, about 100 miles from this port, on the morning of the 16th of March 1887, at about 9 o'clock where she was soon boarded by the principal libellant in this case, where offered his assistance.

"The vessel lay upon the extreme outer point of the reef on hard rock bottom, she was under considerable sail with a fresh wind when she struck and went ashore so as to be lifted fully two feet from her ordinary draft from her main chains forward, at high water, at low water much more.

"For a time the master thought he would be able to get his vessel afloat so declined to accept aid, but at length, at about 4 o'clock that afternoon, finding his efforts ineffectual accepted the assistance of the libellants with several of their vessels there at the time, all professional licensed wreckers who carried out a 4000 pound anchor with 30 fathoms of chain and 85 fathoms of 8 inch hawser and let it go in deep water and as the tide rose, heaved heavy strains with all the power they were able with a four fold purchase led to the capstan. A part of the Libellants manned the pumps as there was found 6 feet of water in her hold, and finally reduced it to 4 feet. They hove with what force they could until two hours past high water that night, but were unable to move the vessel. '

"A portion of the libellants then went to breaking out and moving cotton aft, others constantly pumping in order to keep the water down. The next morning one schooner was hauled alongside to take cotton, but by the time she had received 29 bales, the wind increased and the weather became so bad that she was compelled to drop off, and all the vessels with one

(Pg. 158) exception had to leave their anchorage outside the reef and go inside to seek a harbor, leaving 60 of the libellants on board who continued pumping, breaking out and moving cargo aft, and heaving at the anchor as the tide rose. At Four o'clock that afternoon the 17th the weather became worse, the wind shifted to the southward - a dangerous point, and a violent squall struck the ship with such force as to lift her off the bottom, so that the Libellants succeeded in moving her astern, nearly if not quite half her length, but unfortunately the anchor at that time dragged. The ship partly relieved from the bottom, swung broadside onto the reef and thumped and pounded heavily, at the same time increasing the leak so rapidly that within 40 minutes the water gained, notwithstanding constant pumping, from 4 feet to fifteen; the depth she was in, where it continued. After pumping a long time the libellants concluded that the vessel had bilged and proceeded to save cargo. ,," "The salvors, already represented by libel or petition have saved 4310 bales of cotton and an amount of loose cotton estimated at about 142 bales and others are still at work saving what yet may be got from the wreck. "The bales were very heavy, many of them weighing over a half ton as they came out of the water. It is true, the vessel has been lost but the cargo has or will be almost entirely saved, though in a damaged condition.

"There were 335 men and 41 vessels, two of which were steamers, engaged in the general consort and who worked all the time the weather was such that they could work at the ship, for a month lacking two days, part of the time it was impossible to work on board or be alongside. 9

vessels and 69 men have also worked more or less on their own account and saved 861 bales outside of the general' consort.

"The work has been laborious in the extreme, the bales of cotton were pressed into the ship with much force at first, and being wet had become greatly swollen. During the latter part of the service the bottom of the vessel was so crushed up that it held the bales under (Pg. 159) the beams so that it was almost impossible to break them out, many of them were broken, or necessarily pulled apart, until the water was filled with a pulpy mass of loose cotton and broken ties and dunnage, that made it very difficult and to a certain extent dangerous to dive through it. "The salvors had no appliances for diving or saving labor, but it all had to be done under water by naked divers and hoisted by hand. The bales had become so saturated and heavy that they would not float, but each had to be broken out and slung underwater. About 1700 bales have been dove up from more than 6 feet of water and from that to 18 feet, and about 150 of loose saved in the same way.

"The great question in this case that must influence the amount of salvage is, did the salvors do their whole duty in their attempts (sic) to save the property? First, Was there any dereliction of duty in not preventing the vessel from swinging again aground when partly relieved from the bottom; and secondly, Could they have pumped her out and saved her after she had been partly lightened of her cargo? Salvors are held to a strict accountability for everything which is omitted to be done by them for the saving of property by every means within their power, and if from lack of energy, judgment, or skill. They fail in one particular the amount of salvage awarded, if any, will be reduced accordingly. It is not only honesty of purpose but skill, energy, and good judgment to use every appliance which they can possibly command, that is demanded, yet Courts

(Pg. 160) cannot require impossibilities of them and must only consider the means under their control.

