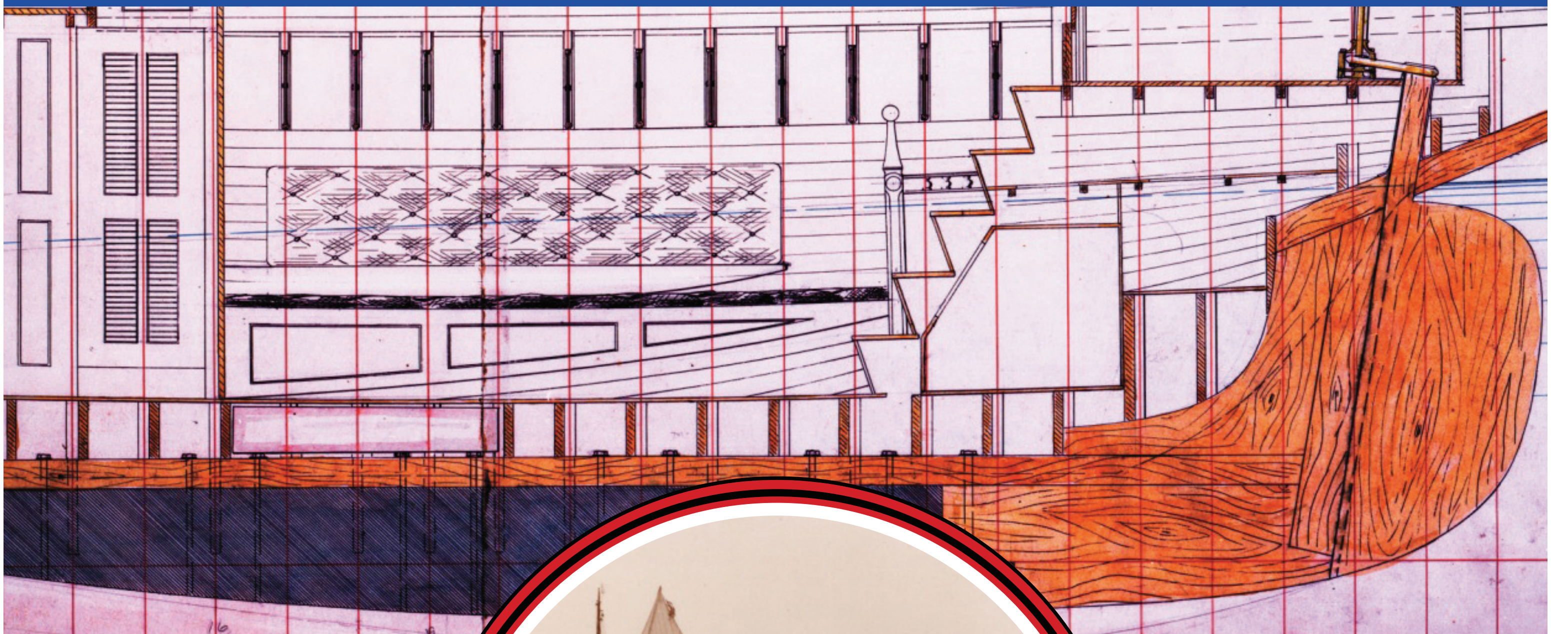
# PROCEEDINGS



HERRESHOFF MARINE MUSEUM

SOCIETY OF NAVAL ARCHITECTS & MARINE ENGINEERS

# THE 6TH CLASSIC YACHT SYMPOSIUM

MAY 2 & 3, 2014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LWL: 12' 6"
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The Classic Yacht Symposium™ 2014

**THE HERRESHOFF MARINE MUSEUM / AMERICA'S CUP HALL OF FAME** is dedicated to the education and inspiration of the public through presentations of the history and innovative work of the Herreshoff Manufacturing Company and the America's Cup competition.

The Museum, bordering beautiful Narragansett Bay, in Bristol, Rhode Island, is one of the nation's most important historic maritime treasures. We regularly host classic yacht regattas, sponsor symposia on classic yacht design and restoration, and operate an outstanding sailing school for youth and adults. We celebrate excellence in design, innovation, education, and technology.

Immerse yourself in exhibits about the Herreshoff Manufacturing Company, the America's Cup, and the fabulous people and yachts that gained fame around the world. Participate in our extraordinary events and expand your horizons. Visit, join, and be a part of a great tradition.

**THE CLASSIC YACHT SYMPOSIUM** celebrates all aspects of classic yacht design, restoration, reproduction, maintenance and use, featuring experienced presenters to promote professional and amateur excellence.



# Table of Contents

# The Classic Yacht Symposium™ 2014

## Additional Papers Included in the DVD



## Herreshoff Centennial Papers Included in the DVD



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**Chris Wick** / Board of Directors,
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Mystic Seaport Museum

The members of the Herreshoff Marine Museum extend their thanks to:

**Paul Bates**, **Andy Giblin**, and the staff of **MP&G** for for their continuing support of the Buzzards Bay 25 ARIA (HMCo. #738)

And to

**Steve Ballentine**, **Amy Ballentine Stevens**, and the staff of **Ballentine's Boat Shop** for the refurbishment of the Herreshoff 12 ½ BULLDOG (HMCo. #991).

Both boats are on display in the Museum's Hall of Boats.

Benefactor:
**Jeanne Eddy**

## Dedication:

The 6th Classic Yacht Symposium is presented in honor of **John Palmieri**

We simply wouldn't have a Classic Yacht Symposium of the caliber we have today if it were not for our Curator Emeritus, John Palmieri. John singlehandedly oversees the writing, voluminous editing and organization of papers submitted for CYS. He has logged thousands of hours on this daunting task and so often, without fanfare or complaint. With his naval officer background, keen intelligence and quick wit, he epitomizes the adage "grace under pressure". We are most grateful for his many efforts over the course of six Symposia.

The Classic Yacht Symposium™ 2014

# Schedule

| | |
|---|---|
| 07.30 | Registration Desk Opens – Coffee Served |
| 08.30 | Morning Program Begins – Opening Remarks |
| 08.40-09.35 | **Restoring BLUE MARLIN, a 1937 Nicholson Twelve Metre**<br>presented by David Pedrick & Allan Savolainen |
| 09.35- 10.15 | **ARION – An Experiment for the Ages**<br>presented by Steve Frary & Adam Langerman |
| 10.15- 10.35 | Morning Coffee Break |
| 10.35- 10.50 | **Introduction to the Herreshoff Centennial Classes**<br>presented by Halsey C. Herreshoff |
| 10.50- 11.30 | **Buzzards Bay 25 Restorations, the MP&G Approach and MINK**<br>presented by Andy Giblin |
| 11.30- 12.00 | **The Newport 29 Cruising Class**<br>presented by Chris Wick |
| 12.00-13.00 | Lunch Break |
| 13.00- 13.40 | **Evolution of the Herreshoff 12½**<br>presented by Steve Nagy |
| 13.40- 14.20 | **One Hundred Years of the Herreshoff 12½ at Quissett**<br>presented by Doug Cooper & Carol Suitor |
| 14.20- 14.40 | Afternoon Coffee Break |
| 14.40- 15.20 | **Traditional Boat Building & Restoration in a Modern Era**<br>presented by Erick Singleman |
| 15.20- 15.40 | **Panel Discussion for the Centennial Classes**<br>Halsey Herreshoff, Moderator |
| 15.40- 16.20 | **The Reliance Project: Discovering Herreshoff Mfg. Co. Capabilities**<br>presented by Sandy Lee |
| 16.30 | Adjourn to Herreshoff Marine Museum for:<br><br>**Reliance Project Tours** *(by prior reservation only – see Registration sheet)*<br>**N.G. Herreshoff Model Room Tours** *(by prior reservation only – see Registration sheet)*<br>**Visit the Centennial Boats**<br>**Birthday Reception in the Museum Hall of Boats** |

# Welcome – from Herreshoff Marine Museum

Dear Classic Yacht Enthusiasts,

Welcome to Bristol and the sixth Herreshoff Marine Museum/SNAME Classic Yacht Symposium! Bristol is a historic sailing and boatbuilding town with a wonderful harbor, great restaurants and spectacular sunsets.

Our CYS 2014 Committee has put together a compelling program for this weekend. We trust you will enjoy the boatyard tour of IYRS to view the CORONET project, the HMCo. New York 30, ROWDY being restored at Baltic Boat Works and the RELIANCE model project located on the HMM campus.

Saturday's events at Roger Williams University (RWU) School of Arts and Sciences include presentations by David Pedrick, N.A. and Allan Savolainen on the spectacular refit of the Camper & Nicholson twelve meter, BLUE MARLIN currently underway at Red Sky Boat Yard in Kotka, Finland. We will celebrate the centennial year of three iconic Herreshoff Manufacturing Company boats: the 12 1/2, the Newport 29 and the Buzzards Bay 25. Halsey Herreshoff, NGH's grandson, will moderate a panel discussion on these HMCo. classics along with A. Giblin, C. Wick, D. Cooper, S. Nagy, E. Singleman, C. Suitor and F. Fossati. I assure you this will be a most lively discussion. The groundbreaking Sidney Herreshoff, 42' ketch, ARION built at The Anchorage, Inc. in Warren, Rhode Island will be explored by owner, Steve Frary and CYS veteran, Adam Langerman. Rounding out the day's presentations, Sandy Lee will update us on the RELIANCE model project. At the conclusion of the RWU events, please join us back at the Museum for a centennial celebration replete with birthday cake and bubbly.

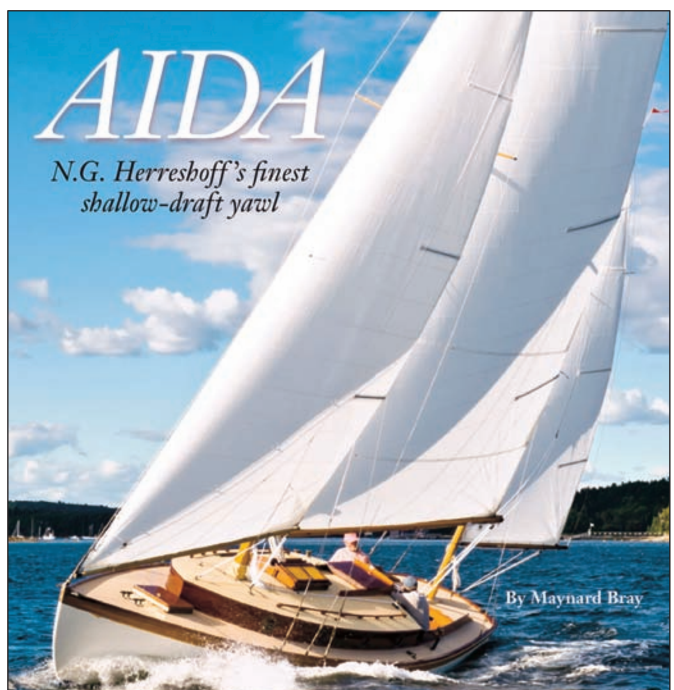
We thank our attendees, presenters, benefactors and sponsors for their generosity and unwavering support for this event. I also would like to thank Roger Williams University for their hospitality and wonderful facilities. Thank you to Peter Noble, President, Erik Seither, Executive Director and Alana Anderson of the Society of Naval Architects and Marine Engineers (SNAME).

I am grateful to the CYS 2014 Committee members for their, at times, herculean efforts to bring this event to life. They remain enthusiastic and committed to the Classic Yacht Symposium while maintaining their delightful sense of humor.

You are all truly the Classic Yacht Symposium's greatest asset and we would not be able to accomplish what we do without your participation and continued support. Thank you.

Please join us in Bristol for CYS 2016.

Jan Davison
CYS Chair, 2014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# Welcome – from Peter Noble, President of SNAME

As president of SNAME it gives me great personal pleasure to write this welcome note to the 2014 Classic Yacht Symposium as this will be a very important forum not only for all involved with classic yachts, but also for all naval architects, yacht and boat designers.

SNAME was founded in 1893 with the following objectives: *"The objectives of the Society are to advance the art, science, and practice of naval architecture and marine engineering in all their applied forms including the construction and operation of ships, marine vehicles, and structures of all kinds and the arts and sciences allied thereto by affording facilities for the exchange of information and ideas among its members and placing on record and disseminating the results of research, experience, and information relative to the objectives.."*

While not exclusively mentioned, the design of yachts and other small craft have been a staple for SNAME members over the years and I firmly belief that much innovation has come from that sector of our profession.

In my own case I grew up in Scotland and spend my formative years on the Clyde coast almost equidistant from the design offices of G.L. Watson and the yacht building yard of William Fife, and as a teen-ager I sailed on many yachts designed by each of these legends.

Slightly later in life while studying for a degree in naval architecture at the University of Glasgow, I was apprenticed to the small Clydeside shipyard of Wm. Denny Bros., whose place in maritime history is secured by the fact that they finished and delivered the clipper ship *Cutter Sark* to her owners when the original shipyard went out of business during her construction. A further important vessel to come from the Denny yard was one of Sir Tommy Lipton's, America's Cup Challengers, *Shamrock II* and *Shamrock III*. I remember we had plating half models of these fine hulls in our drawing office which had been used to take off plate sizes in the days before CAD-CAM programs.

The importance of studying classic yachts to the practicing naval architect cannot be overstated. Today's classic yachts were the cutting edge technology of yester-year and because of the nature of yachting they remind us of the importance of experimentation and feed-back, as key processes in design.

Many classic yachts were developed to win races and incorporated many features which became used in other areas; composite wood/metal construction, better understanding of sail aerodynamics, bi-metallic hulls, advanced rigging techniques, etc. A winner did not usually stay a winner for long and there was (and still is) a strong element of learning from the design of the day by discovering ways to improve and then making a new design with better performance. In the past there have been times of rapid innovation in yacht design where an owner was sponsoring new improved designs in quick succession. The motivation to win and the money with which to accomplish it, was a key factor in accelerating design innovation and the adoption of new technology.

For examples when Mortan F Plant took his schooner the *Ingomar*, one of the first schooners designed by Nat Herreshoff, to Europe in the early 1900s, there was much speculation in the yachting press, to which the owner is reported as replying as follows. *"While my trip to England and Germany is not for racing purposes, as I am not a "mug hunter", I do propose making a cruise and if we should be in the vicinity of racing and invited to do so, we will be glad to participate".* He went on to compete in a number of races in both England and Germany and *Ingomar* won 17 prizes including 12 firsts!

A further lesson which is worth noting was that these classic vessels, full of exquisite design detail, high craftsmanship and technological innovation were generally the product of a single mind (assisted by others of course but led by one designer).

In these days when we see so much design by committee, it is refreshing to think back to an earlier time when John Scott Russell, the great Victorian naval architect was able to state in his massive text book, "The Modern System of Naval Architecture", published in1865

*"A naval architect should be able to design, draw, calculate, lay down, cut out, set up, fasten, fit, finish, equip, launch and send to sea a ship out of his own head. He should be able to tell beforehand at what speed she will go, what freight she will carry, what qualities she will show in a sea, - before it, athwart it, against it, - on a wind, close hauled, going free, - what she will stow, and carry, and earn and expend. On his word you should be able to rely, that what he says, that his ship will infallibly do.*

I encourage as many of my SNAME colleagues as possible to attend the 2014 Classic Yacht Symposium and to spend time observing examples of these fine craft to learn how to become better naval architects and designers. From first-hand experience I can tell you that even a designer of icebreakers and offshore rigs can learn from the past masters of the art of designing for the ocean environment.

*Image Left:*
Launching of the Shamrock III from Denny's shipyard in Dumbarton, Scotland in 1903

*Peter G. Noble* , President
SNAME
*The International Community for Maritime and Ocean Professionals*

# Restoring BLUE MARLIN, a 1937 Nicholson Twelve

**Authors David Pedrick & Allan Savolainen**

**Figure 1** – BLUE MARLIN, with T.O.M. Sopwith at the helm at Kiel Week 1938.

**Figure 2** – New bent frames being fitted into original hull planking.

## Abstract

In 2006, the Twelve Metre Class yacht BLUE MARLIN was intact and able to float on her own bottom, but just barely. Almost 70 years of service had left her in seriously decayed condition, requiring replacement of nearly all of her structural materials. BLUE MARLIN's new owner wished to preserve authenticity to the fullest practical extent, transforming her frames, timbers and planking to be seaworthy again while never losing the soul of Camper & Nicholson's original construction. He also wished to have the restoration project performed in a facility where the work in progress could be observed closely by the public. Objectives of the restoration included: returning BLUE MARLIN's structural integrity to stand up to competitive classic yacht racing; re-creating authentically styled deck hardware; using her original interior panels to create new cruising accommodations while adding increased, new systems; and achieving CE certification attesting to her new, 21st century standards of structure and safety. After some background about the project's beginnings, this paper tells the story of design, engineering and boatbuilding that have given BLUE MARLIN new, long life.

## About the Authors

**David Pedrick** is a naval architect and marine engineer, educated at Webb Institute. His yacht design career began in 1970 at Sparkman & Stephens, working closely with Olin Stephens on the firm's leading-edge racing yachts. In 1977 he opened Pedrick Yacht Designs in Newport, RI. Notable projects have included America's Cup winners, record-setting Maxi ocean racers, luxurious neo-classics, and sail training craft for the U.S. Naval and Coast Guard Academies. David is now working a new neo-classic yawl and his 24th Twelve Metre project while completing restoration services for BLUE MARLIN. He is a founding trustee and past Chairman of the International Yacht Restoration School.

**Allan Savolainen's** craftsmanship was honed at a four-year wooden boatbuilding school in eastern Finland. In 1998, he co-founded the Wooden Boat Center of Kotka, proceeding to restore several yachts, construct a cruising sailboat and build a tradition-inspired powerboat of his own design. Among several Six Metre restorations is the 1938 Sparkman & Stephens DJINN for BLUE MARLIN's owner. In 2004 he established Red Sky Craft, which provides yacht restoration, new construction, wooden spars and general yacht services. Allan has been the master shipwright and director of the BLUE MARLIN project since 2007, expanding into the new Finnish Wooden Boat Center in 2008.

The Classic Yacht Symposium™ 2014

# Restoring BLUE MARLIN, a 1937 Nicholson Twelve

**David Pedrick**
Pedrick Yacht Designs, Newport, RI, USA

**Allan Savolainen**
Red Sky Craft, Kotka, Finland


## ABSTRACT

In 2006, the Twelve Metre Class yacht BLUE MARLIN was intact and floating on her own bottom, but just barely. Almost 70 years of service had left her in seriously decayed condition, requiring replacement of nearly all of her structural materials. BLUE MARLIN's new owner wished to preserve authenticity to the fullest practical extent, transforming her frames, timbers and planking to be seaworthy again while never losing the soul of Camper & Nicholson's original construction. He also wished to have the restoration project performed in a facility where the work in progress could be observed closely by the public.

Objectives of the restoration included: returning BLUE MARLIN's structural integrity to stand up to competitive classic yacht racing; re-creating authentically styled deck hardware; using her original interior panels to create new cruising accommodations while adding increased, new systems; and achieving CE certification attesting to her new, twenty-first century standards of structure and safety. After some background about the project's beginnings, this paper tells the story of design, engineering and boatbuilding that have given BLUE MARLIN new life for her next 75 years.


## INTRODUCTION

Classic yacht restoration comes from the heart. Something about the style and romance of classic yachts stirs appreciation and excitement. Although the decision to save a seriously decayed, old yacht is neither practical nor economical, there is a rationale. The outcome is worthwhile.

1) BLUE MARLIN in the Solent, 1938 (Beken)

Ultimately, the satisfaction from making a neglected classic yacht purposeful and seaworthy again comes from saving a particular piece of history, perpetuating the craft of her designer and builder, returning her graceful and powerful presence to the seas, and renewing the pleasures and excitement of sailing her. Fortunately, there are people for whom all of this matters. They combine a deep passion for classic yachts, a particular fondness for certain types, some idea of what a restoration entails, a vision of the end result and the willingness to support a budget that only grows larger as the project progresses.


*Presented at the Classic Yacht Symposium of the Herreshoff Marine Museum, Bristol, Rhode Island, USA, 3 May 2014; amended to -R1 on 6 May 2014.*

BLUE MARLIN's restoration makes a remarkable story, beginning with the vision of her owner and proceeding through meticulous work by a team of experts in all of the contributing disciplines. Years of passion, patience, talent and craftsmanship by the BLUE MARLIN team have created the story that follows in these pages.

**TOPICS COVERED** (with page numbers)



Note that this is a lengthy paper, not suggested for reading in one sitting. The short version of it can be followed through numerous photographs, illustrations and their captions. The comprehensive content to be found in the text describes many interesting facets and technical details of a thorough and careful restoration that extended over approximately seven years.

## HOW "BLUE MARLIN'S" RESTORATION PROJECT CAME ABOUT

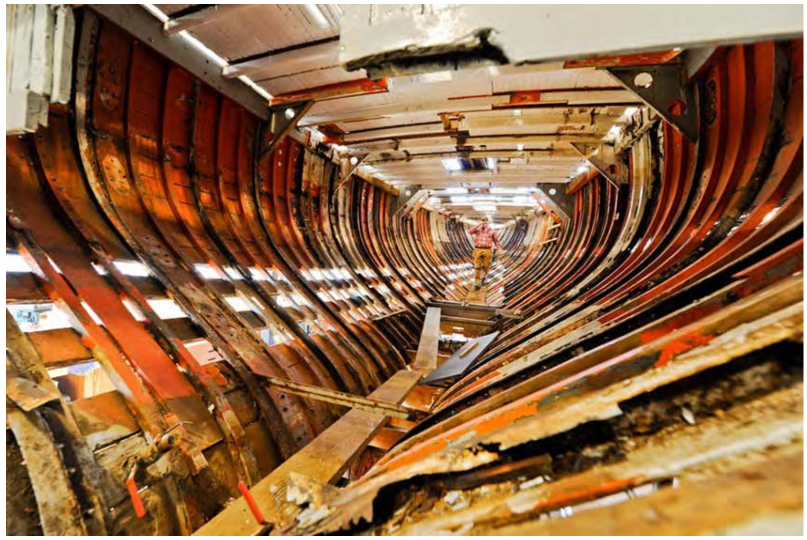
Henrik Andersin, a classic yacht enthusiast in Helsinki, Finland, lives in a country where the love of wooden yachts seems to be a national pastime. There are many classic racing classes and one-offs in Finland, including large, active fleets of International Six Metre and Eight Metre Class yachts.