"In this case was it within their power to have foreseen by any degree of care or diligence the probability of the anchor dragging and prevented it? In the case of the St. James the vessel was permitted to swing back onto the reef by the breaking of a hawser when the salvors had shown a most deplorable lack of skill or judgment in using a small line to lengthen out a large hawser when it was within their power to have used a larger one or increased the strength of that used by several doublings, and the entire salvage was forfeited (Records of this Court, 1872). But in this case the depth of water was properly selected, the largest anchor carried out in the best direction with the strongest hawser that could be obtained. The weight of the anchor was such that no reasonable man would have considered it necessary to back it with another, but would have presumed it to hold in bottom such as it was known to be, as much or he more than the hawser.

"It seems that at the time of the service anyone would have conceded that everything had been done within the power of the salvors to float the ship and but for the change and increase of the wind, the suddenness of the violent squall and sea, and the accidental breaking out or dragging of the anchor through the rock where it first held, it would have been successful.

"The suddenness and severity of the wind and squall prevented anything being done after the anchor had started until it was too late, and the vessel was evidently bilged and leaking so badly that no power of the libellants could control the amount of water in her. I am not satisfied that anything more could have been done to float the vessel than was before she started from the bottom or to prevent her going ashore again. After partly discharging her, the question was very properly suggested both by the wreckers and a board of survey whether she could not then be floated and (Pg. 161) brought to port, but in order to do that it would be necessary to control the water coming into her or undoubtedly she would have sunk in deep water. Had the libellants had at their command a powerful steam pump or had it been within their power to procure one and they had not done so and endeavored to float her, I should have certainly have considered them lacking in energy and enterprise requisite for such an occasion, but they had none. The master wrecker came to Key West and endeavored to procure one but was unable and upon his return found that the vessel was undoubtedly so broken as to be beyond recovery.

"They have therefore done all they could do in saving the cargo, materials, and stores, and bringing them to a place of safety. What amount ought they to receive for this service? It is unquestionably a salvage service. The property was in jeopardy of certain loss: it was only by such means as were used that it could be saved. It was an almost uninhabited coast, a hundred miles from any assistance and several hundred from any except what did offer itself.

"It was on a dangerous reef the approach to which was at all times more or less perilous to vessels. The weather was bad part of the time and all the salvors' vessels were more or less exposed to dangers entirely different from those of ordinary navigation. The actual labor was arduous and long continued, perhaps the number of men employed for the time occupied may not be a true measure of the actual labor performed, as a good deal of the time was taken up by the small vessels bringing cotton to Key West, discharging it and returning. Also there was some of the time when it was impossible to work at the ship, as the sea was sweeping entirely

(Pg. 162) over her and all of those engaged in the service were compelled to lie at anchor inside of the reef. But their time was occupied either in working or waiting, and I consider the circumstances justified the employment of the large number. Nor, am I prepared to say that it could have been done with a smaller number or in a shorter time."

"...I do not consider than an Admiralty Judge should depart from usual rates given in similar cases, and decree according to his feelings at a particular time, whether liberal and generous or otherwise, in salvage cases more than any other class of cases. In questions of salvage, Courts cite precedents of amounts and it is presumed somewhat guided by those cases the nearest parallel in circumstances unless good reason is found for a variation... "

[Cases are cited which pertain to the Judge's decision regarding the amount of salvage to be awarded. The vessels cited were: (Pg. 163):

"The Brothers, “The Fleece," "Friendship," "John Gilpin," "Comanche," "'Thetis," "America," "Telamon," "Yucatan," "Brewster," "Isaac Allerton," "Nathan Kimball," "Maryland,"

(Pg. 164)

"May Howl," "Alfred," "Cora Nellie," "Ajax," "Emery," "Norway," "Kristrel," "North America," "Tellumah," "Elizabeth Bruce," "Alitralia," "Concordia" "Mary Hale", "Helen E. Brooks," "Mimie,"

(Pg. 165)

"Mulhouse," "Indian, Hunter," "Eliza Mallory," "Mary Coe," "Ocean Belle."