Mr. Andersin has more than the usual Finnish fervor for the Six Metre Class, owning three Sixes that he has restored. One is New York Yacht Club Commodore Henry Morgan's DJINN, designed by Sparkman & Stephens in 1938 and a close sister of the highly successful GOOSE. Another is MAY BE VI, a Tore Holm design built right after World War II for Sweden's leading racing yachtsman, Sven Salen. DJINN, which was being sailed then in northern Europe, and MAY BE VI were great competitors, and are now both stable-mates in Mr. Andersin's fleet of classic yachts. His third Six Metre is the 1970 Sparkman & Stephens (S&S) TOOGOOLOOWOO V, known as TOOGIE V.

Nearly 10 years ago, his interest grew toward having a larger yacht that would be good for cruising as well as classic yacht racing. He was interested in a Twelve Metre Class yacht in need of a full restoration, for which the final result would be to very high standards. He had inspected Twelves in Europe and the United States, but had not found a well-pedigreed "basket case" boat that met his needs until 2006, when he was introduced to the Twelve Metre BLUE MARLIN through Hamburg-based yacht broker Peter Koenig. Peter, perhaps Europe's most enthusiastic and committed classic yacht specialist at the time, knew of Mr. Andersin's interest and the forlorn BLUE MARLIN.

Like Mr. Andersin's Sixes, BLUE MARLIN has a significant heritage – designed by Charles Nicholson and built by Camper & Nicholsons (a/k/a Nicholsons) in 1937. After Sir T.O.M Sopwith's 1937 America's Cup campaign with ENDEAVOUR II, he purchased BLUE MARLIN as an interim learning platform while commissioning Nicholson for a new Twelve for 1939, which would be named TOMAHAWK (an apparent combination of names of the owner and his aircraft company, Hawker Aircraft). Sopwith's downsizing from the J-Class to a Twelve was in response to a friendly offer by his rival Harold S. "Mike" Vanderbilt. After competing against Sopwith as skipper of America's Cup winner RANGER in 1937, he offered to race against him in the U.K. in 1939 with VIM, the new S&S Twelve that he was planning.

Nearly 70 years later, when Mr. Andersin decided to purchase BLUE MARLIN, she was afloat in Slovenia, but had not been hauled for several years. Her condition, structural and otherwise, was nowhere near as solid as her pedigree. Mr. Andersin realized that he was taking on a major restoration project, but one whose outcome would be worthwhile.



2) Amidships and forward after interior had been removed. Builder Allan Savolainen might be wondering what he had gotten himself into. (Skogström)

Notwithstanding western Finland's distinguished builders of luxury sailing yachts for export – Baltic Yachts and Nautor's Swan – a Twelve is a very large yacht within the country's domestic yachting community. Yacht builders and service yards for the local Finnish market are scaled correspondingly to yachts of smaller sizes. Mr. Andersin understood that several years would be required to plan the scope of work for BLUE MARLIN's restoration, develop the restoration processes to preserve and enhance the yacht's antique qualities, and allow a small team of talented craftsmen to carry out the highest standards of wood-working and metal fabrication. This project – carefully planned and executed – would be a source of national pride and excitement for Finland's wooden yacht industry and sailing community.

3) Amidships and forward as hull construction was nearing completion. (Skogström)

**TWELVE METRE CLASS BACKGROUND**

The Twelve Metre Class is one of ten classes of yachts that were created in 1907 under the appropriate name of the "International Rule." Prior to that, each country had its own means of handicapping yachts for racing, often based on tonnage rules for commercial cargo vessels. Yachts developed under one country's handicapping rule were usually disadvantaged when they chose to compete in another country.

Led by yachting authorities in the United Kingdom, delegates from eleven European countries convened in London, Berlin and Paris in 1906-07 to create a unified rating rule for international racing. This would help standardize the development of racing designs to a common, international type. In addition to crafting the rating formula for new classes of yachts over a range of sizes, they produced measurement instructions, established construction standards and wrote rules for racing.

The ten classes of International Rule yachts were designated by their ratings in metres – 5, 6, 7, 8, 9, 10, 12, 15, 19 and 23 Metre Class Yachts. The rating was meant to correspond to the approximate waterline length, but design optimization led to waterlines that are actually about 15% longer.

As a by-product of the technical rules, the delegates realized that an organizational structure was needed to foster consistent, international competition. The international delegates went on to found the International Yacht Racing Union (IYRU) in October, 1907, to promote and support unified racing for yachts brought together under the new International Rule. The IYRU expanded its services to international yachting throughout the twentieth century, and was re-branded as the International Sailing Federation (ISAF) in 1996.

The International Rule was promptly adopted for yacht racing in the 1908 Olympics – just 12 years after the establishment of the modern Olympic Games. Sixes, Sevens, Eights and Twelves competed in 1908, with 13 yachts from five countries. Twelves were used again in 1912 and 1920, but few yachts were entered and the class was subsequently discontinued as an Olympic class. Sixes were active and well represented in the Olympics through 1952 (in Helsinki, by the way).

The International Rule didn't gain traction in the United States until 1922. The Universal Rule was already in active use in the U.S. Northeast. Crafted by Nathanael Herreshoff at the request of the New York Yacht Club (NYYC) in 1902, the Universal Rule calculated ratings for letter-class yachts – from S-Boats to J-Class Yachts and much in between. Having adopted the Universal Rule in 1905, U.S. yacht clubs were not motivated to take up the new, basically European Rule when it was first created. That began to change in 1921 with the advent of the British American Cup. Held in the Six Metre Class in the U.K. between teams of 4 yachts per side, this was the world's first recorded international team racing event. The event moved across the Atlantic in 1922, when it was hosted by the Seawanhaka Corinthian YC in Oyster Bay, NY. The regatta at SCYC launched the Six Metre Class in western Long Island Sound.

The Twelve Metre Class was introduced to the U.S. when NYYC members commissioned a fleet of six Twelve Metre yachts in 1927. Identical designs by Starling Burgess were constructed by Abeking & Rasmussen in Lemwerder, Germany for the 1928 racing season in Long Island Sound. After the Great Depression, six more U.S. Twelves followed between 1935 and 1939. Two were designed by Clinton Crane and three by Sparkman & Stephens.

Meanwhile, Twelves thrived in Europe from 1934 to 1939. Thirteen Twelves were built in the U.K. during these years. Eight were designed by Charles Nicholson and two each by William Fife and Alfred Mylne of Scotland. Of four Twelves built in Germany during this period, three were designed by Henry Rasmussen. Two yachts were built in Norway, both designed by Johan Anker.

More than a century after its creation, the International Rule is still used actively for racing in Sixes, Eights and Twelves. It was modified in its early years to accommodate such things as the Bermudian rig (with gaff rigs fitted prior to 1920) and to adjust for unintended influences of rating parameters that produced undesirable design characteristics. The so-called Second Rule was adopted in 1920, with further refinements in 1933 in the Third Rule – still in effect for the Metre classes. The somewhat simplified version of the International Rule's rating formula as revised in 1933 is:

$$\text{Rating (metres)} = \frac{L + 2d - F + \sqrt{S}}{2.37}$$

where:
L = length (metres)
d = girth difference (metres)
F = freeboard (metres)
S = sail area (square metres).

Each of these terms has multiple measurements and sub-formulae for calculating the terms that go into the rating formula.

4) BLUE MARLIN and TRIVIA in the Cowes Regatta, 1938 (Beken)

Ten years after the end of World War II, Twelves were the largest yachts raced competitively as a class anywhere. In response to the post-war economy, and nearly 20 years after the heyday of the J-Class era of the America's Cup, the New York Yacht Club petitioned the Supreme Court of the State of New York in 1956 to change the America's Cup's Deed of Gift (DoG) to accept smaller yachts than the Cup's donors had contemplated in the nineteenth century. The minimum waterline length in George Schuyler's 1887 DoG was 65 feet (19.8 m). The court approved reducing it to 44 feet (13.4 m), just below the typical waterline length of a Twelve. The NYYC then invited a challenge in Twelves from the UK's Royal Yacht Squadron, resuming America's Cup competition in 1958. The America's Cup years of the Twelves, from 1958 – 1987, were glorious, with 76 new yachts constructed worldwide. New countries – such as Australia, New Zealand and Canada – were brought to the Twelves, and interest was revived in France and Italy.

The focus of BLUE MARLIN's story and this paper, however, is in the 1930's. Twelves of this era are now grouped in the "Vintage" Division of the Class, which includes yachts from Rules 2 and 3 preceding World War II.

5) C&N Hull #454 sailing as ALANNA in 1937. She would become BLUE MARLIN in 1938. (Beken)

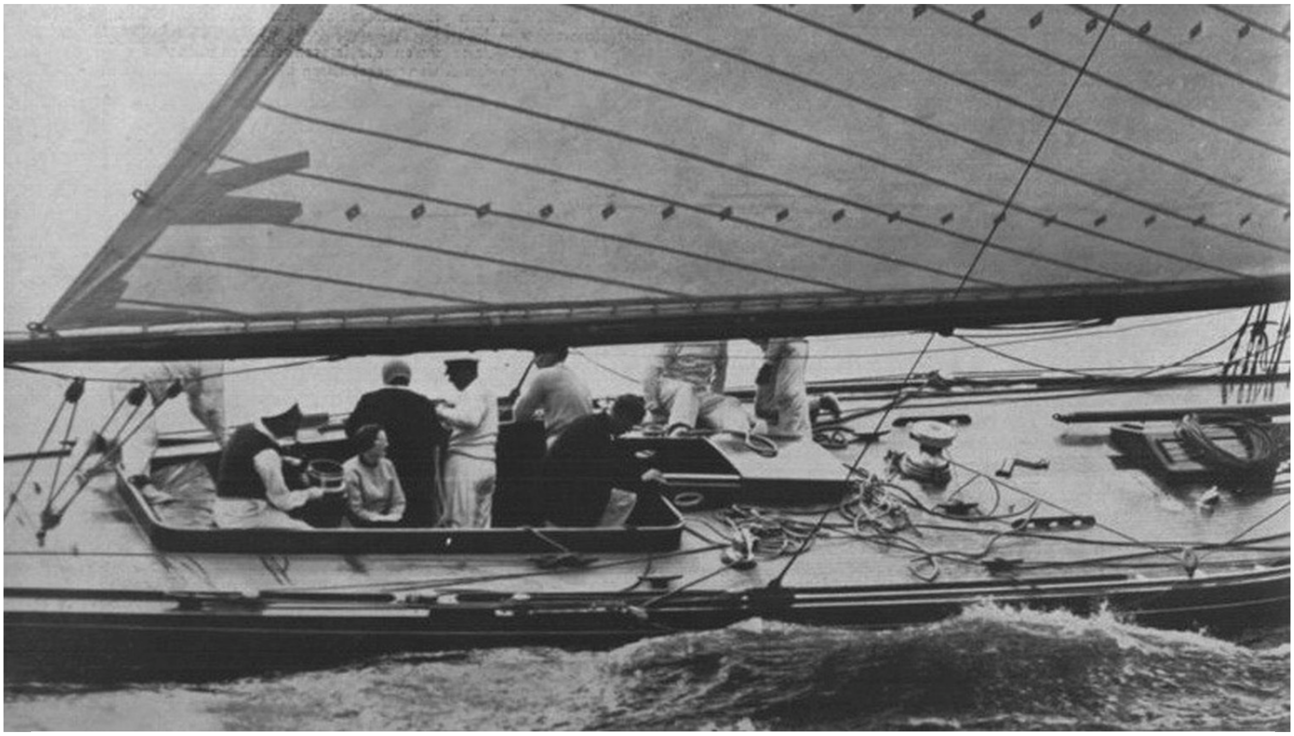
Presently competing in this division in Northern Europe – especially in the Baltic Sea countries of Germany, Denmark and Norway – are about ten beautifully restored Twelves, with several more joining the fleet in the next 1-2 years. Another five or so Vintage Twelves are based in the Mediterranean. Additional Twelves have been restored in Europe, without having been raced recently. BLUE MARLIN will undergo a gentle work-up in Finland in 2014, with plans to race with the Baltic fleet beginning in 2015 and eventually to compete and cruise in the Mediterranean.

## BLUE MARLIN'S HISTORY, IN BRIEF

BLUE MARLIN was built to join an active fleet of Twelves in Britain's Solent – the waters between Southampton and the Isle of Wight. Camper & Nicholsons built five Twelves in 1936-37, the last of which was sold to British yachtsman Charles E.A. Hartridge. Named ALANNA, she was launched mid-season, in late July 1937.

ALANNA had a so-so first season, after which she was sold to Sir T.O.M. Sopwith. Sopwith was a well recognized aircraft builder in World War I. He then furthered his success as chairman of Hawker Aircraft from the 1920's through World War II. He remained active in the aircraft industry well into his 80's, and was honored by a flyby at his 100th birthday in 1988.

Sopwith gave ALANNA the name BLUE MARLIN and Endeavour Blue topsides. He and his talented chief engineer Frank Murdoch made a few upgrades to BLUE MARLIN for the 1938 racing season. One of these was a powerful jib sheet winch on centerline with removable, coffee-grinder-like handles. Sopwith adapted to the Twelve Metre Class quickly, scoring 2 firsts and 9 seconds in 11 starts. Lessons learned on BLUE MARLIN led to significant advances in deck hardware and other details of his new Nicholson Twelve TOMAHAWK for the 1939 season.



6) Sopwith at the helm of BLUE MARLIN at Kiel Week in 1938, testing the waters on the race course as well as scouting out Germany's war machine. He confirmed the need to step up production of his aircraft, which would play a major role in the Battle of Britain two years later, defending against Hitler's massive air invasion. (Riebicke)

BLUE MARLIN was sold to W.R. Westhead at the start of 1939. Although set back by a dismasting in early racing, she had a strong season, scoring 6 firsts, 2 seconds and 3 thirds. In racing that included VIM and TOMAHAWK, she placed an honorable third.

Mr. Westhead remained BLUE MARLIN's owner throughout the War years, after which she had four other British owners from 1946-51, including Mr. Hartridge again from 1948-50, temporarily restoring the name ALANNA. Renamed BLUE MARLIN in 1951, she relocated to Genoa under Italian ownership from 1952-56. For the next fifty years she remained in a single family based on the Adriatic coast of Italy. When Alessandro Colussi died in 1998, his heirs Andreotti and Rosella Colussi kept her until 2006. BLUE MARLIN was floating forlorn in Izola, Slovenia when Henrik Andersin made the commitment to bring her back to her former glory.

After purchasing BLUE MARLIN, Mr. Andersin had her trucked to Finland, where she arrived in early November 2006 in blowing snow.


7) BLUE MARLIN at Red Sky Craft in 2008, in better weather than when she arrived. The construction hall end of the Finnish Wooden Boat Center, to the right, is nearing completion. (Skogström)

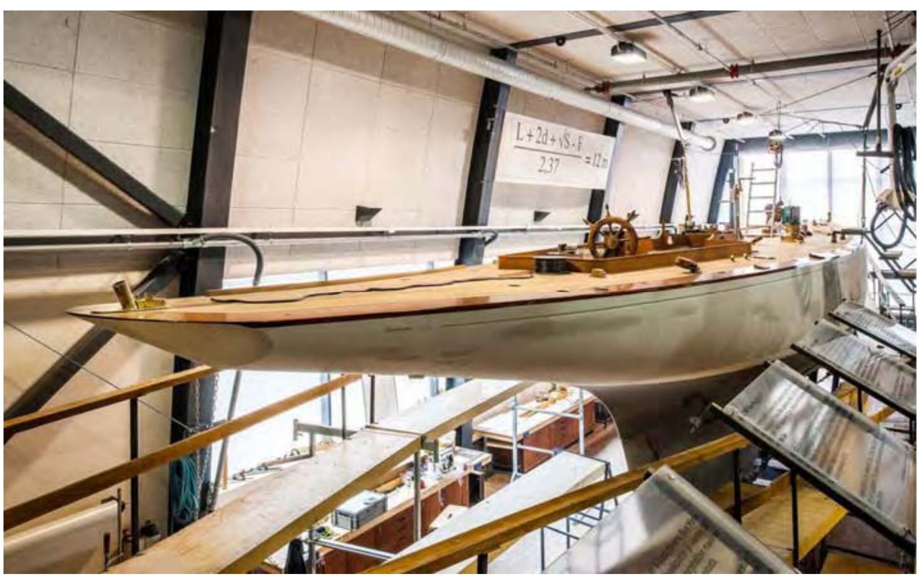
### THE FINNISH WOODEN BOAT CENTER

Part of Mr. Andersin's vision for BLUE MARLIN's restoration was to make the project open for public viewing. Coincidentally, at the time when BLUE MARLIN was delivered to the small port city of Kotka – about 130 km (80 mi) east of Helsinki – a new Maritime Museum of Finland was beginning construction just a 10-minute stroll along a waterfront promenade from her restoration site.

Master shipwright Allan Savolainen (co-author of this paper) was a partner in establishing a Wooden Boat Center in Kotka in 1998 as a co-op center for marine trades. In 2004 he founded the boatbuilding company Red Sky Craft (RSC) on the premises. By that time, he had earned a solid reputation in wooden yacht restoration and construction, including several projects with Mr. Andersin. Mr. Andersin was confident about Red Sky Craft's ability to scale their skills to as large a yacht as a Twelve Metre, although it would require an increase in work space. He envisaged a modern facility for housing BLUE MARLIN's restoration project that would include a mezzanine in the construction hall for public viewing of work in progress.

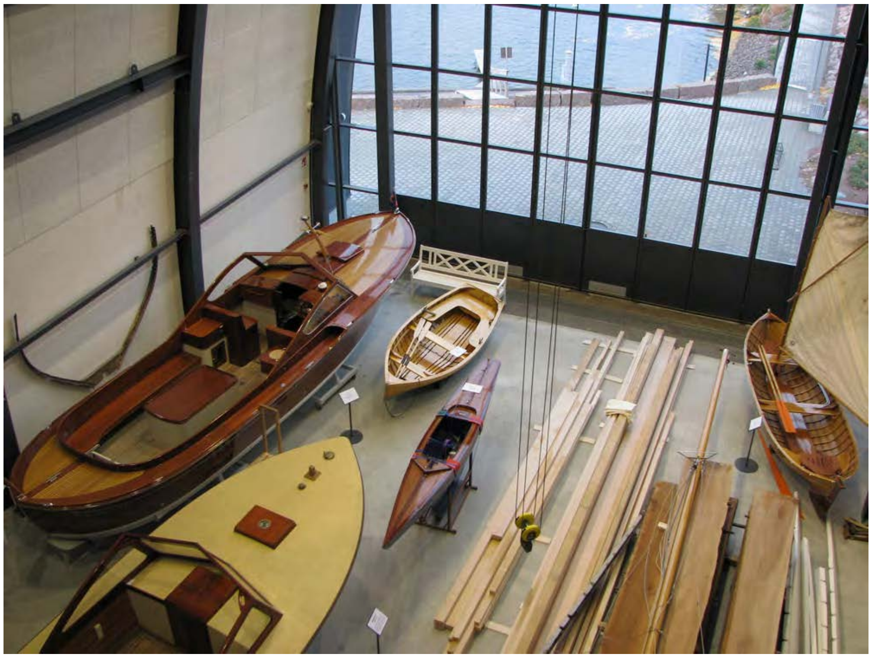

8) BLUE MARLIN and the Finnish Wooden Boat Center in 2007. She was the world's only twin-screw Twelve Metre. (Skogström)

Dedicated in May 2008, this new Finnish Wooden Boat Center was added to the existing property on which Red Sky Craft is housed. In addition to its construction hall, the Wooden Boat Center has an exhibit hall, a café, a meeting room, offices and an upper work and storage loft. When the Maritime Museum - a significant public attraction – opened two months later, the nearby Wooden Boat Center (WBC) also welcomed visitors to see wooden yachts and small craft being built and restored.



9) In the final stages at the WBC, April 2014. Deck fit-out, varnishing and installation of interior components are nearly complete. Work in progress is visible from the sidewalk outdoors and a viewing bridge to the right. Storyboards on the viewing bridge describe the project. (Pedrick)

The WBC experience is complete with exhibits, photo-graphs and storyboards about wooden yachts and how they are built. Sailors and the general public have been intrigued and educated about the construction of BLUE MARLIN and wooden boats from the viewing bridge just a few meters (roughly 10') from where active shipwright work is being performed. For much of the project, until she was re-decked, they could look down inside the hull. More recently, they have watched the completion of her deck and installation of vintage-styled, custom bronze hardware.



10) The exhibit hall at the WBC with a variety of small craft. The motorboat on the left was designed by Allan Savolainen and built by Red Sky Craft. The timber on the floor is spruce and mahogany for BLUE MARLIN. This space is used occasionally for non-marine displays such as art shows, at times in conjunction with the City of Kotka. (Pedrick)

**THE PROJECT TEAM**

In acquiring BLUE MARLIN, Mr. Anderson was committed to restoring her properly, He allowed time to assess her condition and assemble resources for the best possible result. Essential to his embarking into such a substantial project was his trust in boatbuilder **Allan Savolainen** and his crew at Red Sky Craft. Mr. Andersin would provide the time, space, encouragement and, significantly, the funds for them to achieve their best work. Allan was the man with his hand on the helm of every aspect of planning and executing the restoration work. Throughout the project, he was constantly foreseeing many steps ahead in the process, making sure that each step to get there was in the right sequence and fashioned with the best craftsmanship.

When Mr. Andersin went to Newport, RI for a Six Metre Class meeting at the International Yacht Restoration School (IYRS) in early 2008, he met **David Pedrick** and invited him to be the Restoration Advisor for the BLUE MARLIN project, which was just getting started. As the demands of the project came into more complete view, it became apparent that it would benefit from the comprehensive scope of design, engineering and knowledge of yacht restoration that David and his team at Pedrick Yacht Designs could provide.

During the start-up stage, Finnish yacht designer **Kamu Stråhlmann** began documenting BLUE MARLIN's structure and shape. From original design plans and the yacht herself, he produced new CAD plans of her hull construction. Working with a "point cloud" obtained by a precise laser scan of the hull, deck and internal structure, he created a 3D computer model of the actual, as-found, deformed hull shape. Later, he modeled the yacht's centerline timbers in 3D and produced loftings for Allan to begin shaping and setting up Blue Marlin's backbone.

11) Early project team members Kamu Stråhlmann, Allan Savolainen and David Pedrick with owner Henrik Andersin. (Skogström)

Later in the project, as planning of deck equipment progressed, BLUE MARLIN's captain and yacht manager, **Chris Winter**, ramped up his role on the team to project-manage the outfitting of the deck and other systems, and to select the sails and running rigging. Chris, an American ex-pat, has coached Finnish Olympic sailing teams and other programs, and has provided professional services and outfitting for a variety of yacht and boatyard projects in Finland for more than two decades. Working with Allan and David, he undertook the purchasing of deck hardware, other systems and equipment, rigging and sails. He then assisted Red Sky Craft with their installation on BLUE MARLIN. As of this writing, Chris is making the final arrangements to begin sailing BLUE MARLIN in June 2014.

While Camper & Nicholsons' original structure and interior remained substantially intact, her deck had been modified over the years. Only her cockpit and scuttle for companionway were still from 1937. For guidance about restoring and replicating features on BLUE MARLIN's deck, in particular, Mr. Andersin turned to noted British yacht historian **William Collier**. Having written his doctoral dissertation on the Camper & Nicholsons shipyard, William is the world's master authority on the work of the shipyard and designer Charles Nicholson. He also revived the name of the leading-edge, late nineteenth-century Scottish yacht designer G.L. Watson for his restoration design services company. William provided general guidance about Nicholson's methods, examples of winches used by Nicholson and Sopwith in the late 1930's, and specific design services through G.L. Watson & Co. in areas such as the skylight and foredeck hatches, the toerail and other deck details.

Behind the tangible work of BLUE MARLIN's restoration was **Leo Skogström**, the Managing Director of the Finnish Wooden Boat Center throughout most of the project. He was instrumental in the vision of the Center, as well as in much of the public and government relations for the WBC's creation and subsequent operations. Leo, who has a significant yachting background, facilitated the acquisition and shipping of BLUE MARLIN from Slovenia. As a superb photographer, Leo documented the progress of work on the yacht and recorded interviews of various participants and authorities, some of which are available on the web sites BlueMarlin.fi and, for the Wooden Boat Center, suomenpuuvenekeskus.fi with language choices that include English.

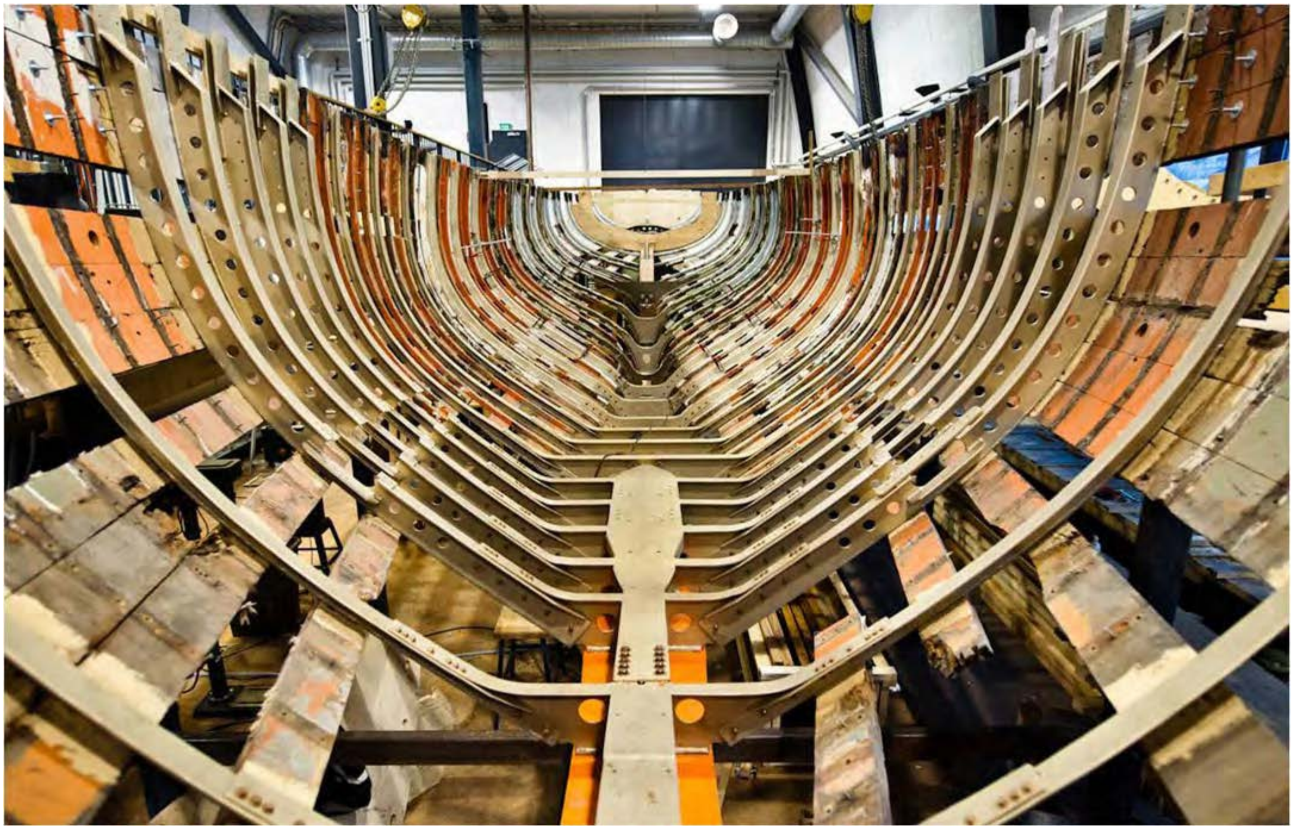
The project team members named here are the principal professionals hired by Mr. Andersin to carry out BLUE MARLIN's restoration. He was, of course, the CEO of the team whose vision and direction were essential to the conduct of work by the professional team. For clarity, when "project team" is mentioned in this paper, it refers to the hired professionals, but Mr. Anderson was always closely engaged as the *de facto* team leader in all of the principal planning and decisions.

## RESTORATION OBJECTIVES AND APPROACHES

Mr. Andersin's original intent for BLUE MARLIN was to restore her as a cruiser-racer. She will join the Baltic racing fleet's superb, classic Twelves and have suitable accommodations and systems for cruising and deliveries between racing and cruising venues, as well. With the goal of setting an exemplary standard of historical integrity in BLUE MARLIN's restoration, Mr. Andersin directed that the yacht's structural reconstruction, outfitting of the deck, detailing of spars, and revisions to the interior be as faithful as practical to her original design, construction and aesthetics. Where enhancements have been incorporated, they are meant to be characteristic of similar British yachts of the late 1930's.

A fundamental guiding principle of her restoration is that BLUE MARLIN would never cease to be BLUE MARLIN. As structural materials were replaced progressively, as much of her original hull would be kept for as long as possible. Her somewhat deformed hull would be brought back exactly to Nicholson's lines. In restoration terms, where her original "fabric" was beyond re-use, new materials would be of like kind as the originals, except where poor-performing original materials caused unacceptable, early decay.

12) In the construction hall, March 2009, before truing up the sheerline (Pedrick)



13) Bronze grown frames in place; original planks remain attached to serve as ribbands for forming and clamping the new bent frames, January 2011. Frames and floors have bolted connections. They were in and out of the hull for various stages of fitting, aligning, soda blasting and final assembly. (Skogström)

While being faithful to Nicholson's exact structural design, David Pedrick realized that necessary, improved strength could be engineered through subtle enhancements. Where original components were reasonably sound, it was intended that they would be re-used. Regrettably, the seriously rusted and rotted structure of the hull and deck offered little opportunity for that, although some original pieces were re-used.

Original joinery panels in the yacht's interior were in good condition and could be adapted to suit the more open, new arrangement plan that Mr. Andersin desired for BLUE MARLIN's future use. New, wood spars with traditional fittings would be made. Additional features to support adaptive re-use would include improved sail handling hardware and cruising systems.

The restoration process was to be approached methodically and patiently. There was much to learn about the original design, engineering and construction by Camper & Nicholsons before getting into significant physical work on the hull. The restoration would be carried out by a very talented wooden boatbuilder with a relatively small team, planning on several years' duration to apply their craftsmanship to their best abilities. Not rushing the schedule would also extend the extraordinary public learning experience that this restoration would provide.

All of the planning, design, engineering, construction and outfitting for BLUE MARLIN's restoration has endeavored to be as authentic to her original creation as could reasonably be achieved. A few deliberate exceptions were chosen to make her more durable, seaworthy, manageable and comfortable than she was in her first life. While all wood species would be true to her original construction, her rusted steel hull components would be replaced with bronze, faithfully replicating the original frames' shapes and locations.

Her interior would be reconfigured to suit her future life as a cruiser-racer, including an engine as well as modern electrical and plumbing systems. More visibly, her sail handling systems would be upgraded from her woefully primitive original deck hardware. Nevertheless, the style of hardware upgrades would follow the designs of winches and fittings on Sopwith's and other British racing yachts of BLUE MARLIN's original era.

**SAFETY STANDARDS**

The BLUE MARLIN project has gone beyond the familiar considerations of classic yacht restoration, though. She establishes a new standard of safety and durability in a restoration through compliance with the European Union's (EU's) Recreational Craft Directive (RCD) that was established in 1994. The fundamental purpose of the RCD is to harmonize the safety standards of boating industry products throughout Europe.

The RCD invokes a number of criteria through the International Standards Organization (ISO) in many areas such as: hull structural engineering, stability, steering, cockpit drainage, deck hardware, bilge systems, tanks, electrical systems, fire safety and virtually all manufactured components that go into a boat. Completed yachts, including incorporated components, offered for sale within the EU must be certified in all relevant areas to achieve the CE mark (Conformité Européenne). Although classic yachts, defined by the RCD as prior to 1950, are exempt from having to meet the requirements, BLUE MARLIN's restoration has taken a 21st century view about certified construction, safe operation and commercial value that are intrinsic with earning CE (CE) compliance.

There are four categories of service that set respective levels of stringency on safety requirements for structure, stability, flooding, equipment and other risks to personal safety. They are related to limits of wave height and wind strength associated with the respective category, presuming correct handling and good seamanship. For offshore yachts, Category A is effectively for operating in the open ocean with exposure to potential, substantial storms. It permits operation in significant wave heights exceeding 4m (13') and wind strengths exceeding Beaufort Force 8 (40 kts). Category B is effectively for coastal conditions, presuming that a harbor of refuge is available if conditions threaten to exceed the 4m/40kt limit. Category C has upper limits of 2m (6½') for waves and Beaufort Force 6 (27 kts) for wind - too low a bar for venturing offshore. BLUE MARLIN has been engineered and equipped for the maximum safety level of Category A.

**DESIGN INFORMATION**

At best, after 70 years, design information about classic yachts is hard to come by, except when yacht designers' works have been archived. Most of the drawings of Charles Nicholson and the Camper & Nicholsons shipyard were regrettably lost when the shipyard was bombed during World War II. However, the British National Maritime Museum in Greenwich has been able to collect copies of many prints that Nicholsons had sent out to other parties. Some of these were redrawn in the 1950's to create new, undamaged master copies.

Mr. Andersin and Allan Savolainen contacted the Maritime Museum in 2007 to obtain all of the plans and records in its archives that would be helpful to BLUE MARLIN's restoration. They learned that there were very few plans for her, but information from four preceding Twelves built by Nicholsons in 1936-37 proved to be helpful.

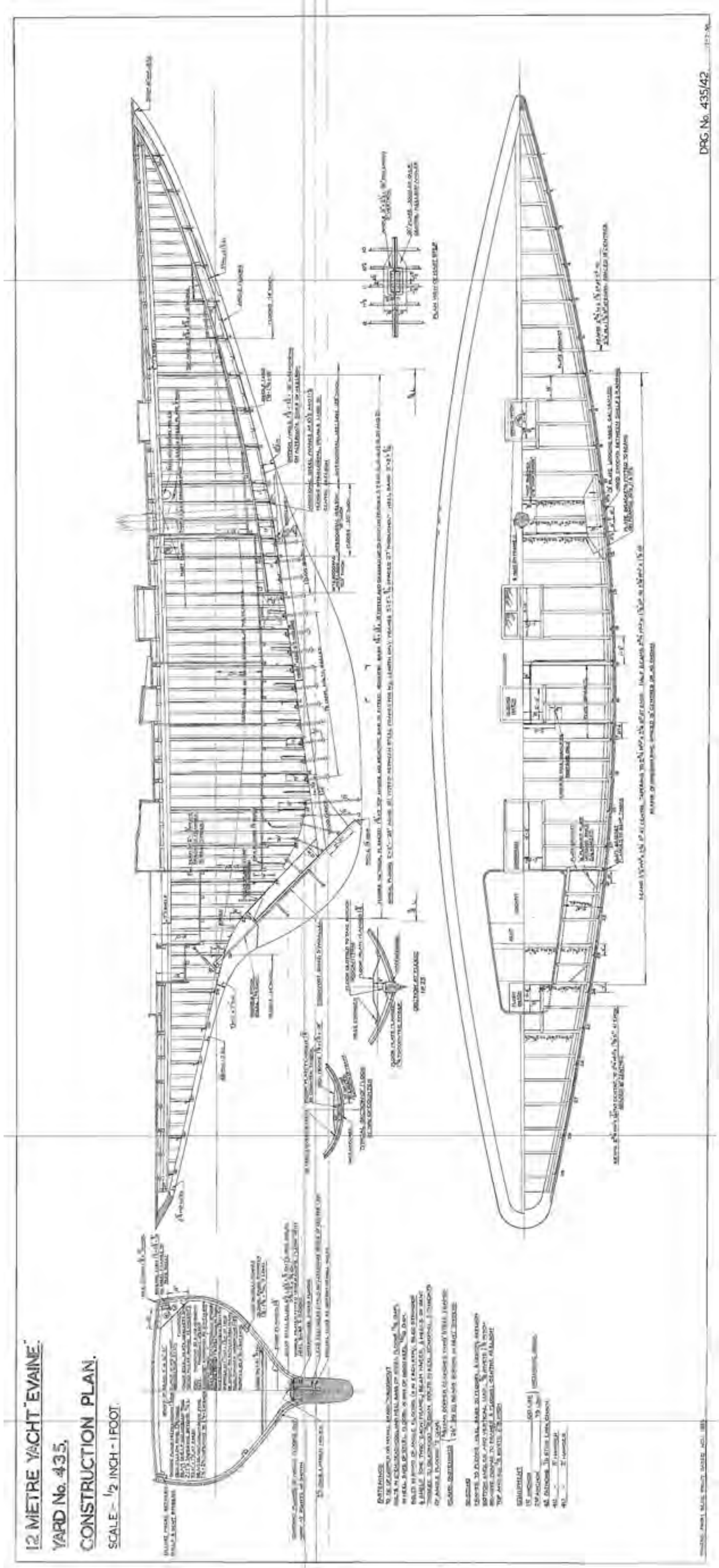
The lead yacht in this series was EVAINE in 1936, followed by TRIVIA, WINGS, LITTLE ASTRA and ALANNA in 1937. (ALANNA was re-named BLUE MARLIN in 1938). Only the hull lines and a sail plan for BLUE MARLIN seem to have survived WW II via paper copies distributed in other places. Fortunately, the Maritime Museum had a reasonably complete set of plans for EVAINE, which was restored in 1996-97, as well as a few plans of other near-sisterships.

The most useful original drawings were prints of the original lines and sail plans of BLUE MARLIN/ ALANNA and a construction plan of EVAINE that had been redrawn in 1958. When details of BLUE MARLIN's framing system were compared to EVAINE's plan, it was found that the framing arrangement and scantlings matched exactly. Although the hull section shapes of the two yachts were a little different – BLUE MARLIN was drawn to a longer waterline – it became apparent that the lead yacht's construction plan was used on the shop floor for her succeeding near-sisterships.

ALANNA's original lines plan and a 1939 sail plan as BLUE MARLIN enabled Pedrick Yacht Designs to recreate her Twelve Metre Class rating certificate within reasonable tolerances. An RORC (Royal Ocean Racing Club) certificate produced in Italy in 1953 gave some additional confirming guidance, as well.

New rating targets for the restored BLUE MARLIN would incorporate various credits that are now granted to older Twelves. These credits were established for the Class Rule in 2000, anticipating a large gathering for the America's Cup Jubilee Regatta in Cowes in 2001. (37 Twelves of all ages competed there.) The credits provide more equitable competition within a fleet that spans several decades of design development.

One is an age allowance. Another is a credit for the drag of a qualifying propeller installation. The rating credits allow some combination of a deeper flotation – providing increased sailing length and stability – and/or increased sail area. With practical limitations on how much sail area could be physically placed on BLUE MARLIN – as well as significantly increased weight from her new, heavier framing, an engine and other cruising systems – her eventual measurement immersion for rating would be deeper than when she was first built.




14) Construction plan for EVAINE, drawn by Camper & Nicholsons in 1935; redrawn in 1958. This plan was evidently used for the construction of succeeding Twelves, even though their hull lines varied from one another. (British National Maritime Museum)

15) Superbly detailed model of BLUE MARLIN made in 2010, displayed at the Wooden Boat Center. The Center's café is below. (Pedrick)

16) Features of the deck, rig, running rigging, cockpit and salon were thoroughly researched and recreated by the model maker. (Pedrick)

While the real BLUE MARLIN was being prepared for restoration, a very skilled model-maker in Finland crafted a fully detailed and rigged scale model. Working from limited plans and photographs, he interpreted a remarkably complete and accurate model of the hull, deck fit-out, spars and rigging. He even built the salon, complete with its gimbaled table, and visible through the hinged doors and hatchway of the companionway scuttle.

**HULL SHAPE**

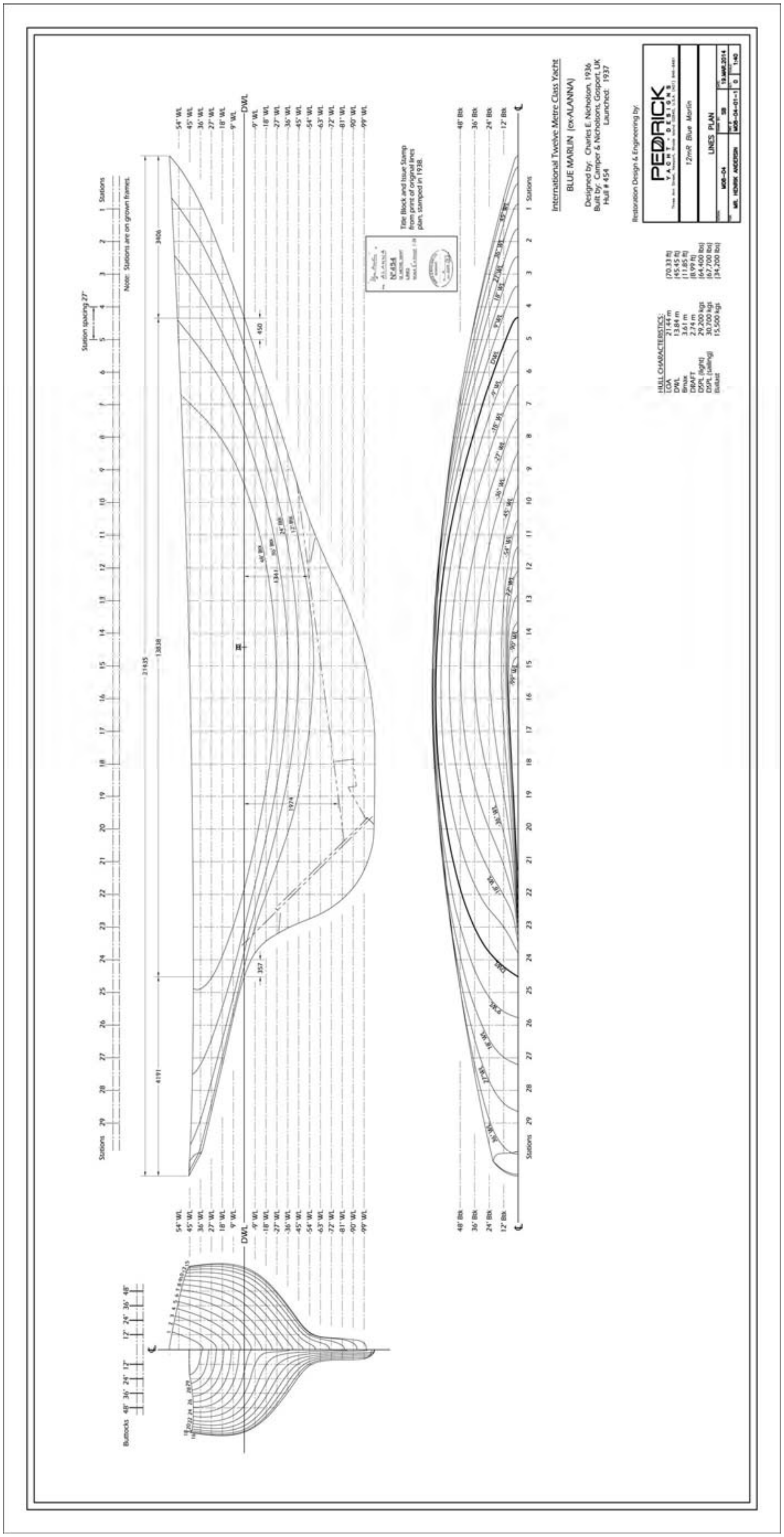
BLUE MARLIN's single-plank-on-frame construction suffered from typical "this old boat" deformation. Eventually, it was found that her frames in way of the mast and chain plates had become straighter and the wood keel had been pushed away from the sheerline as the result of mast compression and weak frames. The after end of her stem post was joined to the wood keel under the mast step, where the forward end of the fin keel also tapers to nothing. This is a typical, problematic structural weakness in wooden yachts. Her sheerline had deformed over time as well, being higher in way of the shrouds, and drooped toward the transom.

17) Frames in way of the mast and chain plates, port side. Plywood had been inserted between the rusted frames and rotted planks to mitigate leaks. (Pedrick)

To discover and correct BLUE MARLIN's hull shape, two methods of 3D modeling were undertaken seven time zones away from each other. Both of these entailed substantial effort. The yacht's existing, deformed shape was measured with a laser scanner that recorded some 20,000 points on the hull. This point cloud was converted by Kamu Stråhlmann into a 3D surface model of the as-found, 70-year-old hull.