(Pg. 163)

"The Ship 'Yucatan' laden with cotton and [rock] was lost near Cape Florida. The salvage was 43% on the cargo saved, shares $62.

"The 'Brewster,' cotton laden, was lost on Carrysford reef, Salvage 1-3.

"The 'Isaac Allerton' was driven over the reef and sunk in five fathoms of water, over 400 persons were engaged in saving cargo; one half of the net value of the amount was decreed....”

(Pg. 165) "1859. From the wreck of the 'Indian Hunter' salvors saved 3432 bales of cotton valued at $88,220. Salvage of 25%, 42, and 50% was given upon the dry, damaged, or saved by diving. The last case cited was almost precisely similar in the locality, season of the year, and character of the services rendered with the one under consideration."

"These were a few of the cases of similar character as the present decided in this Court previous to 1861, and in an opinion in the "Ocean Belle" that year, Judge Marvin remarks, 'The most usual rates of salvage for saving cotton on this coast when the ship has been lost and the cargo saved, has been 25% on the dry, 40% on the wet saved without diving, but taken from under water and 500/0 and in some instances 55% and 60% for saving it by diving in the lower hold.'"

"In the fall of 1865 during a severe hurricane several large cotton ships were driven ashore or on to the reef, and more than a million and a half dollars worth of cotton was saved within a short space of time..."

(Pg. 166) Vessels listed as lost during this hurricane:

"Bickmore,"

"Caroline Nesmith,"

"Howard,"

"John Wesley.") ,

(Pg.166) "Since these cases there have been comparatively few vessels lost on this coast from which cargoes have been saved under similar circumstances, there have though been some. "In 1871 a portion of the cargo of the Spanish bark 'Aquila' was saved for which the Court paid 27% of the dry and 42% of that wet and damaged, and 50% upon that saved by diving."

[Also cited: "Mississippi," "North western")

(Pg. 167) "In 1872, the brig 'Amazon' was lost on the reef in the vicinity (sic) of where the Slobodna was, and her cargo consisting of cotton was saved in the same manner, 35% was given upon the entire cargo.

"In the same year the ship 'St. James,' loaded with 1500 tons of Rail Road Iron was lost on the same reef. The cargo was saved with great exposure and labor, 50%, 62%, and 68% were given upon the net proceeds.

"In 1874, the British steamer 'Mississippi' was run onto Fowey Rocks near Cape Florida when she filled with water. Her cargo consisting of the looser heavier kinds of assorted merchandise, cotton ties, hard ware, earthen ware, &c. was save partly dry and partly by diving or hooking up from the bottom. The salvors were saved to (sic) great deal of labor as all the hoisting and discharging was done by the hoisting engine of the steamer, 30%, 40, and 50% was given according to the circumstances of each class of cargo saved, whether dry from the top of the water or by diving. The crews of two of the vessels that arrived first at the wreck shared $50, but the others from $15 to $32."

"In 1879, The 'Mary E. Riggs' laden with cotton (Pg. 168) struck the reef but a short distance from where the 'Slobodna' went ashore, and bilged before the salvors were enabled to get her afloat. They saved 4,646 bales of cotton, but the ship broke up before they could complete the service and about 300 bales went adrift."

(Pg. 169) "It is to be regretted that the modern wrecking appliances can not be introduced upon this coast, but the nature of the service, the extent of the reef line to be watched and the uncertainty of remunerative employment has so far prevented it. The character of the bottom, sharp coral rock, demands that the assistance to be of service must be speedy. The introduction of improvements (sic) requires the concentration of capital at. One point that the lack of means of rapid communication renders oftentimes useless. In this case, the cargo has been appraised by appraisers appointed by the Court, in its present condition and circumstances at $46 per bale for the dry cotton, $38 per bale for that partly wet, $27 for that wet and $16 per bale of the loose cotton, and no objections have been made to the same. The materials and c stores have been sold for $2751, and the proceeds brought into the registry of the Court.