Meanwhile, Pedrick Yacht Designs developed a Multisurf 3D CAD model from a print of Charles Nicholson's original lines for Hull 454, which carried ALANNA's name at that early stage of her construction. There were no dimensions on the original plan to indicate such things as the station spacing, waterline length and length of overhangs, nor was displacement given. The drawn stations, instead of using a common 10-station grid on the datum waterline (DWL), had no particular relationship to any reference on the lines plan. Working from a print that was several generations removed from its original drawing, scaled dimensions could not be trusted to the precision that was needed.

The dilemma was solved after insight from William Collier about how Nicholsons built their hulls. It tied in directly to how they worked on the shop floor. Stations on the lines plans were drawn where the steel (or "grown") frames were to be located. Once the frame stations were faired on the loft floor, they could be patterned and fabricated without any further interpolation




18) Lines Plan of BLUE MARLIN developed by Pedrick Yacht Designs in 2009-2010. A 3D hull model was faired using Multisurf. The model was adjusted repeatedly for the closest match to a 1938 print of the original lines drawn in 1936. (Pedrick Yacht Designs)

of section cuts from the lofting. Frames were arranged relative to the location of the mast, and, per Lloyd's Twelve Metre scantling rules, were spaced at 27". By setting the frame spacing in the CAD model accordingly, the length of the modeled hull could now be calibrated longitudinally. Hull breadths in the 3D model were scaled according to measurements taken of BLUE MARLIN's beam at the deck and at the outer breadth of tumblehome amidships.

The next challenge was to index as-built frame locations to the hull's lines plan. Locating the station grid relative to the ends of the hull was not precise enough to align the lines plan to the as-built hull. Consequently, frame locations in the hull were recorded by tape-measure distances from the mast's close-fitting opening at the partners. The laser point cloud's surface model included the mast partner opening, whose position was measured relative to reference points on the scanned hull surface. The inside of the hull, including frames, was also scanned, but the point cloud's mast partner reference in Kamu's 3D hull model became the key to indexing as-built frame locations to the original lines plan.

The best match between the respective 3D surfaces of the existing hull and the shape of the hull per Nicholson's lines was made by overlaying the two CAD models on-screen. Trial-and-error shifts of vertical position and trim relative to one another were made until a best-fit alignment of the two models was found.

This nesting process established that the longitudinal locations of BLUE MARLIN's as-built frames matched the stations drawn on the lines plan within measurement tolerances. With that confirmation, the sections on the lines plan could be trusted for restoring the hull shape to the new metal grown frames as defined by the lines plan, just as it appeared that Nicholsons had done originally when building ALANNA from the loft floor.

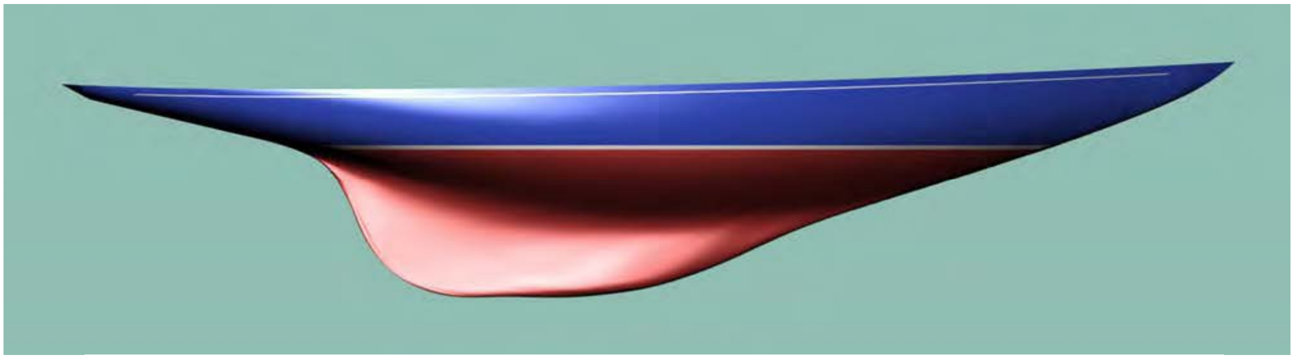
After the longitudinal references were established, the vertical positioning of the actual hull relative to the lines plan was assessed. The as-built sheerline couldn't be trusted automatically, because sheerlines don't always end up as drawn on the lines plan. Furthermore, BLUE MARLIN's hull was far from straight fore-and-aft. Her sheerline was visibly deformed, and measurements along the centerline timbers showed that the hull's profile had deformed, as well. Substantial sectional deformation in way of the mast was also found. Using frame references, the check on sheerline height and the 3D overlay, a DWL height (Z direction) and the longitudinal location of the frames (X direction) were established on the actual hull. These anchored the datum references to which the original form of the yacht could be restored according to the lofted shapes of her new, bronze, grown frames.

A lesson learned along the way was to not fully trust the original, hand-drawn lines. A readily noticeable discrepancy was found in a change of beam at the transom made by Nicholsons. In the course of validating the beam at the deck with the lines plan, the breadth of the afterdeck was found to taper to a narrower transom. This may have been found necessary to avoid developing hollows in surface diagonals through the counter, which are not permitted by the Class Rule. Since BLUE MARLIN was the fifth of a series of Nicholsons Twelves in 1936-37, the shipyard had probably already discovered that a transom adjustment was needed to meet the Rule's "hollows" prohibition. The original lines plan had not been revised to the as-built transom breadth, though, so field measurements in 2009 were used to match the counter lines of the 3D CAD model to the actual yacht.

A greater problem came from a drafting error in Charles Nicholson's lines plan, found when trying to reconcile the Multisurf 3D hull model to the lines plan. PYD's model was developed using seven control stations from bow to stern, the profile and the 3D curve of the sheerline/deck-at-side. One control station was just forward of the after end of the waterline, where the hull shape near centerline changes rapidly as the profile rises from the rudder to the counter. This is a difficult area to model, at best, because the girth of the keel/rudder sections from the bottom of the rudder to the beginning of the counter reduces rapidly to zero. From a 3D fairing standpoint, it resembles squeezing the middle of a toothpaste tube, but having to produce a fair and precise shape. After a long struggle with uncontrollable distortion in the CAD model's surface between the rudder and the canoe body, David examined this region of the lines plan using traditional 2D lines fairing techniques on a drawing board.

The source of the fairing problem turned out to be in Charles Nicholson's drafting. The three lines plan views (sections, waterlines and buttocks) failed to match each other by about 25 mm (1") in this local region, with the greatest error being in the section that had been chosen as a control station in the Multisurf model. The faulty hull section being used as a target in PYD's 3D modeling had been contorting the software's splines away from the true, fair surface. The original error was probably caught on Nicholsons' loft floor, but was never put back into the lines plan. Once David found that PYD had been trying to force a 3D surface to pass through an erroneous control station, this troublesome area could finally be faired successfully.

After making adjustments in those two areas of the lines plan, hull sections in the 3D model were faired throughout for a best fit to the original body plan. Minor



19) Half-hull of BLUE MARLIN, computer-rendered from her newly created 3D CAD hull model. (Pedrick Yacht Designs)

remaining differences were within the accuracy of the original, scaled drafting of the lines plan, drawn at a scale of 1:24, (½” = 1’-0”). There were distortions, as well, in the generations-removed, scanned print that served as the best surviving record of Charles Nicholson’s original work. The new, 3D surface model to which BLUE MARLIN has been restored is fully faithful to Charles Nicholson’s original design work, but with improved fairness.

**PLANNING FOR STRUCTURAL RESTORATION**

A yacht’s restoration typically begins with observing, documenting and studying her as-built structural details and condition. Where possible, information about the builder’s typical practices and the basis for structural scantlings should be identified. Before taking anything apart, it’s best to know how it’s meant to be put back together.

BLUE MARLIN had two significant sources of structural specifications in addition to her as-found condition. One was Camper & Nicholson’s construction plan of EVAINE, mentioned previously. The other is the scantling rules with which International Rule yachts must comply to be measured and rated. For BLUE MARLIN, this was the “Rules and Regulations for the Construction and Classification of Yachts of the International Rating Classes,” governed by the classification society Lloyd’s Register of Shipping. Lloyd’s Rules have extensive tables of dimensions for structural members, properties of permitted materials, 50 pages of descriptive text and periodic inspection requirements (in effect for Twelves through most of the twentieth century).

In the common practice of the era, Twelves were specified to have three types of transverse frames. Regular frames alternated between lighter frames that could be steam-bent and more robust ones that had to be cut from solid timber (thus called grown frames) or, alternatively, shaped from steel angles. The lighter ones are called bent frames, as they would be steam-bent. Additionally, at least three web frames were to be located in the vicinity of the mast.

Builders of medium-sized yachts (such as a Twelve) in Europe in the early twentieth century tended to use a hybrid combination of galvanized steel frames and timber for intermediate bent frames, primary longitudinal members and planking. In the wooden yacht world, this is generally referred to as composite construction. Most yachts were of single plank-on-frame construction. This form of composite construction is how Camper & Nicholsons built their Twelves.

Although the long life of so many early Twelves built to Lloyd’s Rules would suggest a durable level of strength, time has proven that their bottom framing and structure in way of the mast are inadequate. Eventually, problems with hull deformation and leaking plank seams have generally required older Twelves to add corrective bottom structure in way of the mast and ballast keel.

These and other structural failures were evident inside BLUE MARLIN. Galvanizing on the steel frames had disappeared in her early decades, causing much of the framing to rust away, especially below the waterline. Repairs had been made poorly over the years. Although the hull planking appeared to have had some hope of re-use when seen outside, other problems were found after her interior joinery had been disassembled. The combination of copper rivets for fastening planks onto steel frames set up galvanic action that contributed to rot and disintegration under each frame. Decay extended through typically one-third of her 35 mm ( 1-3/8”) mahogany plank thickness. Even the topsides weren’t free of this problem. With steel frames having destroyed the hull planking at 27” intervals, the hope of re-using any of it was gone.

Aside from assessing the ravages of rot and corrosion, Pedrick Yacht Designs had doubts about the fundamental adequacy of Lloyd’s scantling requirements for Twelves. As a design office that emphasizes responsible engineering, PYD studied Lloyd’s Rules’

20) Mast area and bow with all of original structure, early 2009. (Pedrick)

21) Steel Z-frame in topsides forward, with both flanges rusted away. (Pedrick)

22) Rusted butt plate and rotted hull planks in topsides aft. (Pedrick)

requirements for scantlings in comparison to two present-day industry scantling rules for the purpose of bringing BLUE MARLIN into compliance with 21st century regulatory requirements.

The American Bureau of Shipping (ABS) developed its "Guide for Building and Classing Offshore Racing Yachts" (ORY) in the 1980's. Then, between 2000 and 2012, the International Standards Organization (ISO) published a comprehensive set of construction and scantling standards for small craft (up to 24 m, or 79 ft, LOA), with which compliance is mandatory for recreational marine craft sold in the European Union. Yacht scantlings are specified in ISO 12215-5 and additional parts of the 12215 series.

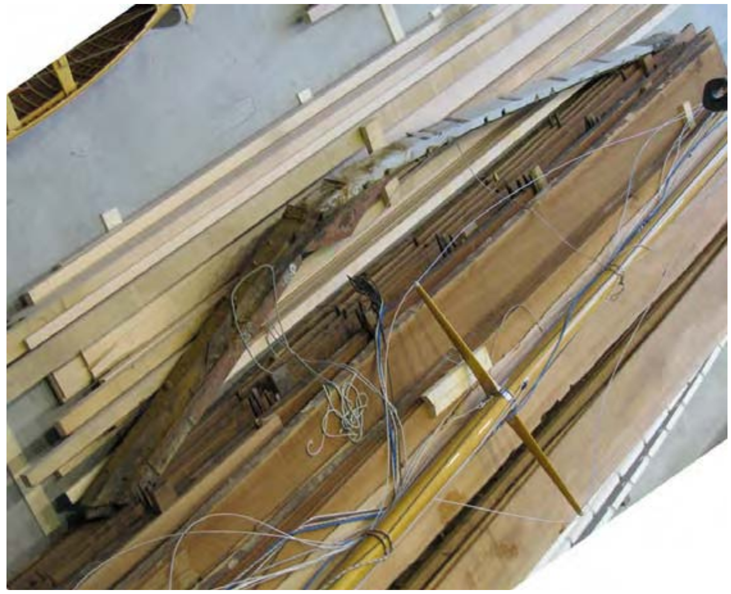
PYD found that BLUE MARLIN'S bottom and mast frame structure to Lloyd's Rules was much weaker than required by the more recent scantling requirements of ABS ORY and ISO 12215. PYD upgraded BLUE MARLIN's replacement structure through rigorous engineering to the ISO 12215 standards, achieved primarily by an increase in frame scantlings from the bilge stringers to the timber keel.

**MATERIALS FOR CONSTRUCTION**

Historic restorations are strongly encouraged to use original fabric to the fullest practical extent – a stipulation of the U.S. Secretary of the Interior's Standards for Treatment of Historic Properties. Where it has to be replaced, it should be with materials of like kind as the original. Where original materials had compromised the durability of the yacht (or other historic structure) or are no longer available in suitable quality, similar materials promising improved structural integrity may be substituted. Furthermore, restoring seaworthiness and safety in marine craft often requires greater latitude in material replacement than may be acceptable in land-based properties. These rules were followed wherever practical in BLUE MARLIN's restoration,

Camper & Nicholsons used Honduras mahogany in BLUE MARLIN's centerline timbers and hull planking. The equivalent species in today's market and in ISO's structural standards is generically South American mahogany. However, because this is now a protected species in the European market, it could not be imported for this project. African mahogany had to be sourced, instead.

The master of high quality yacht timbers in Europe is John Lammerts van Bueren. His company, Touchwood, in The Netherlands harvests the world's finest, aircraft-grade Sitka spruce from forest land in Alaska. John is a passionate sailor, a classic yacht enthusiast and a leader of the Eight Metre Class in Europe. He has supplied his superb Sitka spruce to about a hundred classic yacht projects from Metre Class restorations to the recent replica of the three-masted schooner ATLANTIC.



24) Original stern timbers, made in three parts. The stern post on the left rises from the wood keel. The counter timber is relatively straight on the right. They are ship-lapped onto the curved horn timber in the middle. It is resting on spruce for the mast. (Pedrick)

John consulted in sourcing other species of timber for BLUE MARLIN, as well. He kept his eye on suitable mahogany that flowed through various European suppliers for about six months before finding the perfect log for BLUE MARLIN. It was an amazing piece, large enough to supply all of the structural mahogany for the entire yacht – 1.5 m (5') in diameter x 9 m (30') long. John and Allan traveled to the German sawmill to direct how the log should be cut. As its inside was exposed, they made decisions about thicknesses and directions of subsequent cuts to optimize the thickness and grain orientation of planks for the centerline timbers, planking and other structural members.

23) Mahogany, drying in the Exhibit Hall of the Wooden Boat Center. Six Metre mast on top. (Pedrick)

The centerline timbers were laminated from relatively thick mahogany planks into two long, shaped pieces. The stem timber goes from the stemhead to a hooked scarph joint on the keel timber under the mast step. The stern timber incorporates the stern post ahead of the rudder, the horn timber curving over the top of the rudder, and the counter timber to the transom.

The wood keel was made of a single, solid piece of a rugged marine industrial timber called bilinga, finishing approximately 8 m (25') long x 800 mm (2½') wide x 170 mm (7") thick. Bilinga is a West African species of tropical hardwood that is very dense, tough, durable and rot resistant. Allan wanted to keep it green to minimize drying before getting into its future, immersed environment, so he kept it in an unheated shed, wrapped in plastic to retain its natural moisture until it was fitted to the hull in late 2011.

Bent frames were made of elm, now an almost extinct species. The frames themselves were generally sound, even at their lower ends where the heels of the frames were pocketed into the centerline timbers. However, the hull plank screws were a soft and not very durable alloy of bronze, and couldn't be backed out of the frames. Their heads snapped off, leaving their screw ends inside the elm. Because seam locations for all of the new hull planks were planned to exactly match Nicholsons' original layout, this would prevent proper location of the new fasteners. Consequently, practical circumstances required replacing the elm frames. Once again, the challenge of finding high quality material took significant research. Eventually, Allan located a small forest of elm trees in Scotland from which he was able to match the original bent frames' materials in like kind.

After finding so much decay throughout BLUE MARLIN's structural timbers, only the sheer clamps and bilge stringers from Nicholson's original hull and deck construction could be re-used. Made of Douglas fir and located completely within the yacht's relatively dry interior space, the wood was in perfect condition and would go back into the restored hull exactly as originally fitted.

25) Original sheer clamps and bilge stringers, restored and waiting for reassembly. Mid-2010. (Pedrick)

The original planked deck of yellow pine had been covered with an additional layer of plywood. Aside from damage to the original decking from fasteners and water, the deck and beams would need to be removed for access to the inside of the hull while renewing the framing and rebuilding the interior. The planked deck would be replaced with a new plywood sub-deck to improve watertightness of the deck and torsional stiffness of the hull. Deck sheathing would be changed to teak for greater durability compared to the original pine, although incurring extra weight. Approximately matching, sprung planks with V-grooves were glued the underside of the plywood to re-create the appearance of a traditional, single-planked deck.

The original deck beams were specified on EVAINE's construction plan as Oregon pine, otherwise known as Douglas fir. Although they appeared encouragingly good from underneath, their tops had extensive damage from fasteners and intrusion of water. Their dovetail joints into the sheer clamps had become excessively loose over most of a century, as well. They were too compromised to re-use, so new beams and carlins were made of the original species, Douglas fir.

While there was no question about having to replace all of the badly rusted steel framing, a good solution wasn't immediately obvious. Frames were made either in a Z-form with two 50 x 50 mm (2" x 2") galvanized steel angles riveted through their overlapping transverse flanges, or as a simple angle against the hull. Their fore-and-aft flanges had been pried to a bevel angle that conformed to the local hull surface. Even presuming that their original galvanizing was well done, it could ultimately not survive well in a salt water environment, especially when coupled to copper rivets or bronze bolts in wet planks. For the restoration, new steel angles with post-galvanizing after forming and drilling were planned for the grown frames initially, but not comfortably.

The change in thinking about the metal frames began over a wood component, actually – the knee connecting the rudder post to the wood keel. This is in the deepest, narrowest part of the bilge, where it is hard

26) Original oak crook sternpost knee. Note that the Wooden Boat Center's construction floor is end-grain, wood blocks. (Pedrick)

27) New sternpost knee in bronze. It includes female-threaded sockets for bolts through keel and sternpost. (Pedrick)

to access and is perpetually wet. The original, oak crook knee had held up pretty well under the circumstances. However, Allan proposed bronze as a more durable solution that excels in wooden boat construction. Stainless steel would have been inappropriate because it wasn't an available material in the 1930's. Also, for this application, neither stainless steel nor wood fare well together when submerged in sea (or bilge) water. The choice of fasteners is also a problem, since stainless steel rusts when encased in wet wood, and bronze sets up a galvanic loop with stainless steel in seawater.

In a meeting with Allan and David in September 2009, when Mr. Andersin was racing DJINN in the Six Metre World Cup in Newport RI, he asked about replacing all of BLUE MARLIN's problematic steel with bronze. With the extraordinary effort and expense going into her restoration, it would be wasteful to condemn her to a limited future due to rusting steel. Although bronze is more costly, it will last forever, essentially – long after the wood hull might once again succumb to terminal neglect.

When PYD searched for good structural bronze in late 2009, it turned out to be hard to come by. Suppliers generally stock bronze in soft tempers for projects in architecture and art. Structural bronze plate in harder, stronger tempers is in limited supply worldwide. Getting plate in the desired strength levels, thicknesses and quantities was a challenge. Inquiries with a number of U.S. suppliers seemed to point to single mill in Germany as a common source. Especially since BLUE MARLIN was just cross the Baltic Sea, the Carl Schreiber Mill was chosen to supply the bronze plate from which her frames would be made. Even at that, and with a watchful cooperative agent in Rhode Island keeping track of inventory at the mill, it took more than a year to obtain all of the required bronze in the alloys, tempers, thicknesses and quantities that the project needed. Round bar and smaller quantities of plate were sourced from National Bronze in Houston, Texas; and Alaskan Copper in Kent, Washington. Specialty bronze fasteners such as fin-head bolts were purchased from C.C Fasteners in Tonawanda, New York, and Top-Notch Fasteners in Mankato, Minnesota.

## SETTING THE HULL TO RESTORE HER SHAPE

With Nicholson's original lines of BLUE MARLIN's hull and keel converted into a reliable 3D model, restoration of her true hull shape was ready to begin. As of 2009, BLUE MARLIN was in the Wooden Boat Center's construction hall without her lead keel and timber keel, and was empty of her interior joinery and systems. The mechanical process to align her hull was to suspend it from her upper topsides with adjustable posts to facilitate working the sheerline into its original shape.

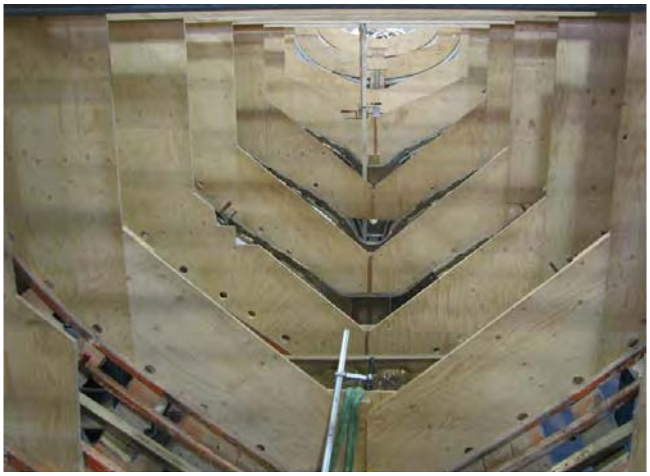
Vertical jackscrews supported the hull at eight locations on each side, plus one on centerline near each end of the LOA. The jacks were attached to steel pads that were through-bolted to the upper planking, each one straddling a bent frame. The hull had been loosened up by removing alternate planks below the waterline. The height of the sheerline at each jack location was surveyed by Allan, and the jacks were adjusted to set the sheerline to match the designed heights of Nicholson's lines. In doing so, the hull was put in level condition fore-and-aft as well as port and starboard. The jacks would stay fixed to the hull until after the centerline timbers and all the frames and floors – both metal and bent - had been fitted.

28) Jackscrews bolted to the topsides planking at bent frames were used to align the hull and carry its weight until final installation of all the new frames and floors. (Pedrick)

The depth of the hull's centerline profile below the sheerline was checked in several critical places, such as at the top of the ballast keel, to understand where corrections in the height of the centerline timbers might be needed. The region of the mast step was found to be down by about 25 mm (1") from her originally drawn profile. Measurements of her full profile from bow to stern helped confirm a datum waterline (DWL) height from which all further height references would be taken.

Internal station molds were fitted to restore her sectional shape to Nicholson's lines plan. Their installation required removing the decks, bilge stringers and some of the beams. As station molds were installed, more of the deck beams could be removed.

Full molds were lofted from the 3D hull model, offsetting the outside surface by the hull's planking thickness. Station molds were located at roughly 1.1 m (45") spacing – generally in every second grown frame bay. They were located at bent frames so that the hull could be pushed tightly against each mold. Then the mold and frame were screwed together to hold the hull to



29) Station molds aft, with bronze frames being fitted, October 2010. (Pedrick)

its designed shape. Seventeen station molds secured BLUE MARLIN's true sectional shape and symmetry until the new bronze grown frames would take over that function.

With the station molds holding BLUE MARLIN's substantially intact hull to her restored shape, she was ready to begin receiving her new bronze frames. As new grown frames, in their primary structural role, defined the hull shape, station molds were cut back and eventually removed altogether. Gradually, sound new material would continue to replace the old, unserviceable frames and planking.

## DEVELOPMENT OF 3D CONSTRUCTION MODEL

BLUE MARLIN's construction plans began in 2D – in fact, in Charles Nicholson's drawings for EVAINE (hull #435). Initially, when a construction plan for BLUE MARLIN wasn't found, the project team presumed that it had been lost in the WW II bombing of the Camper & Nicholsons shipyard. Later, William advised us that the shipyard likely never drew a separate construction plan for Hull #454, building successive Twelves to EVAINE'S drawing, instead.

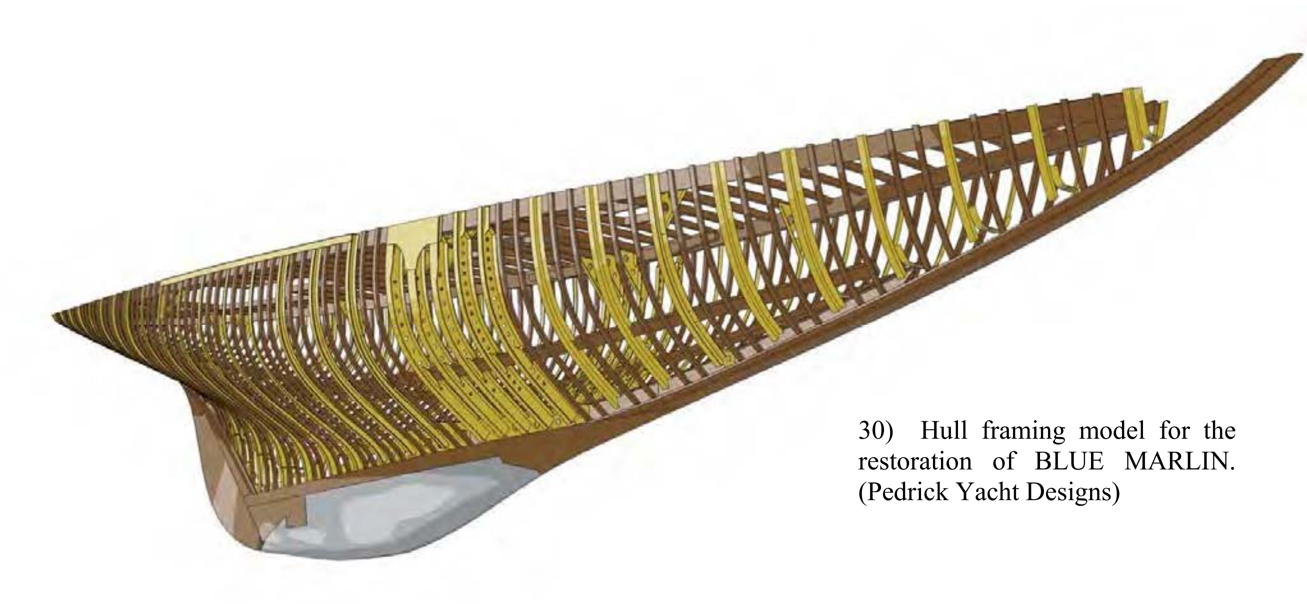
Meanwhile, structural details in BLUE MARLIN appeared to be virtually identical to EVAINE's construction plan. Verification of BLUE MARLIN's as-built framing to EVAINE's plan was undertaken by Kamu Stråhlmann. From inside the hull, the only significant differences were that BLUE MARLIN's rudder stock was farther aft relative to the frames; and her mast was one bay farther aft in the partner frames than EVAINE's, perhaps to increase weather helm over the earlier yacht. Kamu drew preliminary 2D hull and deck construction plans from which both he and PYD began to develop different parts of BLUE MARLIN's frames and longitudinal members in 3D.

Eventually, PYD drew all of BLUE MARLIN's internal components in Rhinoceros 3D as a three-dimensional jigsaw puzzle before respective parts were manufactured and assembled. The hull surface model, which had been created using Multisurf, was imported into Rhino for all subsequent design development. Although some early stages of design had been laid out in 2D, using AutoCAD, most of the later use of 2D drawings was for annotated reference output from the 3D model.

The fully developed structural model assured completeness and fit of all framing elements. The model was also used to work out the best arrangement of interior accommodations, the propulsion system, tanks and domestic systems into the hull's limited space. Structure was used productively where suitable and was avoided otherwise. The internal volume and shape of classic yachts makes this difficult generally, and BLUE MARLIN's extensive fit-out placed an even greater challenge on fitting everything in.

Changing BLUE MARLIN's metal frames to bronze and engineering them to ISO standards meant that every structural element had to be designed, calculated and detailed. Nicholson's original frames to Lloyd's Rules for scantlings (section dimensions of structural components) served as prototypes, but could not be simply copied. New upper frames were designed to the original dimensions of 50 mm (2") x 50 mm flanged sections, but with increased plate thickness to compensate for the lesser strength and elastic modulus (stiffness) of bronze compared to steel. Bottom structure was engineered to satisfy the scantling requirements of today's ISO 12215-5 code for new construction by increasing the depth of the midships frames to 60 mm at the bilge stringers, and then to 80 mm at their attachment to the floors. Engineering to ISO standards was extended to all other highly stressed members in the hull, deck and equipment foundations.

Lloyd's scantlings requirements for frames at the mast and chain plates were insufficient for the very large loads applied there, both in practice and according to better design codes today. A series of five Z-frames of only 50 mm (2") depth had been fitted originally, running completely outboard of the bilge stringer. The new bronze mast frames were increased to 140 mm (5½") in depth. They bridge over the inboard face of the stringer, adding substantial strength and stiffness to this failed region of original construction.

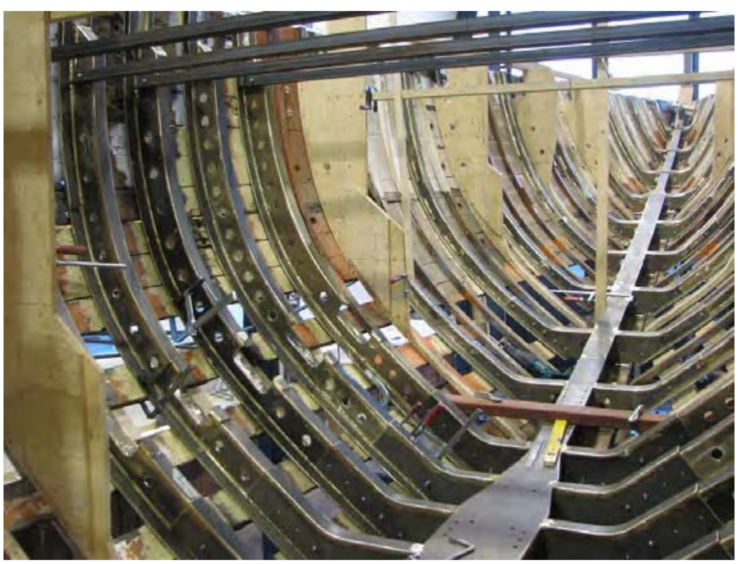


30) Hull framing model for the restoration of BLUE MARLIN. (Pedrick Yacht Designs)

The scope of PYD's structural design services increased when Allan requested nested drawings for waterjet-cutting of all individual pieces of bronze from large plates. This goes much beyond the level of construction information that a yacht designer would typically provide to a builder, but it removed the burden of that work from Red Sky Craft. In one day, hundreds of individual pieces in a cutting drawing could be produced from several large bronze plates (typically about 1.5m x 3.0m, or 5' x 10'), contributing significantly to the project's ultimate efficiency of construction.

As a batch of parts to be cut was put together, a drawing having several nested plates would be e-mailed overnight from PYD's office to the waterjet cutting company in Finland. Typically, about two hundred parts would be cut the next day and delivered to RSC on the second day. Ultimately, there would be nearly 1,500 individual pieces of bronze produced this way, each identified by a waterjet-inscribed label, as well as grid references where appropriate, facilitating assembly by RSC.

Piece by piece, metal or wood, the entire framing system of the hull was created in PYD's 3D model over the course of about a year in 2010-11. Every bracket and joint was included, as well as holes for bolted connections. Virtually all pieces except for the bent frames were subsequently cut to loftings taken from this model.



31) Robust web frames at the mast step and chain plates. Original frames had shallow depth, passing between the hull and bilge stringer. New frames are to the full depth of the stringer, with bridge plates bolted across the stringer after it was installed. (Pedrick)


32) Cutting drawing of bronze framing parts from plate measuring 3.2 m x 1.6 m (10.5' x 5.25'). (Pedrick Yacht Designs)

**HULL CONSTRUCTION PROCESS**

Work on the hull began in the second half of 2008 after the interior had been dismantled carefully, catalogued and stored. The bilge area – the most damaged part of the hull – was opened up by removing the wood keel, rusted steel floors and lower planks in way of the bilge. The steel under the mast step had rusted almost completely away.

Some of the bottom planks as well as the timber keel were removed to make the hull more flexible for aligning the sheerline. The topsides planking was kept in place throughout all of the framing restoration process. It was the last hull material to be replaced as re-planking progressed from the bottom and worked upward.

The centerline timbers had only a little rot, but they were checked and worn, especially below the waterline. With as extensive a renewal of materials as BLUE MARLIN would require throughout, it did not make sense to re-use these compromised, 70-year-old main timbers. They were removed and replaced with new, long, laminated mahogany timbers that eliminated a few of the joints that had connected the original ones.

The timber plank keel itself would remain as a solid piece that would not be fitted until near the very end of the restoration. A substantial, temporary, glue-lam strong-back timber of equal thickness was secured to the shop floor, positioned precisely to the lofted dimensions for the top of the lead ballast. It provided the foundation to which the two forward and after centerline timbers would be bolted initially. Later, all of the floors for frames along the strongback's length would be bolted to it temporarily.

33) New horn timber, laminated integrally with the sternpost and counter timber. (Pedrick)

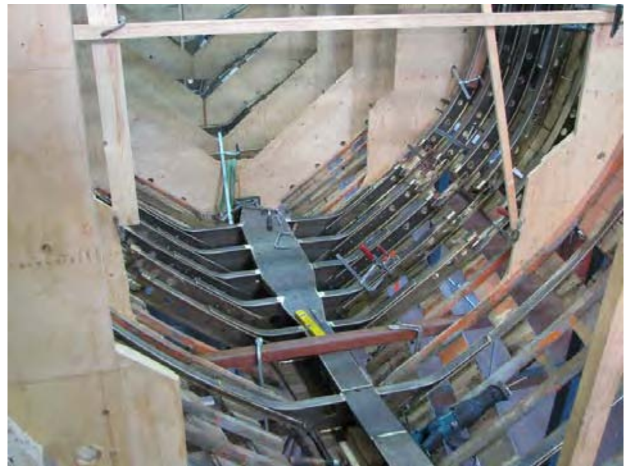
The new centerline timbers from stem to transom were fitted to BLUE MARLIN's 1937 frames and planking in mid 2009. The rudder post was joined to the strongback with the substantial, new bronze knee. Later in construction, a new mid-bearing for the rudder would through-bolt to this knee, as would the after bolts for the ballast keel.

The transom was the next new component to be made. The original transom was made from a solid piece of mahogany measuring approximately 1200 mm wide x 600 mm F&A x 300 mm high (4' x 2' x 1'), carved out inside but still quite thick. Its interior surface was badly rotted from the hazards of being in this essentially unventilated and inaccessible hinterland of the hull. A new transom was made in exactly the same form, although from a laminated block of mahogany made of horizontal lifts. Red Sky Craft carved the inside surface to the same tractor-seat contour as BLUE MARLIN's original transom, shaped to accept the end of the counter timber.

Most of the original frames were fastened temporarily to the new centerline timbers. The bilge stringers were removed to facilitate installation of the station molds. Station molds were cut with clearance for the sheer clamps, so the clamps could remain in the hull for awhile.

Station molds were fitted in the first half of 2010. The topsides planking and most of the bottom planks were still in place, held together by the original bent frames. New bronze frames would be fitted next, starting with a substantial set of frames at the mast in mid-2010.

The new mast step girder, spanning five new web frames plus extensions forward and aft, was a welded assembly that included transverse floors. The frames themselves, which were bolted to the floors, began the process of defining BLUE MARLINS's shape by her metal frames, just as Camper & Nicholsons had built her in 1937. As her new frames were installed, they supported the hull planking in its true, originally lofted position. The nearby station molds could then be cut back and eventually removed.



35) Mast step, web frames and aft end of bow girder. Full station molds amidships are shown here, October 2010. (Pedrick)

Lloyd's scantling rules at the time stipulated that there must be additional structure to support the rig loads, but didn't specify a specific configuration for it. Nicholsons chose to fit a substantial, riveted steel girder from the mast step to the stemhead, to which the grown frames' floors were also riveted. This same configuration was replicated in the new, welded bronze girder and floors. Due to the girder's considerable size and weight with floors attached, it was made in three subassemblies that were bolted together. The forwardmost unit was the first to be installed, through-bolted to the new stempost with fin-head bolts. After the final segment was bolted to the stempost, the very heavy mast step assembly was raised through the bottom of the hull and joined to it. New bronze frames from the bow to the mast web frames followed.

34) Stations molds cut back in the bow, where bronze frames have been fitted. Full molds are in place from amidships aft, October 2010. (Pedrick)

36) Bow girder, floors and bronze frames. Original bent frames are still in place, October 2010. (Pedrick)

37) Installing steam-bent frames amidships, early 2011. (Skogström)

By January 2011, additional grown frames had been fitted through the midships region to the forward end of the sternpost knee. Bronze counter frames had also been installed. The old planking was bolted to the new frames through their original fastening holes, where copper rivets had formerly attached the planks to the steel frames. Later, when new planks were fitted, their seams were in exactly the same place as the originals, and the fastening holes in the bronze frames were transferred to the new planks.

New bent frames had also been fitted from the bow through amidships, using the original planks as ribbands for forming and clamping the steam-bent frames. At this point, bent frames were waiting to receive their floors.

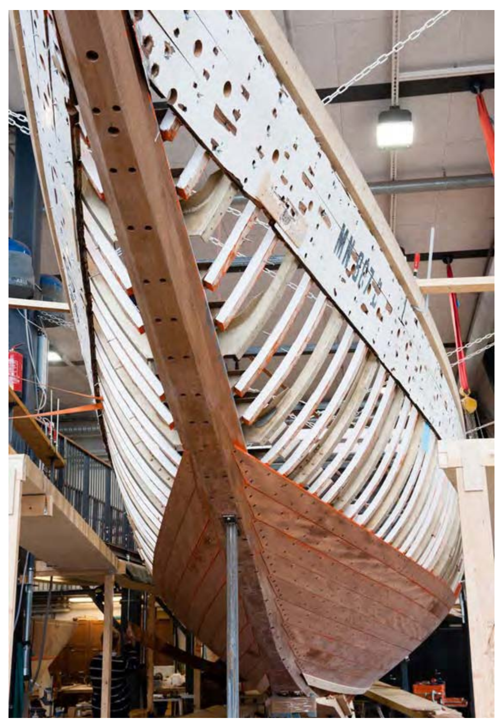
BLUE MARLIN originally used a single strap floor between each of two bent frames within a grown frame bay. This required the garboard planking to transmit the bent frames' bending moment to the floor. It also required the heels of the bent frames to be pocketed into the keel timber for their end support. Aside from the structural weakness of Nicholson's original detail, repeating it would perpetually trap water in the keel pockets with little chance to dry out.

Allan was conscientious about minimizing intrusion of water throughout his approach to construction, making sure that it could not collect anywhere but the low point of the bilge. He requested that the bent frames stop just above the timber keel, and that they be fitted with stiff, individual bronze floors that were well limbered. The keel pockets in Nicholsons' original construction were eliminated. The much improved floor system assures even greater strength, stiffness and long life to BLUE MARLIN's bottom structure.

Allan planned for long-term dryness and cleanliness of the deep bilge. The aftermost reaches of the bilge are difficult to access under the engine pan, and ventilation there is poor. He asked PYD to engineer an access plate through the hull planking at the deep bilge to permit good, end-of-the-season cleaning, as well as to improve bilge ventilation throughout the winter storage period. A 100mm (4") diameter, off-the-shelf, bronze screw plate for this is attached to a robust, bronze internal foundation in way of the lower hull planks, starboard side.

BLUE MARLIN's mahogany hull planking is 35 mm (1-3/8") thick, caulked below the waterline to permit room for the wood to swell without overstressing the frames. The topsides, without significant swelling, could be edge-glued for improved hull strength and to maintain fairness for her Endeavour Blue topsides – Sopwith's color for the 1938 racing season.

Planking began in February, 2011. Planks were coved on their inside surface where needed to match curved contours of the frames. The last plank was fitted in April 2011. Bilge stringers and sheer clamps had been installed, and she was starting to receive her deck beams. Bunging, fairing, priming and painting proceeded through 2012.



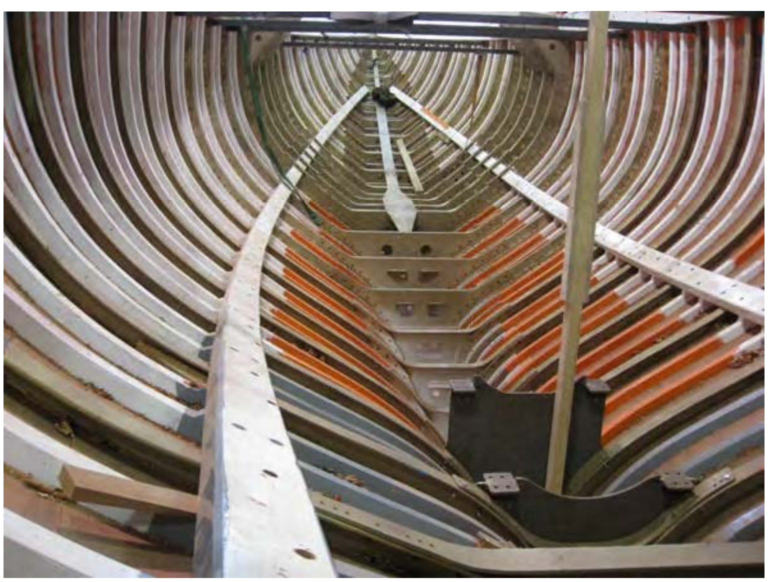
38) All framing completed. New lower planks. Original upper topsides still in place, early 2011. (Skogström)

39) Planking installed and sanded, May 2011. Mr. Andersin's Six Metre TOOGOOLOOWOO V is on the far side of the viewing bridge. (Pedrick)

Allan learned of master caulker John Zimmer of Port Townsend, Washington, who was hired to perform his now-rare craft on BLUE MARLIN in May 2013. (His work is well documented in one of the videos listed at the end of this paper.)

41) John Zimmer, caulking in May 2103. (Skogström)

40) Inside the hull after planking, May 2011. Bridge plates on the mast web frames can be seen over the bilge stringers. Engine beds in the foreground were fitted before the hull was planked. (Pedrick)



By mid-2011, Red Sky Craft had begun to fit interior components into BLUE MARLIN's hull. Areas of work included foundations and machinery for the engine and propulsion system, as well as the steering, electrical and piping systems. Spar construction – both timber and metal parts – followed in 2012 into 2013. Work on joiner panels was done over the course of several years as period of the construction program permitted.

Note in the photo at the top and elsewhere in this paper that the shop and yacht were always kept in clean and orderly condition – the Red Sky way, always presentable to the public.

**KEEL**

Allan's choice of timber for the wood plank keel was bilinga – a very strong, durable species that performs especially well in marine construction applications. It was kept wrapped at Red Sky Craft for several years to retain its natural moisture. In late 2011, the roughly 8 m (25') long x 200 mm (8") thick solid plank was taken into RSC's shop for shaping. The glue-lam strongback that had supported BLUE MARLIN's hull during the restoration was removed, and the new keel timber was bolted to the floors for its initial dry-fitting. After dry-fitting the plank keel, it was coated with a single-part, gray underwater barrier coat before permanently joining it to the hull's centerline timbers and bottom framing. The lower planks, which had been reserved to facilitate this assembly, were then closed up.

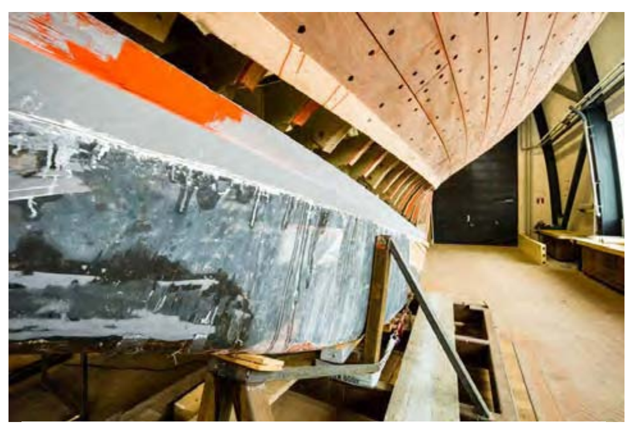
42) The timber keel being shaped in late 2011. To preserve moisture in the wood, the time from wrapped storage to fitting, sealing and installing the keel under the hull was kept to a minimum. (Pedrick)

The space below the sole was laid out to provide long-term access for servicing the keelbolts. The sole bearers and black water tank, located between the structural floors and the sole, disassemble easily for re-torquing the keelbolts periodically in the yacht's early years of service.