"Considering the entire case and all the surrounding circumstances it is ordered that from the foregoing values all the expenses of landing, storing, watching, and labor heretofore incurred and the costs herein be deducted and the libellants and petitioners have receive and recover the following rates for salvage on the net values so found of the quantities severally saved by them to wit:

"On the cotton saved dry and appraised at $46. Per bale, 25%.

"On that partly wet and appraised at $38. Per bale, 33 1/3%.

"On 435 bales wet saved from water less than 6 feet, 40%.

"On the balance saved by diving in water more than 6 feet in depth and loose, 50%.

"And inasmuch the crew assisted in stripping the ship, the libellants receive 45% of the net (Pg. 170) proceeds of materials and stores and that the matter be referred to E. Locke, commissioner of this Court for investigation and computation as to the amounts severally due libellants and petitioners hereunder. This will make the individual shares about $45 which is small compensation, but as a proportion as I can feel justified in awarding."

(Signed)

James W. Locke, Judge.

(Pg. 174) "Having computed the salvage on the net value of property saved, under interlocutory decree of the Court I report the salvage to be as follows:

"Enoch W. Baker et al. on Materials oc. $ 1,102.75

"On 1650 bales dry cotton, 584 partly wet, and 1306 wet, and 62 1/2 loose 41,233.97, 42,336.72

"H. Strenge et al on 456 bales of wet and 13 1/2 bales loose cotton. 5,256.97

"Peacon et al. on 145 bales wet & 31 1/4 bales loose cotton 2,017.31

"A. Albury 29 bales wet & 3 loose 379.90

"Ob. T. Roberts 13 bales wet & 3 1/2 loose. 185.92

"J. A. Russell. 1 bale wet and 22 1/2 boxes 175.47

"E. de Vedig 38 bales wet cotton 458.34

"E. de Vedig 2 bales loose cotton 25.46

"J. R. Russell, 52 bales wet cotton 642.20

"T. Curry 6 bales wet and 6 bales loose 117.60”

E. Weatherford, 30 bales wet, 1/2 loose 374.12”

J. Roberts, 2 bales loose. 14.50

TOTAL: $51,984.51

APPENDIX B:

GLOSSARY OF SHIP PARTS[3]

Aft: In, near, or toward the stern of the vessel, to the rear or stern of the vessel.

Amidship(s): In the longitudinal, or fore and aft center of a ship. Halfway between stem and stern (front and rear).

Anchor: An iron implement for holding a ship at rest in the water by means of a fluke or hook which grips the bottom. (From the Greek word for hook)

Ballast: Heavy weight, which gives ship stability when the vessel is not carrying cargo.

Ballast Tanks: Tanks carried in various parts of a ship for water ballast, to keep the vessel on an even keel.

Barques: Sailing vessel with three or more masts; all of them square-rigged except the after mast, which is fore-and-aft rigged.

Bilge: The rounded portion of a vessel's shell that connects the bottom with the sides.

Bilge Keel: A fin fitted on the bottom of a ship at the bilge to reduce rolling. It commonly consists of a plate running fore and aft attached to the shell plating by angle bars. It materially helps in steadying a ship and does not add much to the resistance to propulsion.

Bilge Keelson: A keelson located near the turn of the bilge

Bilge Plate: Any plate in a bilge strake.

Breast Hooks: Knees placed in the forward part of a vessel, across the stem, to unite the bows on each side.

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[3] Definitions are adapted from Paasch's *Illustrated Marine Encyclopedia* (1977), Steffy's *Wooden Ship Building and the Interpretation of Shipwrecks* (1994) and McKenzie's *Seatalk, The Dictionary of English Nautical Language* (2005).

Capstan: A revolving cylindrical device used for heaving in lines or anchors. A vertical, spool-shaped rotating drum around which cable, hawser or chain is wound for hoisting anchors, sails and other heavy weights. A capstan rotates around a vertical axis, as opposed to a windlass, which revolves around a horizontal axis.

Center Keelson: A longitudinal beam fastened on top of the keel of a vessel for strength and stiffness.

Chock: Pieces of cargo in order to prevent shifting of the cargo.

Clipper: Swift sailing ships with sharp bows and fine lines.