When BLUE MARLIN's keel was removed from the hull in April 2008, the casting was found to be in good condition. The bronze bolts, too, were remarkably sound. When one 73-year-old bolt was removed for inspection in 2010, it looked like it had just come from Nicholsons' machine shop. The chatter marks from turning the threads in a lathe were even visible in the threads' surface. The casting and bolts were cleaned up and re-used. However, because of the significant amount of weight added aft for machinery, systems and batteries, some lead was cut out of the after end of the casting to help compensate for the effect on trim.

43) A 70+ year old keelbolt in excellent condition. (Pedrick)

44) A pocket had been removed from the original keel casting, apparently to correct flotation in 1937. Tape marks the boundary of additional lead removal required now by the added engine and systems. (Pedrick)



45) BLUE MARLIN's 1937 keel joined to the newly restored hull in approximately March 2012. (Skogström)

**SAIL PLAN AND CLASS RATING**

The sail plan of a Twelve Metre is influenced strongly by the Class Rule due to a sensitive trade-off of length versus sail area in the rating formula. Length, displacement and stability tend to increase together, while rated sail area must reduce correspondingly. Tuning a Twelve's rating parameters to a targeted range of sailing conditions is restricted to a relatively narrow working range of parameters.

As a development class, Twelves start out on the drawing board with ever-evolving design choices in a continual search for gaining a competitive advantage. Principal design features are the designed length, hull characteristics, hull form, keel design and sail plan.

BLUE MARLIN was set up competitively with her peers of the late 1930's, establishing a reasonable starting point for planning her 21$^{st}$ century rating condition. A 1939 sail plan gave the fundamental measurements of her sail plan. However, influences of the current Class Rule and modern sails alter the sweet spot of rating parameters and sail plan dimensions.

The primary new consideration comes from a substantial revision of the Twelve Metre Class Rule to help mitigate the effects of design obsolescence and increased weight over time. The 2001 version of the Rule (still based on the 1933 Third Rule) added an age allowance for classic Twelves under a new "Appendix E." Appendix E permits a designer's choice of accepting increased immersion and its associated greater measured length, or increasing rated sail area, or a combination of both, provided that the rating with age allowance does not exceed 12.000 meters.

A secondary influence on design optimization is the effect of sail technology on outright boat speed and stability. Newer laminated sails, as permitted for the Vintage Division of Twelves – BLUE MARLIN's era – are far more efficient than the Egyptian cotton sails of the 1930's. They heel the yacht less and produce more driving force in a given wind strength, which affects the trade-offs of sail area relative to hull characteristics.

Because BLUE MARLIN has acquired considerably more weight in several areas, Appendix E is essential to keeping her a viable racing Twelve. Her structural weight has grown significantly due to the change to bronze framing that meets modern, conservative, ISO code requirements. Also, in her new life as a dual purpose cruiser-racer, her propulsion system, generator, sound-proofed engine compartment, batteries, tanks and other ship's systems are virtually all items of added weight compared to her sparse original equipment. Since she had almost no winches as fitted out in the 1930's, most of her new winches and other deck hardware cause added weight, as well.

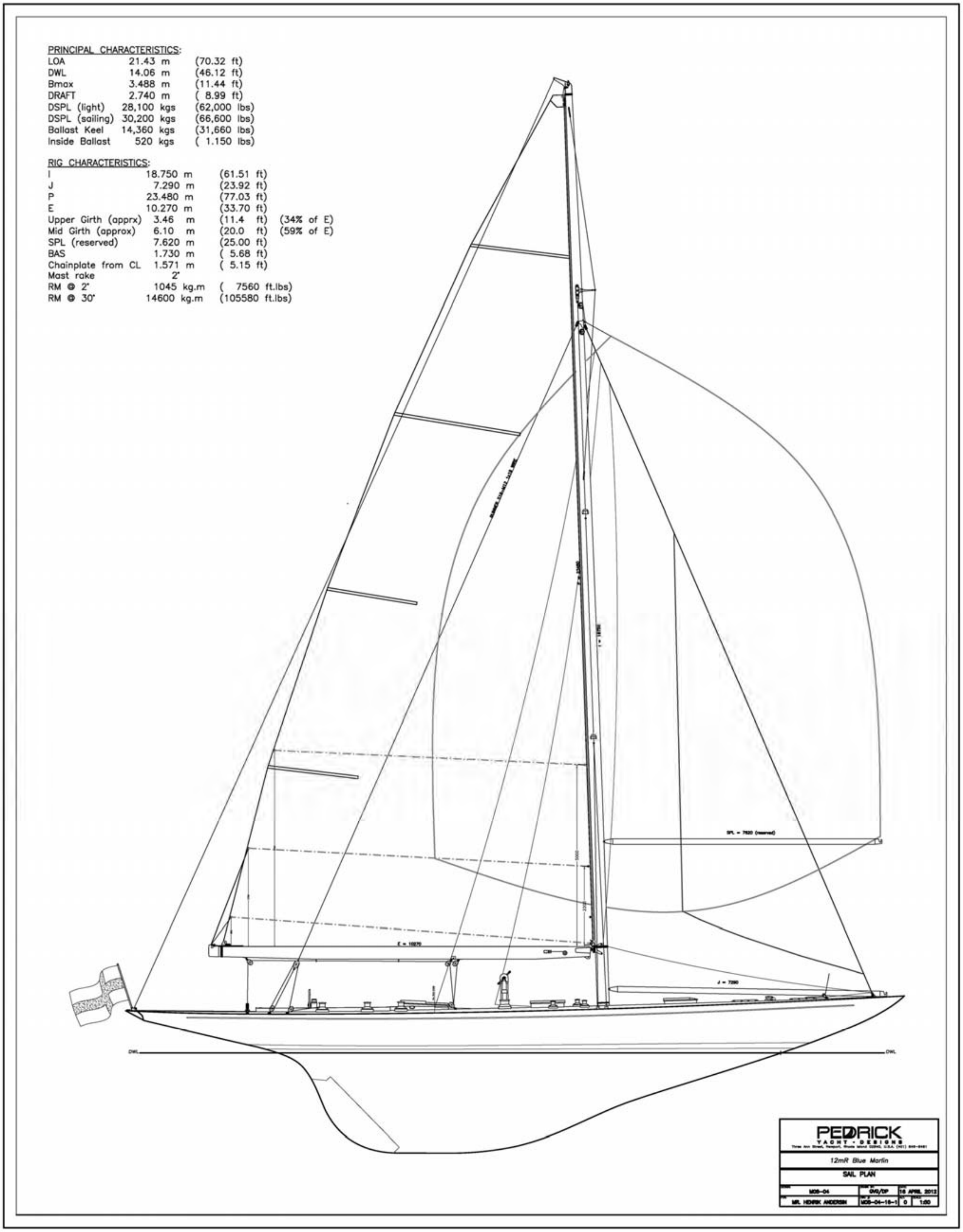
The 2001 changes in the Class Rule also introduced a separate rating credit for having an exposed propeller and shaft. Racing Twelves weren't fitted with self-propulsion during their original, active racing years. However, many older Twelves have added it for convenience and safety, and to avoid needing a dedicated tender. The propeller allowance is only credited when fitted on a traditional, exposed shaft and strut, and able to meet a prescribed minimum cruising speed.

BLUE MARLIN now receives a credit of 1½% of rated sail area for such an installation, gaining about 2.7 m^2 (29 sq ft) of sail area. The weight and location of the engine aren't specifically considered in this allowance. The aft-mounted engine on BLUE MARLIN complicates resolving her weight and trim differences from her original measurement waterline.

Because the Class Rule limits the maximum height of the headstay and the head of the mainsail, variations in sail area are limited to the length of the fore triangle base, the mainsail foot and the height of the boom above deck. After looking at the limits of where the headstay could be attached to the stem, and how long the boom could be and still have safe margin to clear the topmast backstay in a flying jibe, their respective dimensions ended up within 50 mm (2") of BLUE MARLIN's 1939 sail plan.

With nearly three tons of added weight in bronze structure, added deck hardware, an engine installation and cruising systems, less about a ton removed from the keel casting, BLUE MARLIN will be floating significantly deeper than her originally designed racing trim. The age allowances of Appendix E and the propeller credit are being used to absorb the increase in rated length that will result from floating deeper. Fortunately, the original amount of sail area on BLUE MARLIN was generous originally. It doesn't need to be increased and is physically constrained from doing so. Consequently, BLUE MARLIN's sail plan on the following page remains virtually identical to her 1939 condition, but flying far more efficient sails.

An amazing piece of sailmaking history came out of BLUE MARLIN's sail locker in 2011. At a time when Mr. Andersin and nearly all of the project team members were in Kotka, an old sail was pulled out of a bag. It was a rare find, shown in photographs following the sail plan.




46) New Sail Plan of BLUE MARLIN. Sail dimensions are nearly identical to her original design by Charles Nicholson. (Pedrick Yacht Designs)

47) Parachute spinnaker from BLUE MARLIN's original year, 1937. Discovered in the yacht's inventory in 2011 after 74 years. The sail had only a few, small tear repairs. This could well be the sail that is being flown in Beken's 1938 photo on page 4. (Pedrick)


48) Sailmaker's stamp: Ratsey & Lapthorn Sailmakers, Gosport, 1937; Parachute Spinnaker. Note: Gosport is where Camper & Nicholsons' shipyard was located. (Pedrick)

## DECK ARRANGEMENT

BLUE MARLIN's deck arrangement has been adapted to serve both short-handed cruising and contemporary day-racing. The aesthetics of Nicholson's deck, cockpit and hatches have been faithfully restored, while adding sufficient winch capacity and other sail-handling hardware for buoys racing. She will be joining the very active and well-sailed Baltic Classic Twelve Metre fleet, whose yachts are principally from Germany, Denmark and Norway.

The first step in creating the deck plan was to confirm locations and styles of the cockpit and hatches. Given that layout, the sail plan guided the necessary or preferred locations of sail handling hardware. Exact positions of deck hardware were adjusted to suit original beam locations. Finally, hardware was selected or designed and engineered to meet calculated, maximum working loads. The end result achieves a classic style that is faithful to the Camper & Nicholsons 1930's pedigree but which accommodates good, contemporary practice in competitive sail handling.

BLUE MARLINS's cockpit and companionway scuttle had survived intact but was worn beyond re-use. Sadly, her original butterfly skylight and hinged, raised foredeck hatch had become victims of modernization decades ago – replaced by ordinary, aluminum-framed, acrylic hatches. Guidance about the configuration of the original hatches came from period photographs. William Collier then applied his expertise about everything Nicholsons to the detailed design of replica hatches that are as faithful as possible to the original work of Camper & Nicholsons.

49) Original companionway scuttle from BLUE MARLIN. This was replicated to match the deck's other varnished mahogany. (Pedrick)

50) Helmsman's cockpit on sistership TRIVIA, the first of four Twelves launched by Nicholsons in 1937. (Pedrick)

Charles Nicholson's design of the cockpit had a deck-height partition at the binnacle. The helmsman's area was separated from the main cockpit, and the working cockpit was relatively small. (See photos of model on p. 13 and TRIVIA on p. 30.) As a more user-friendly arrangement, BLUE MARLIN's revised cockpit layout was made more spacious by eliminating this partition, using a sole-mounted steering pedestal instead.

Settees were added in the cockpit to improve cruising comfort. They are simple benches that can be removed when racing to maintain open crew space. Ergonomics when the settees are in place required making a small increase in the cockpit's breadth. While doing that, the cockpit's length was increased similarly. The effect is a subtle scaling of the original coaming, preserving a similar taper angle and height above deck. Except for removing the barrier forward of the helmsman, the difference in the revised cockpit's appearance will be indistinguishable from original photographs of the yacht.

Drainage requirements for CE code compliance presented some challenges. Drains must be able to empty the cockpit's entire volume of water within a calculated time, which is in the order of 3 minutes for Category A. The continuous coaming above deck level significantly increases the amount of floodable volume used in the calculation. ISO requires that sufficient capacity to meet the drain time requirement be demonstrated by pipe flow calculations. Additionally, a fixed companionway sill must contain standing water to a lesser height. BLUE MARLIN meets this requirement with a fixed sill whose height complies with Category B and a hinged panel that can be raised to meet Category A when there is the risk of encountering such conditions. Her original pair of paneled, vertically hinged doors at the companionway entrance is fitted above the cockpit's fixed sill, as originally designed. The extension sill hinges up inboard of the doors when needed and, when not in use, blends into the trim at the companionway's top step.

51) BLUE MARLIN's original companionway doors. (Pedrick)

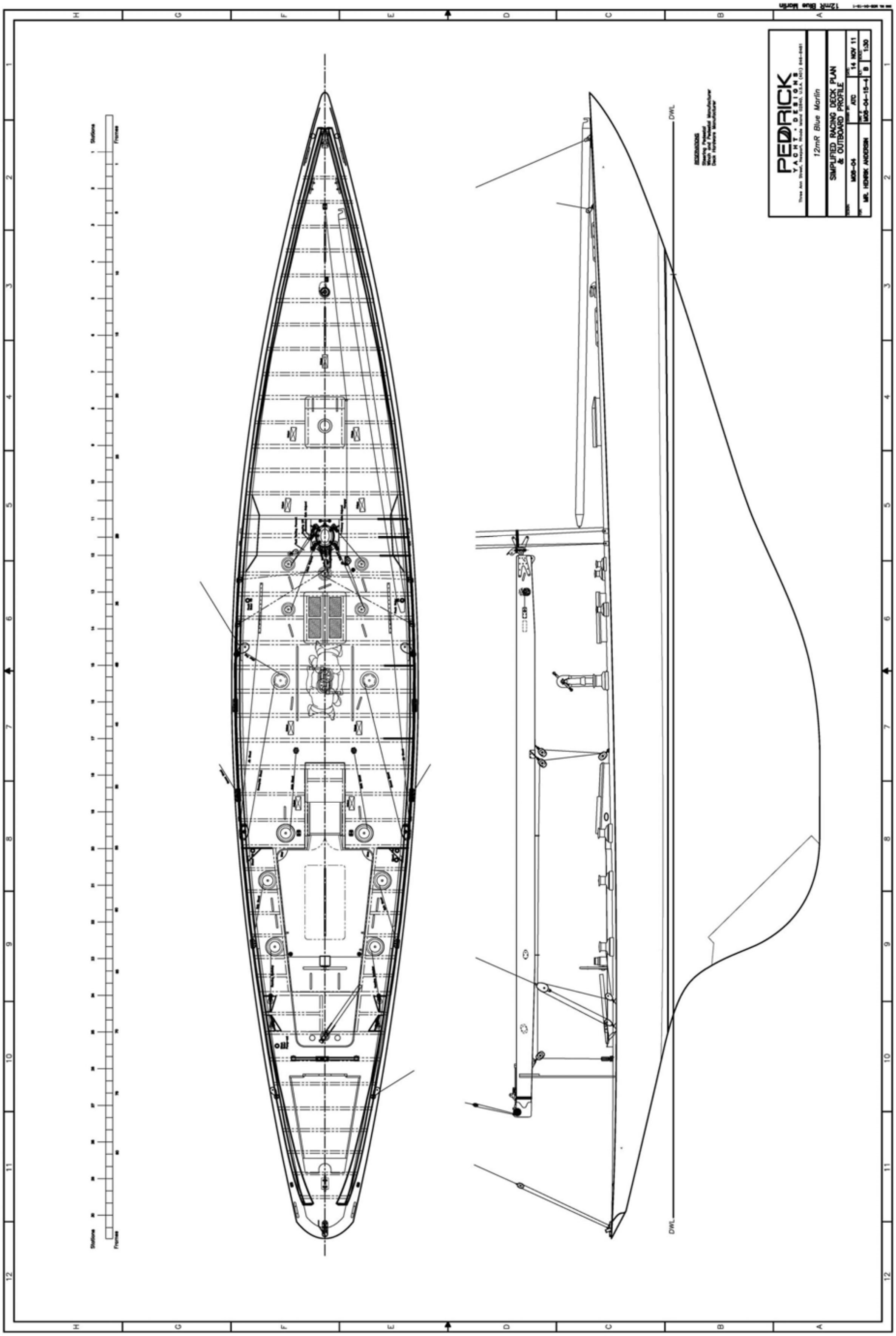
Pedrick Yacht Designs developed the deck layout and hardware for BLUE MARLIN, drawing from the firm's extensive experience in Twelves. PYD has worked on twenty-four different Twelves, ranging from classic restorations and refits to new designs that have won the America's Cup twice. For her planned racing competitiveness, BLUE MARLIN would need enough winches to execute dip-pole jibes, but limited to no more than the minimum necessary for safe and efficient operation. Primary winches with appropriate speed and power for genoa sheets and spinnaker afterguys would be part of this requirement.

The original 1937 jib sheet arrangement wasn't an option. Each of the two sheets had a block tethered to the clew for a two-part system. When tacking, one end of the sheet was tailed for fast, initial take-up and then cleated. The other end was always attached to a cascading tackle for final trimming.

The new mainsheet system has been designed to permit fast manual take-up of the sheet in a jibe, as well as to have suitable power for manual upwind trimming in strong winds. It is led to a pair of top-action winches.

PYD's initial winch layout in the spring of 2011 was extensive, including dual pedestals for the genoa sheets and liberal use of self-tailers. However, it was apparent that making the winches in bronze would not be enough to disguise the modern character of this winch package. A more classic arrangement in an antique style would follow.

The 2011 Twelve Metre World Championship in Flensburg, Germany gave David the opportunity to observe restoration practices and deck hardware that are characteristic of European Classic Twelves. All ten competitors were from before World War II, and their deck equipment ran the gamut from reasonably authentic to blatantly modern. Two consistently top-performing yachts in this fleet are VANITY V (Fife, 1936) and TRIVIA (Nicholson, 1937). With much credit to their owners and crews who sail them so well, they are a bit under-winched, both in quantity and in accepting faithfulness to top-action, traditional style winches without self-tailers. Another notable area of authenticity is tiller steering on VANITY V.




52) Deck Plan showing deck beams and sheer clamps. Running rigging leads are also shown. After locating winches and hardware according to their essential sail handling requirements,, they were positioned to integrate their under-deck foundations with the deck's primary structure. (Pedrick Yacht Designs)

Mr. Andersin's goal for BLUE MARLIN's deck fit-out was to be authentic-looking to late 1930's British yachts. Sympathetic aesthetics were to be maintained while specifying practical, adaptive additions. Charles Nicholson's sail handling systems gave a limited starting palate, though. As indicated by the jib sheeting system described above, BLUE MARLIN's original deck fit-out was surprisingly primitive – well off the pace of American Twelves of her era. It was appropriate to improve on her earlier sail handling hardware, as many yachts tend to do over time, but in a style based on British yachts of BLUE MARLIN's early sailing years. This led to creating extraordinary custom winches and other deck hardware, described in the next section.

By the time of the 2011 Flensburg Twelve Metre regatta, BLUE MARLIN's captain and yacht manager, Chris Winter, had come aboard the project team. After David's study of classic Twelves in the Flensburg fleet, guided especially by TRIVIA and VANITY V, Mr. Andersin, David, Allan, Chris and William agreed that the level of deck fit-out should be kept relatively modest. Nevertheless, practical considerations called for adding a few winches. The principal one is a pair of genoa sheet winches with a single grinder pedestal, for which suitable precedent existed among other British Twelves of the late 1930's.

As team discussions evolved, Pedrick Yacht Designs refined the deck layout and designed period-style, custom winches and hardware. Beginning aft in the deck plan, running backstay winches are positioned outboard of the cockpit, just forward of the helm. Secondary winches for spinnaker sheets are forward of those. Genoa sheets can also be led to these winches when cruising, for which they are motorized. A pair of mainsheet winches is outboard of the scuttle, forward of and operable from within the cockpit. The starboard mainsheet winch is motorized for cruising. When jibing, the four-part mainsheet can be tailed at both winches to double the speed of take-up.

The mainsheet is on a controllable traveler, a rarity in the 1930's but fitted to Sopwith's TOMAHAWK and the Fife Twelve FLICA II in 1939. The traveler control pendants and topmast backstay are adjusted by cascading tackles under the afterdeck, led through the cockpit walls.

A grinder pedestal based on a design by Sopwith and his engineer Frank Murdoch is located where a large capstan-style winch had been added to BLUE MARLIN in 1938, visible in the photograph on page 6 that was taken in Kiel. An interesting feature of the winch is that it was driven by removable grinder handles. Pedestal grinder winches had appeared in the U.S. in the mid-1930's but were a few years slower catching on in the UK.

53) Winch pedestal on ENDEAVOUR II in 1937, also retro-fitted to ENDEAVOUR I. (Beken)

As a suitable, adaptive upgrade to Sopwith's 1938 winch on BLUE MARLIN, William offered a photograph of an elegant chain-drive grinder pedestal that Sopwith had on both of his J-Class yachts in 1937. Mr. Andersin was enthusiastic about it, and asked William to prepare a scaled drawing of ENDEAVOUR's pedestal for BLUE MARLIN. The original pedestal had a chain drive, while the new replica uses a modern belt drive. The pedestal connects to a pair of genoa drums outboard of the pedestal with under-deck shafts and bevel-gear boxes that fit closely under the deck.

Five winches have been placed around the mast to serve three headsail halyards, the main halyard, topping lift, foreguy, boom vang, cunningham and reef lines. When laying out various leads and winch locations, care was taken to obtain a fair lead for a tackle boom vang that leads from either of two locations on the covering board P/S to the utility winch on centerline aft of the mast.

A robust anchor handling system was designed to suit both the convenience of cruising and ultimate safety if/when anchoring in gale-force conditions is required. A 55 kg (120 lb), stainless steel, Rocna plow anchor uses a rope rode having a 4 m (13') chain leader. The windlass is a low-profile Muir Storm VR 3500 with rope-chain gypsy, cast in polished bronze. The rode feeds into a deep, watertight locker under the foredeck. The anchor can be taken below through the fore hatch with a halyard and then transferred to secure stowage aft of the rode locker by an overhead traveler and tackle system.