Composite Sailing Ship: The technique of composite ship construction (wooden planking over a wrought iron frame) emerged in the mid-19th century as a transitory stage in the evolution of fast commercial sailing ships.

Dagger Knee: a knee fitted at an angle, neither vertically nor horizontally.

Deadeyes: Circular blocks in the shrouds or stays to adjust tension.

Dead rise: The measurement of the angle between the bottom of a boat and its widest beam.

Deadwood: Heavy longitudinal timbers fastened over the keelson. The timbers of the bow and stern are fastened to the deadwood.

Deck: A structure of planks or plates, approximately horizontal, extending across a ship or boat at any of various levels, esp. one of those at the highest level and open to the weather.

Drift Pins: A steel pin driven into a hole in a piece of metal to enlarge, shape, or align the hole.

Downeaster: A square-rigged merchant vessel combining large carrying capacity with a relatively sharp hull. They got their name from having been built in Maine, downwind and east of all the major East Coast ports, and were being used largely for the California grain trade (1865-1890).

Foc'sle (Forecastle): the part of a vessel at the bow where the crew is quartered and stores, machines, etc. may be stowed.

Fore-mast: The forward mast of a boat with more that one mast.

Frame: Transverse iron beam that defines the body shape of the vessel and where keelsons, stringers, and outer plating are fastened.

Futtock: A curved or vertical timber that when paired with a floor or additional futtocks makes the frame of a wooden ship.

Gaff-sail: A four sided sail used instead of a triangular main sail.

Gaff-topsail: A light triangular or quadrilateral sail set over a gaff.

Hanging Knee: Vertical wooden knees used to support deck beams.

Hog (Hogging): When a vessel loads too heavily at the ends it causes an arching or bending upward, of the hull at the amidships area. This can be caused by the vessel working in heavy seas with a large wave under the amidships section. Opposite of **sag**.

Hull: The frame or body of a vessel, exclusive of her masts, yards, sails, and rigging.

Keel: (1) The backbone of a vessel, running fore and aft along the center line of the bottom of the hull; the timber at the very bottom of the hull to which frames are attached. (2) A flat surface built into the bottom of the boat to prevent or reduce the leeway caused by the wind pushing against the side of the boat. A keel also usually has some ballast to help keep the boat upright and prevent it from heeling too much. There are several types of keels, such as fin keels and full keels.

Keelson: The main, central longitudinal iron member that is mounted atop the keel and connects to frames.

Knee: An angular piece of timber or steel that reinforces two joining surfaces of different planes.

Lodging Knee: a horizontal wooden knee for securing a deck beam to a ship's side

Main-Mast: Principal mast of a ship.

Mast: A pole, or long, strong, round piece of timber, or spar, set upright in a boat or vessel, to sustain the sails, yards, rigging, etc. A mast may also consist of several pieces of timber united by iron bands, or of a hollow pillar of iron or steel.

Mizzen-mast: The mast aft of the mainmast in a sailing ship - the shorter mast behind the main mast, or the third aftermost mast of a three-masted schooner or square-rigged ship.

Orlop: Name given to the lowest deck in a ship

Paddlewheel: A steam-driven wheel with boards around its circumference, situated at the stern or side of a ship so as to propel the ship by its rotation.

Parrel: Ropes or irons used to secure yards at the slings to the mast; rope parrels are commonly roved through balls of wood, so that they hoist easily on the mast.

Pintel: One of the pins (on the forward edge of a rudder) that fit into the gudgeons and so suspend the rudder.

Plating: Iron plates used for covering the outside of the frames.

Rigging: The ropes, chains, etc., employed to support and work the masts, yards, sails, etc., on a ship.

Sag (Sagging): When a vessel loads too heavily in the center it causes a bending downward of the hull at the amidship area. This can be caused by the vessel working in heavy seas with large waves under each end and no support under the center of the ship. Opposite of **hog**.

Schooner: A vessel with two or more masts, with fore and aft sails on both masts, normally less than 150 tons, but some of the triple masted schooners built on P.E.I. in the 1880's exceeded 700 tons.

Sheathing: A layer of metal covering the external face of wooden planks to prevent fouling and protect the outer hull.