54) Antique British winch used as prototype for BLUE MARLIN's new, custom top-action winches. (Pedrick)

## CUSTOM SAIL HANDLING HARDWARE

A breakthrough in BLUE MARLIN's deck hardware came from a pair of winches that Mr. Andersin purchased through a marine antiques dealer for the Wooden Boat Center. According to the dealer, they had come from a British Twelve of BLUE MARLIN's era but of unknown identity. They are of appropriate size, and the British manufacturer's name and city are engraved in the base of the winch. They are also similar to William Collier's records of Nicholsons' "Style E" winches of the period. These Wooden Boat Center winches would become the prototype for custom winches for BLUE MARLIN.

They have attractive proportions, with a relatively wide, flat skirt and a deck flange of larger diameter than the skirt. A square spud on top receives the winch handle. BLUE MARLIN would need two sizes of top-action winches, for which Pedrick Yacht Designs created consistent designs based on the antique prototype. New, custom drums were designed to fit on respective sizes of commercially available internal winch parts. The drive shaft would use today's standard socket drive, rather than the original spud.

A subtle adaptation was to configure the original, single-speed drum design to suit the gear housing for two-speed drive internals. Space for the second stack of gears was created by fitting the housing into a cup that was topped by the deck flange. The cup fastens directly onto the deck, hidden by a wood plinth between the deck and the flange. The elevated flange helps preserve the visible proportions of the antique-style winch. When cruising, their plain drums can be exchanged with self-tailing drums of similar style.

In addition to replicating the original ENDEAVOUR chain-drive pedestal mentioned previously, William proposed that the drum design of the primary winches be based on the first ENDEAVOUR's "rowing winches," used in 1934 and replaced by the pedestal system in 1937. The curious name comes from the unconventional system for the winch's drive mechanism. Reminiscent of the spokes for turning old ship's capstans, two rowers powered the winches with the operating end of oars that ratcheted from the winch base just above deck level. Eventually, dimensional restrictions on available, large-diameter winch internals required BLUE MARLIN's drums to have somewhat taller proportions than those of the rowing winch prototype. The skirt of the drum is also elevated above the deck by the space needed for the three-speed gear stack. This height also helps the vertical lead-in angle of the genoa sheet from the footblock to the drum.

55) Rowing winches on J-Class yacht ENDEAVOUR in 1934. (Beken)

After discussions with several candidate winch makers about PYD's preliminary designs, a competitive bid led to selecting Harken for the complete winch package. Harken's winch division in Italy engineered the designs to suit their standard winch internals and manufactured custom drums in strong, nickel aluminum bronze. Harken also developed the under-deck gears, shafting and controls for the cross-connected primary winches, using a foot-operable lever control on the pedestal base for the clutches, rather than modern foot buttons.

56) Winches and mast partner blocks installed, February 2014. (Skogström)

Custom bronze footblocks, cheekblocks, deck eyes and the main traveler system were also designed in vintage style by PYD. Manufacturing was by a combination of Blockmakers Ording in the Netherlands and Harken's Custom Division in Wisconsin. All deck hardware was in nickel aluminum bronze for consistency of color as well as its relatively high strength.

Genoa footblocks had to satisfy dual-purpose sheet leads. When using the primary winches, the sheet reverses around its footblock approximately 160 degrees. When led aft to the secondaries for cruising, the sheet deflects only about 25 degrees at the footblock. When transferring the sheet between its forward and aft leads, it makes the 135-degree sweep between them without any obstacle in the footblock.

3D CAD modeling was used in designing a pleasing, elongated octagonal shape with clearance for the large sweep of the sheet. As a very highly loaded fitting, the block and its fastenings had to be engineered carefully. The footprint of its base also had to meet constraints imposed by constraints in its under-deck foundation at the sheer clamp. Later, 3D design was an effective tool for determining the foot-block's best cant angle to the deck for proper leads at both ends of the extreme change in lead angle. The top surface of the footblock was styled with 3D contours to give the appearance of a casting, although it was NC machined from thick plate. Generally, BLUE MARLIN's hardware fabrications constructed from bronze plate were welded with generous fillets, ground smooth and polished to give the appearance of traditional castings.

57) Footblocks designed by Pedrick Yacht Designs and manufactured by Blockmakers Ording. (Skogström)

Woodshell blocks are used liberally for the mainsheet system, genoa lead blocks, running backstays and base of the mast. For these, Blockmakers Ording offered elegant designs, high quality manufacturing and cooperative customization. Their fittings are also strength-rated – not always available in classic-styled hardware. Ording's standing blocks are made with a clean, strong deck collar that keeps the blocks upright while having sufficient articulation for variable leads. All bindings, fittings and sheaves are of nickel aluminum bronze. Ording also provided custom fabrication services for the PYD-designed footblocks, cheekblocks and deck eyes. All blocks were designed to accept free-running bronze sheaves having roller-bearing and side ball races.

58) Ording blocks with bronze stand-up bases for halyards. (Skogström)

All of the footblocks, deck eyes and tracks attached along the covering board were bolted to bronze foundations in way of the sheer clamp. Each of these custom deck fittings had to be designed prior to working out the engineering of its under-deck foundation. Details of each foundation's footprint, attachments and locations of bolts, as well as the exact positioning of the deck fitting, had to be tailored to the physical advantages and constraints of the local deck beams and sheer clamp. In-plane bearing strength for hardware attachment bolts through the deck was increased by inserting G-10 fiberglass bushings set in epoxy. All of the bronze foundations along the sheer clamps had to be permanently fastened in place before the deck plywood could be installed.

Silicon bronze was chosen for the under-deck foundations because of its superior performance in a wet environment. The foundations won't be seen again until the next time the plywood deck is removed, anticipated in someone else's lifetime. Even with careful sealing, water will inevitably find its way past the hardware fastenings, risking damage to the foundation and close-fitting wood structure. The end grain of the deck timber is protected throughout its thickness by G-10 bushings that reinforce the bolt holes.

**DECK CONSTRUCTION**

BLUE MARLIN's deck beams and carlins were re-made to match Camper & Nicholsons' original form of construction. Minor changes were made to strengthen some beams and make adjustments in the carlins for the cockpit and hatches. Douglas fir was used, corresponding

60) Deck beams in bow completed, early 2012. All beams are beaded on their lower edges. Anchor rode locker has large opening for acrylic hatch. (Pedrick)

to the specification of Oregon pine on EVAINE's construction plan. Beams and carlins were laminated in plank-thickness lifts, rather than being solid as made originally. Their ends were made to fit tightly into the existing dovetail notches of the original sheer clamps.

59) Prefabricated deck beams, October 2010. (Pedrick)

Beam installation began in May 2011. The siding of beams in way of the genoa grinder system was increased due to local loading from the primary winches. Additional, bronze structure aft was designed for the running backstays and main traveler. Blocking was added between beams for all winches and the anchor windlass.

61) Breastplate with flanges bolted through the sheer clamps. Watertight sockets receive bolts to secure the removable anchor roller, as well as the jib tack plate. (Pedrick)

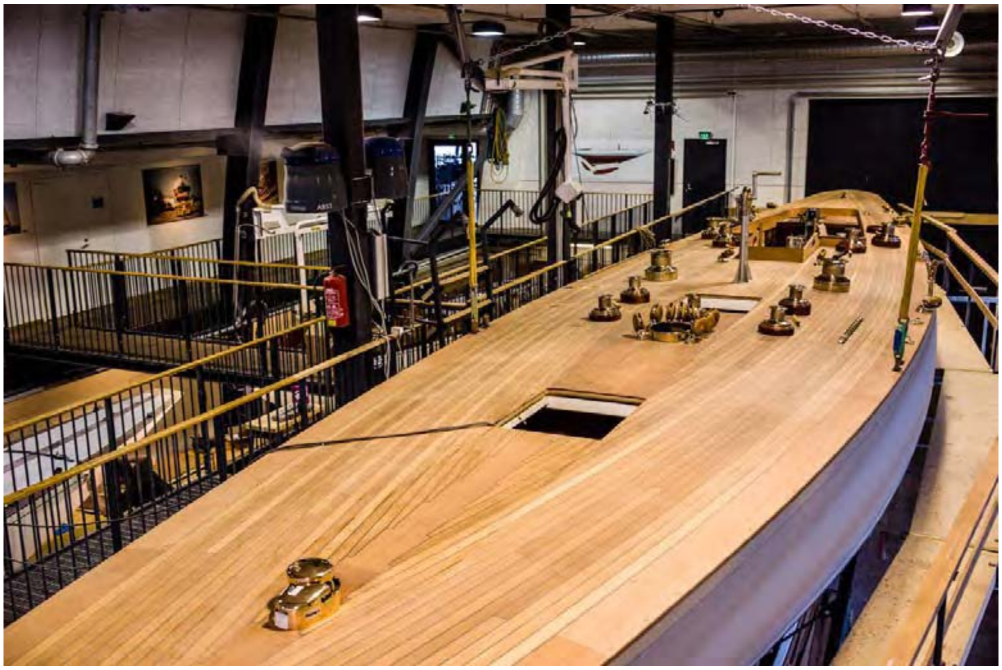
62) Holes through the forward end of the deck will receive threaded sockets that secure into the breastplate sockets. There is an additional anchor roller socket in the stem cap. The headstay tang is connected directly to the centerline girder. Note the Six Metre and rudder sculpture in the background. (Skogström)

An especially strong foundation was designed to carry the load of a removable, bronze bow roller. The roller and foundation were engineered to withstand the most severe, dynamic storm loading for which the ground tackle was sized. The roller base bolts to watertight bronze sockets at deck level. The deck sockets are, in turn, fastened into welded sockets in a substantial bronze breastplate that is secured to the sheer clamps. This replaces the original timber breasthook, whose function was just to hold the sheer clamps together at the bow.

Cockpit framing was re-engineered to meet ISO's increased structural requirements. Its sole is part of a fire- and sound-insulated boundary for the machinery compartment beneath it. Primary access to the engine space is through a large, watertight hatch in the sole, custom-built to CE certification by Rondal – the spar and equipment affiliate of the Royal Huisman Shipyard in the Netherlands. Watertight Rondal hatches were also made for built-in liferaft lockers through the cockpit side walls. The exterior surfaces of the three Rondal hatches were finished by Red Sky Craft with wood overlays to match their respective surrounding surfaces.

The forward end of the cockpit well is supported by the aft accommodations bulkhead. Machinery space partitions run along its sides. A bronze beam spans across the breadth of the hull where the main footwell steps up to the helmsman's sole. There is also a centerline pillar here that carries load directly onto the horn timber. This bronze framing structure also supports principal components of the steering system.

63) Hull soon after setting it onto the ballast keel, early 2012. Plywood deck is installed at the bow and stern. (Skogström)



64) Overview of deck, February 2014. Anchor windlass is on the foredeck. Note the viewing bridge in the middle of the shop and along the far walls. The bays next to BLUE MARLIN can accommodate two Six Metre Class yachts or others of similar size. (Skogström)

The cockpit was built as a subassembly that could be taken in and out of the deck repeatedly to facilitate construction of the machinery compartment, propulsion system, steering system and other components under the cockpit.

The deck is constructed in three principal layers that total 38 mm, slightly more than the Lloyds' Rules' minimum of 35 mm. The main structural layer is 15 mm (5/8") thick, Lloyd's type-approved Okoume marine plywood, pre-fabricated into just six panels for the entire deck. Cedar bead-board, 9 mm thick, was glued to the under-deck surface of the plywood before the panels were installed on the deck beams.

The bead board planks are sprung from the deck-at-side to maintain the appearance of a single-planked deck, including a false covering board around the perimeter. The boarding was painted white before installing the plywood panels onto the deck. Panels are butted at deck beams, and a false king plank hides the plywood seam on centerline. The upper surface was finished similarly with teak, bounded by varnished mahogany for the covering boards and the king plank. The outboard edge of the covering board is varnished mahogany for the full thickness of the deck.

Installation of deck panels began in early 2012. After all panels were installed, the entire surface was sealed with 200 GSM (6 oz/sq yd) fiberglass cloth set in epoxy. This was to preserve the watertightness of the deck at the top of the plywood, as well as to provide a hard surface at which to stop when the teak deck eventually has to be stripped and replaced.

Teak decking was applied as individual, sprung planks. The teak is 13 mm (½") thick for a durable wear layer, glued down with WEST G-Flex epoxy and vacuum-bagged. The upper and lower sheathing layers of teak above and cedar below the plywood are structurally effective in the fore-and-aft direction. The teak was laid in the second quarter of 2013, and seam caulking was completed in July 2013.

Red Sky Craft used the original companionway scuttle as the prototype for fabricating its replacement. A new butterfly skylight and a hinged foredeck hatch were made to replica plans by William Collier's design firm G.L. Watson & Co. The foredeck hatch now has a separate hinged lid for a forward compartment that houses the anchor wash faucet and small items like sail stops.

Before closing up the deck in the latter part of 2012, Red Sky Craft was working in many other areas, including the interior, machinery and systems. RSC was also constructing the mast and boom in 2012-13.

Deck hardware installation began in the summer of 2013. Deck furniture, hardware and finishing details are now being completed for BLUE MARLIN's launching in the early summer of 2014.

**INTERIOR ARRANGEMENT AND JOINERY**

Twelves in BLUE MARLIN's era were required to have a basic cruising interior. Nicholson's design was appropriate for the limited interior volume of a Twelve, although it was compartmentalized with only a small salon for general use.

The salon was just forward of the cockpit, but only long enough on the starboard side for a cabinet next to the companionway and a settee for the remaining space, ending at a midships head. The port side had an additional cabinet forward of the settee before reaching the passage door to the owner's cabin. Paneling extended upward from the settee, with no pilot berths.

The head compartment to starboard of centerline separated the salon from the owner's cabin. A raised single berth on each side of the owner's cabin had drawers below. There was a hanging locker to port, opposite the head. The main bulkhead at the mast, which was non-structural, was at the forward end of the cabin. There was a very modest galley forward of the mast, then narrow settees and sail stowage. Overall, the arrangement provided a total of only four berths.

Nicholson's arrangement plan provided very little social space, or even room for sail handling. Mr. Andersin wanted a more open interior to allow for these purposes. Additionally, he wanted a simple forward cabin for his own use while cruising.

The original interior was constructed in lightweight Spanish cedar, with handsome, fielded panels. As a token to weight-saving, Nicholsons' craftsmen had routed grooves in the backs of panels' stiles and rails. Considering how little weight was saved in this hidden area, it seems more like a psychologically satisfying gesture by the carpenters than a meaningful difference in the overall weight of the interior, especially considering this lead-mine type of yacht.

There had been almost no changes to BLUE MARLIN's interior since she left the builder's yard in 1937, so the materials were almost 100% original. The joiner panels were in good condition, and would be re-used to the greatest practical extent.

Removal of the interior began in the earliest discovery stages of BLUE MARLIN's restoration. The initial stage of work was for Red Sky Craft to dis-assemble the joinery panels one at a time, label each one according to its as-built location, and put it into storage for later stripping and refinishing. Interior removal was necessary to expose the inside of the hull so that its condition could be assessed. As the yacht's minimal systems became accessible, they were removed.

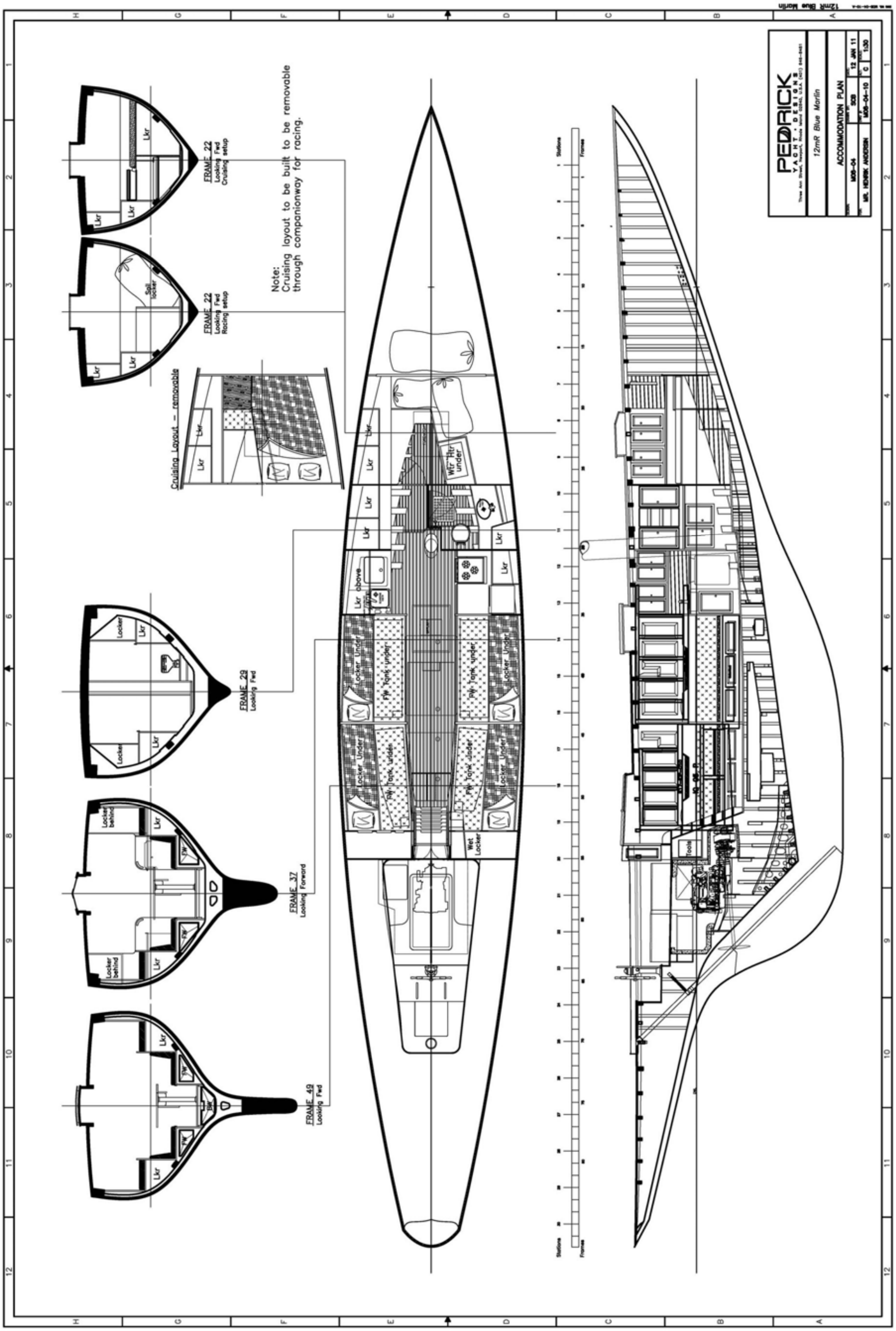
The new arrangement plan would be an exercise of rearranging the original furniture as effectively as possible. Before adapting joinery panels into the new plan, Pedrick Yacht Designs measured each of the existing panels and drew them in CAD. In some locations – especially in way of settees – lengths within the new interior could be designed to match the existing panels. The outboard panels were placed a little farther outboard, and a pilot berth was added above each settee.

65) Berth front from original owner's cabin. It is being re-used as a pilot berth front. The original settee fronts in the salon are being re-used. A matched set of new panels has been made for the midships settees and pilot berths. (Pedrick)

PYD developed details of BLUE MARLIN's new arrangement plan starting in the second half of 2010, after substantially completing the structural modeling of the hull's frames. Bulkheads and built-in furniture were located efficiently in relation to frames and bilge stringers. Even with 3D design as an indispensible tool, though, fitting the yacht's many systems components into small spaces between joinery panels and the hull turned into a serious competition for space.

Beginning aft, the new arrangement plan has lockers just forward of the cockpit bulkhead, similar to the original plan, although they now extend up to the deck. A foul weather gear locker is to starboard. An electrical locker is to port, housing batteries and electrical system devices. The salon's port and starboard settees now have pilot berths outboard of them.

Where the original interior had a full bulkhead just forward of the salon settees, there is now just a small partition on each side of the yacht to separate the first set of settees from the second set. Each settee now has a pilot berth outboard of it, doubling the original number of sleeping berths. Also, before reaching the mast, there is an open galley with a sink and fridge box to port and the stove to starboard.




(66) BLUE MARLIN's new arrangement plan. Open from the companionway to the mast. The galley is P/S just aft of the mast. The door to the head is just forward of the mast. (Pedrick)

The head is forward of the mast to starboard. The passageway and shelf lockers are to port. Forward of this are sail bins in a U, ending at the anchor rode locker. A removable double berth with a proper mattress can be fitted over the bins to starboard, creating a modest owner's cabin when in cruising mode.

A significant piece of loose furniture has managed to survive the intervening decades of various ownerships. The salon's gimbaled drop-leaf table is in good shape, including tight joints on the hinged brackets that support the leaves when raised. The table has been restored for re-use in BLUE MARLIN's salon.

67) BLUE MARLIN's original drop-leaf table being restored. Pendulum weights are placed upside down. They go in the box on the floor behind the table. (Pedrick)

In the course of modeling panels for the new interior in Rhino 3D, PYD provided RSC with guidance about which existing panels to use in specific ways – whether essentially as is, or with proposed modifications. Some of the original panels had more height than would fit in the new arrangement. Where panels needed to be made smaller, RSC took them apart, shortened their individual pieces as required, and put them back together. Where new panels were required due to insufficient original pieces for the new arrangement, Spanish cedar to match the original panels was sourced through John Lammerts Van Bueren. RSC prepared a number of staining samples to find the best color match between old and new panels.

68) Stiles and rails of a set of fielded panels, which have been removed to be restored separately. This piece was reduced in size to fit outboard of the new pilot berths. (Pedrick)

Bulkheads and partitions have been made in Nicholsons' original style, faced with varnished, tongue-and-groove boards having a recessed flat along each seam. The first completed partitions were in the paint shop by early 2012. However, because finished joinery wasn't needed until late in the restoration process, work on it ebbed and flowed with other demands of the project over the next two years.

69) Forepeak sail bin partition, Spanish cedar tongue-and-groove boards with flat relief along edges. (Pedrick)

The anchor rode locker is made of plywood with a fiberglass interior. (See Photo 60, p.36.) Its exterior is finished with flat-grooved facings as in the joiner bulkheads, but painted. An acrylic opening hatch facing the cabin permits observation of the rode while raising the anchor, as well accessing the rode to handle it manually if necessary. The 55 kg (120-lb) anchor stows below in chocks forward of the foredeck hatch. After lowering the anchor through the hatch by a halyard, it can be raised by a tackle on a traveler mounted under the deck beams and then transferred to its stowage chocks immediately aft of the rode locker.