Sister Keelson (Side Keelson): A reinforcing keelson between the main keelson and the commencement of the bilge curvature.

Squall: A strong wind characterized by a sudden onset, duration on the order of minutes, and a rather sudden decrease in speed.

Square-Rig: Rigged with square sails as the principal one.

Stringer: A longitudinal stiffener for the side of a ship made of angle bar, bulb angle channel or plates, etc. Depending upon their locations, stringers are known as bilge stringers, side stringers, whole stringers, etc.

Tonnage: A quantity of cargo normally expressed as a number of tons. Deadweight, gross, net, displacement.

Top-mast: The second mast, or that which is next above the lower mast.

Wale: One of the heavy planks or strakes extending along the sides of a wooden ship.

Winch: A machine worked by hand or steam-power, used to aid in the loading and discharging of cargo.

Windlass: a device for raising or hauling objects, usually consisting of a horizontal cylinder or barrel turned by a crank, lever, motor, or the like, upon which a cable, rope, or chain winds, the outer end of the cable being attached directly or indirectly to the weight to be raised or the thing to be hauled or pulled; Similar to **winch**.

APPENDIX C[4]

:TABLE OF DOCUMENTED FEATURES FROM 2011 FIELD SEASON

Feature Name	Feature #	Length (approx.)	Width (approx.)	General Location
Capstan	1	2.0 Ft	2.0 Ft	Ravine 2
Keel Piece A	2	1.6 Ft	1.2 Ft	Ravine 2
Keel Piece B	3	4.0 Ft	1.5 Ft	Ravine 2
Keel Piece C	4	1.5 Ft	1.0 Ft	Ravine 2
Keel Piece D	5	3.0 Ft	1.0 Ft	Ravine 2
Keel Piece E	6	3.0 Ft	0.5 Ft	Ravine 2
T-Beam	7	7.0 Ft	0.5 Ft	Ravine 2
Wood Piece	8	4.5 Ft	0.5 Ft	Ravine 2
Wooden Piece	9	3.0 Ft	1.0 Ft	Ravine 2
T-Beam with Mast Fragment	10	11.0 Ft	0.5 Ft	Ravine 2
Mast Piece A	11	7.0 Ft	2.5 Ft	Ravine 2
Mast Section	12	3.0 Ft	4.0 Ft	Ravine 2
Mast Piece B	13	4.5 Ft	2.0 Ft	Ravine 2
T-Beam	14	4.5 Ft	0.5 Ft	Ravine 2
Wood Fragment	15	.8 Ft	1.5 Ft	Ravine 2
T-Beam	16	4.0 Ft	0.5 Ft	Ravine 2
Unknown	17	5 Ft	0.3 Ft	Ravine 2
Rider Knee Cluster A	18	4.0 Ft	1.0 Ft	Ravine 1
Rider Knee Cluster B	19	1.3 Ft	1.5 Ft	Ravine 1
Rider Knee Cluster C	20	2.2 Ft	1.2 Ft	Ravine 1
Rider Knee	21	4.8 Ft	0.7 Ft	Ravine 1
Unknown	22	2.0 Ft	1.0 Ft	Ravine 1
Plating	23	4.0 Ft	2.0 Ft	Ravine 1
Rider Knee Fragment	24	3.0 Ft	0.5 Ft	Ravine 1
T-Beam	25	5.2 Ft	0.5 Ft	Ravine 2
T-Fitting and Iron Plate	26	8.2 Ft	2.8 Ft	Ravine 2
I-Beam	27	18.0 Ft	0.5 Ft	Ravine 2
T-Beam	28	12.0 Ft	0.3 Ft	Ravine 2

[4] Information provided by Bendig et al's *Slobodna Site Report: Main-Mast Site Mapping and the Search for Slobodna's Stern* (2011).

Unknown	29	2.3 Ft	2.0 Ft	Ravine 2
I-Beam	30	12.3 Ft	0.6 Ft	Ravine 2
T-Beam	31	6.3 Ft	0.5 Ft	Ravine 2
I-Beam	32	12.6 Ft	0.3 Ft	Ravine 2

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