Two fresh water tanks are located exactly amidships, under the forward settees. Two fuel tanks are under the after settees, a little aft of the yacht's LCG (longitudinal center of gravity). A fuel day tank is outboard of the cockpit to starboard near waterline height. The black water tank is centered below the sole, a little forward of the fuel tanks. These necessary tank locations claim most of the space within the joinery that is below the tops of the settees. They are generally close to the yacht's LCG, so they have a relatively small effect on trim in any state of fluid content.

As with almost every piece that has gone into the construction of BLUE MARLIN's hull and internal components, interior panels were prepared, dry-fitted and adjusted for a perfect fit. Virtually all of the joinery has been fastened into the hull prior to being taken back into the workshop for final finishing. As of this writing, a few months before launching, about half of the joinery has been re-installed into the hull while Red Sky Craft completes final installation of piping, wiring and remaining items of equipment in the scarce space behind the joinery. In RSC's careful manner of construction, the finished joinery pieces that are waiting in the shop have been installed before, and will go back aboard easily after the systems work is ready to be closed up.

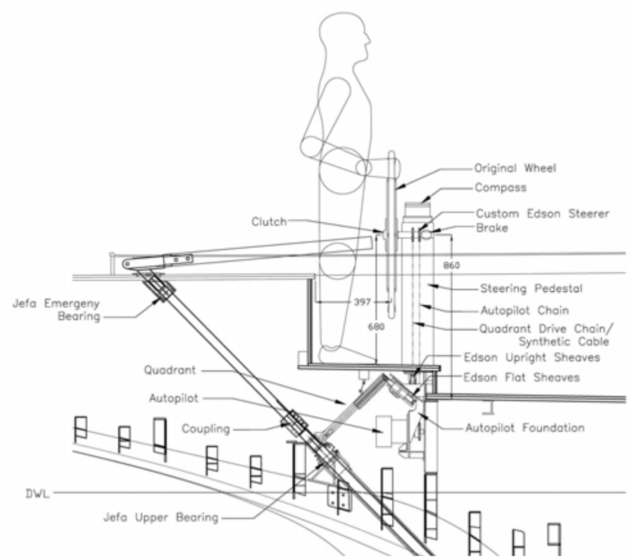
## MACHINERY AND SYSTEMS

Nicholsons' rudder and steering gear on BLUE MARLIN were adequate but below the standards of safety and efficiency that are appropriate for a yacht today. Most of the blade was from a single, broad plank of wood, parallel to the stock. The steel rudder stock extended just far enough into the hull to pass through a bronze shaft bearing and packing gland on top of the horn timber, topping off with a relatively short stub for the quadrant and a square head for the emergency tiller. The tiller had to pass through an opening in the face of the helmsman's seat – a risk in rough seas when an emergency tiller might, in fact, be needed.

Because an original drawing of the rudder wasn't available and its condition inside couldn't be examined without destroying it, it was decided to keep the antique rudder intact. It became the centerpiece of a wall sculpture at the Wooden Boat Center, visible in the background of Photo 62 on p. 37.

The new rudder has a substantial, internal bronze framework that is clad in solid wood, similar to the original rudder but in a structure that has been engineered to meet new ISO requirements. A middle length of removable stock passes through a glued-in, fiberglass tube for the length of the horn timber. It's secured mechanically into a splined joint in the top of the stock within the rudder. The joint is designed in a way that transmits the entire weight of the rudder into the middle stock, which has a collar that, in turn, transmits the weight onto a thrust bearing above the horn timber. Side load is taken by low-friction, Jefa roller bearings at the bottom of the horn timber and in the upper bearing housing above the timber. A watertight boot below the steering quadrant encases the bearings.

The rudder blade is supported at its connection to the middle stock and by two bearings below that. The majority of the rudder's side load is carried by a new, strong, intermediate bearing that is bolted to the bronze sternpost knee. A pintle at the bottom of the stock is supported by an Oilite bronze bearing set into a new, bronze heel fitting. The heel fitting is attached to the after end of the keel casting as well as by a substantial bolt into the sternpost knee.



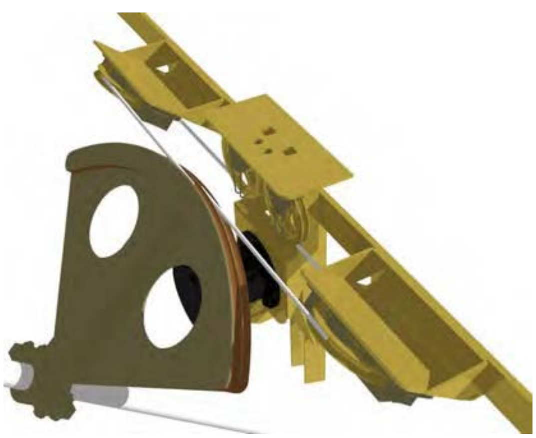

70) Overview of steering system components above the rudder. Elegant solutions for stock assembly, bearing support, quadrant, autopilot and steering cables have been arranged securely in a very confining space. (Pedrick Yacht Designs)

The steering overview above shows the arrangement of components in the confined space between the horn timber, floor for a grown frame, and the cockpit sole. A new top length of stock is for the emergency tiller. It's coupled above the quadrant and finishes with a square head and a self-aligning bearing below just below deck level. A removable deck plate gives immediate access for the tiller.

The original quadrant employs a simple design approach that was replicated in the new quadrant. It uses a conventional tiller arm to which a plate was bolted. Its rim is wood in two pieces, one each side of the quadrant plate, riveted together, and scored for the steering cables. The new rudder is a faithful copy of this design, now made of bronze with its plate welded to the tiller arm, and using Tufnol (Micarta) for the scored rim pieces, bolted together.

71) BLUE MARLIN's original steering quadrant. (Pedrick)

Space between the rudder stock and the base of the pedestal was quite constricted for all the components that had to be arranged there. The entire system was designed in 3D by Pedrick Yacht Designs and executed with great care by Red Sky Craft.



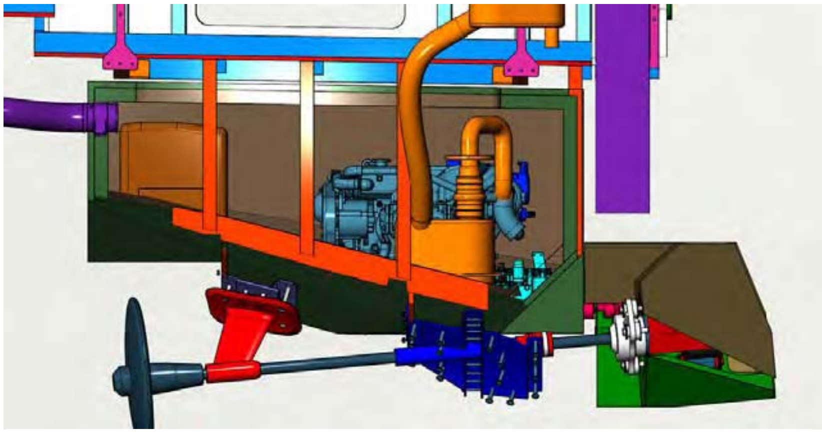
72) Quadrant, autopilot and steering sheaves. All steering input components are attached to a bronze beam spanning a grown frame as well as a pillar to the horn timber. (Pedrick Yacht Designs)

73) Steering pedestal frame with steering head. (Pedrick Yacht Designs)

The new, square-based binnacle has an internal stainless steel framework. It's bolted directly to the bronze structure under the sole that carries the steering cables and autopilot. The frame is clad in mahogany, similar in appearance to the half-binnacle that was mounted to BLUE MARLIN's original cockpit partition. (See also photo of scale model on p. 13 and TRIVIA on p. 30.) Stainless steel was used here because nickel-aluminum-bronze contains enough iron (4%) to be magnetic, which would affect the compass on top of the binnacle.

The steering head includes a clutch and wheel-brake mechanism that allows the wheel to be safely disengaged and locked when the autopilot is engaged. A Jefa rotary autopilot activates the drive train and cables to the quadrant via clutched components in the steering head. PYD developed the concept from typical America's Cup steering heads for a trim tab system. Its detailed engineering and manufacturing was by Edson International, New Bedford, Massachusetts.

74) BLUE MARLIN's wheel. (Pedrick)

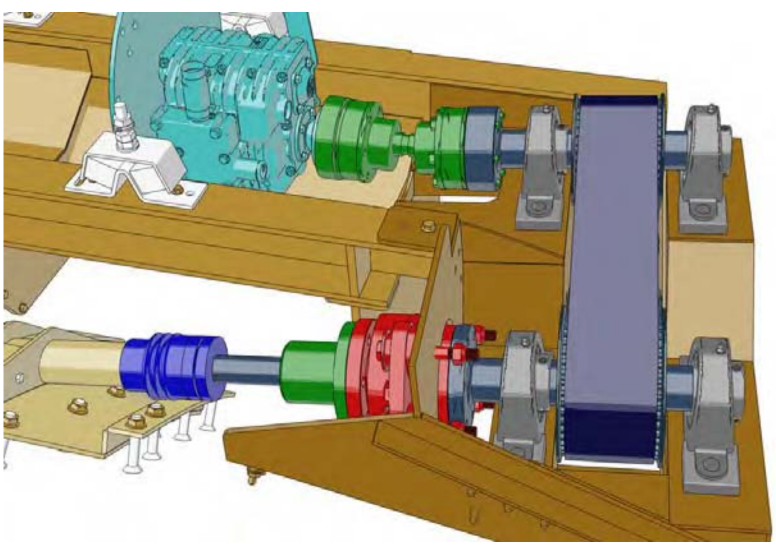


75) Propulsion system arrangement with exposed shaft and relatively large exhaust system components. The water-lift silencer is inside the engine compartment. The water-drop separator is outboard of the cockpit. A bronze shaft log foundation spans several planks and frames. The bolt pattern was designed to original plank positions long before the hull was re-planked. (Pedrick Yacht Designs)

The propeller is mounted on a skewed, exposed shaft that's supported by a single-arm bracket. This installation qualifies for the Class Rule's propeller credit, which requires that the angle of the shaft from the hull be at least 20 degrees. The most suitable shaft and propeller alignment was determined before checking this angle, and was found to be just slightly greater than required for the credit. An offset belt-drive system was developed and engineered by PYD to connect the skewed shaft to a soft-mounted engine located on centerline under the cockpit. This compact arrangement avoids any intrusion into the accommodations – difficult to do on a Twelve. The entire system is mounted on bronze foundations within the engine compartment.

BLUE MARLIN's propulsion system has been sized generously. A Yanmar 4JH4-THE diesel, rated 80 kw (110 hp) maximum, was chosen over lower-powered versions of this engine for its advantage in carrying a relatively large-diameter propeller. The 600 mm (24") diameter propeller will deliver increased thrust at low RPM's when maneuvering or when operating in adverse wind and sea conditions. It will also reduce noise by operating at lower engine RPM's in cruising mode.

Several other measures to mitigate engine noise were specified by Soundown, located in Salem, Massachusetts. The engine compartment is constructed of QuietCore plywood panels lined with fire-retardant, sound abatement insulation and perforated aluminum. Soundown also specified the exhaust system. Wet exhaust goes to a low water-lift silencer and then rises to a high-mounted water-drop separator, from which exhaust water drains overboard. A dry, 4" exhaust hose runs aft to an outlet about half-way out the counter. The engine compartment is protected by a Fireboy extinguishing system that includes automatically actuated closures in the compartment's air intakes and outlets.



76) Custom drive train that provides lateral offset and a change in shaft angle. Components from the transmission are an Aquadrive constant velocity (CV) joint, an offset drive with Gates belt and Klee cogs, an Aquadrive vibration-dampened thrust bearing and a Packless Sealing Systems bellows shaft seal. (Pedrick Yacht Designs)

A 5 kW Panda generator in the engine compartment serves an integrated electrical system. Power management devices for the AC and DC system, are in the salon's port, aft locker, with the breaker panel on its door. DC power is supplied by a pair of 24-volt lithium ion batteries, charged through the power management system. AC power is by invertors, the generator or shore power. The generator starts seamlessly when the batteries need charging or when high-amperage AC power is needed, such as for BLUE MARLIN's electric cooking. The integrated power management system and lithium-ion batteries are by Mastervolt, Cabin heating is supplied by a diesel-fired Webasto hot air heater. A duct on the starboard side has outlets for the foul weather gear locker, salon, head and Owner's cabin.

The fresh water system is conventional, with pressurized hot and cold water to the galley and head. The AC hot water heater is just forward of the head, minimizing the length of supply lines. Two fresh water tanks totaling 400 l (105 gals) are under the midships settees. The head flushes with sea water by an electric macerator pump. To comply with strict no-discharge laws in the Gulf of Finland and the Baltic Sea, a 360 l (95 gal) black water tank has been provided under the sole. Diesel fuel is stored in a pair of tanks in the after salon settees plus a day tank outboard of the engine, high on the starboard side. Fuel capacity totals 330 l (87 gals). All tanks were custom made by Tek Tanks in the U.K. with CE certification.

There is no propane system aboard. All cooking is electric. Both the head and a stove hood in the galley have forced-draft air exhausts. They are led to under-deck, water-trap vent boxes with extendable mushroom vents just aft the foredeck hatch.

Fitting all of these systems into the limited interior space of a Twelve Metre has been difficult to design and build. The pleasing result, though, is the most thoroughly equipped and best finished cruiser-racer in the world's Twelve Metre fleet.

**SPARS AND RIGGING**

New wooden spars for BLUE MARLIN have been constructed by Red Sky Craft using select, aircraft-grade Sitka spruce. Timber with high ratios of stiffness and strength to weight was sourced through Touchwood in the Netherlands – John Lammerts van Bueren's company whose company's web site address is sitkaspruce.nl. German naval architect Juliane Hempel engineered the mast section to the Class Rule's maximum dimensions and minimum weight while achieving desired stiffness properties.

The section is made of rectangular staves that produce radial grain orientation around the mast's entire circumference. Stave dimensions vary according to the sizes needed for the front, back, sides and shoulders of the mast section. Juliane worked closely with John to plan the exact cutting of the spruce logs for the most efficient stave sizes and grain direction.

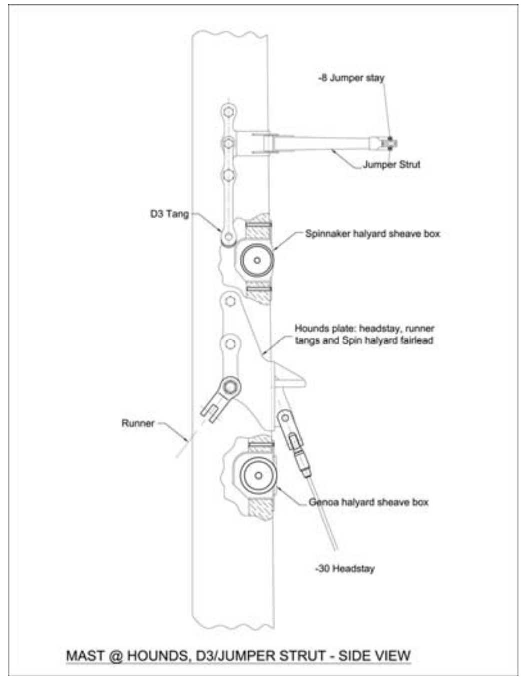
RSC built a 28 m (91-ft) table in the loft of the Wooden Boat Center to shape and assemble the mast. Lengths of spruce were scarphed into full-length staves before tapering them top and bottom. A total of ten rectangular, tapered staves were glued into hollow, port and starboard halves of the mast section. The outside and inside contours of the tapered mast were then shaped carefully with hand-tools. Thicker areas for sheave boxes, tangs and tracks were determined by Pedrick Yacht Designs and sculpted to the inside surface of the sections by RSC.

77) Spar bench on left, in loft at Wooden Boat Center. Tapered staves are at right. November 2011. (Pedrick)

The mast's shroud configuration is typical of Twelves from the mid-1930's to today. By Class Rule, the sail plan is a true, three-quarter rig, with the headstay and running backstays attached at a location called the "hounds." Two sets of spreaders carry the shrouds to a little above the hounds. Jumper stays stiffen the mast both laterally and fore-and-aft from a little below the hounds to just below the masthead. A topmast backstay controls bend in the upper part of the mast, and a pair of checkstays is used to control bend in its mid-length.

The mast that came with BLUE MARLIN had galvanized steel fittings that appeared to be original. The spar itself had broken during the early years, and was replaced again in BLUE MARLIN's later life. The fittings appeared to have been moved from one spar to the next. They were crude and heavy, and halyards were external. The new mast has traditional dogbone-style tangs and other fittings that are more typical of racing yachts of the 1930's, and halyards are run inside the hollow mast. For best strength to weight above boom-level, fittings are made of stainless steel. The fittings were bead-blasted after fabrication to give the appearance of BLUE MARLIN's original galvanized steel fittings.


78) Masthead fitting with sheave and pin for a two-part main halyard; also, backstay crane, VHF antenna, LED masthead light and base for wind instruments. Gantline block is a stock, practical concession, difficult to be seen from the deck or dock. (Skogström)




79) Side view of mast at hounds. Carrying the headstay and running backstays, it is the most highly loaded part of the mast. (Pedrick Yacht Designs)

PYD designed and engineered all of the fittings for BLUE MARLIN's rig, applying its extensive experience in racing rigs on America's Cup Twelves, as well as wooden masts on smaller yachts. Metal fittings are reasonably straightforward to analyze and design. However, transferring large rigging loads by means of bolted connections in a spruce mast requires specialized engineering and detailing.

Every fastener's load, from vertical bearing of tang bolts to horizontal tear-out of machine screws for tracks, was quantified to determine the necessary local reinforcement of the mast wall. All bolt holes were reinforced with G-10 fiberglass bushings in a thickened mast wall to give more load transfer area into the wall, as well as to protect the grain of the wood from water damage. Bronze and G-10 fiberglass tapping plates were inserted as internal splines in the mast wall when joining the two halves of the mast together.

The hounds fitting combines multiple, substantial loads. It carries the headstay, running backstays and fairleads for the two spinnaker halyards. It requires tang bolts through the sides of the mast, additional screw fasteners around the forward half of the mast, and a tailored shape of the wrapper plate for best load transfer into the mast wall. A separate jib halyard sheave box is close below the hounds. A double spinnaker halyard sheave box is a little above it. Three internal halyards for the main and two spinnakers need to have fair leads through this crowded area inside the mast. 3D design was a useful tool for resolving matters of functional design, reliable engineering and aesthetic design.

All halyards and the spinnaker pole topping lift have high exits on the mast to facilitate jumping them when hoisting. They lead through Ording blocks at the partners to fewer winches than there are halyards, for which some sharing has been provided. The lower part of the mast from a little above the partners is solid – a requirement of the Class Rule and a conservative practice. Drains allow water squeezed out of halyards to exit to the deck, keeping the inside of the yacht dry at the mast. A fiberglass wiring conduit was run through the solid part of the mast to a connecting bus below the partners.

The mast step incorporates both a fore-and-aft adjustable, bolted heel plate and an internal, hydraulic mast jack. The arrangement also provides for bolting the mast to the step to prevent it from jumping out of the step in the event of a dismasting. The fore-and-aft positioning of the heel plate allows tuning the rake and pre-bend of the mast, since there is no adjustability at the mast partners. The jack permits pre-tensioning and easy tuning of the standing rigging. Except when being tuned, the mast butt sits securely on shim plates stacked on the fixed heel plate, and hydraulic pressuring the jack is released.

80) Mast heel plate assembly. Top plate is attached to the mast heel. Internal hydraulic jack raises the plate so that spacer shim can be placed under it. Vertical bolts secure the top plat and shims to the fixed step plate. Tie rod from deck secured to the tang on the step plate. (Skogström)

To adjust the shrouds after sailing, the jack raises just enough to remove the shim plates and set the mast at a lower position. The slackened shrouds can be adjusted and the process reversed to pre-tension the shrouds for the next sail. Similarly, when the yacht is not going to be sailed for awhile, a shim plate can be removed to reduce the rig loads on the hull.

The Sitka spruce boom has a rectangular box section that tapers at both ends. All boom fittings, including the gooseneck foundation on the mast, are made of nickel aluminum bronze. The boom is fully fitted out with sail controls, all of which are led to tackle systems and/or

81) Outboard end sheave box. End cover gives access for reeving internal running rigging. Engraving on cover will include the original builder's name (Camper & Nicholsons) and the build year (1937). (Skogström)

82) Boom gooseneck fitting, showing superb workmanship. Main piece shown attaches to boom. Strap for mast and gooseneck toggle are at left. (Skogström)

winches. The outer end of the boom has sheaves for the outhaul, topping lift, a flattening reef and the first of the two regular reefs. The second reef, anticipated only for deliveries and cruising, is led outside the boom. Boom-mounted winches for the outhaul and topping lift are near the forward end. The two internal reef lines from the outboard end lead through concealed rope clutches and sheaves at the inboard end. Their tails lead to the deck and an available winch by the mast.

All of the hardware for the mast and boom was dry-fitted before the halves of their spars were joined permanently. All holes were drilled and bushings installed. The inside surfaces of the spars were cleaned and thoroughly sealed before being glued together.

BLUE MARLIN will use a traditional tackle boom vang hung from a strop around the boom. A single block on the boom connects to another single with a becket and snap shackle at the deck. The vang attaches to either of two heavily reinforced padeyes on each side of the deck, whose locations assure a fair lead to the centerline utility winch aft of the mast.

The spinnaker pole has a track on the mast for conventional dip-pole jibing. The spinnaker halyard is usually on the starboard forward winch, and the topping lift is usually on the forward winch on the port side. To facilitate sharing the jib halyard winch – starboard aft – the foreguy's lead block has a cam stopper and fairlead to transfer it to the utility winch to free up the jib halyard winch. The main halyard is dedicated to the port aft winch.

Standing rigging is contemporary round rod except that the running backstays and topmast backstay are Kevlar, and the checkstays are Dyneema. Ocean Yacht Systems in the U.K. provided the standing rigging to PYD's specifications.

Running rigging was selected by BLUE MARLIN's captain and manager, Chris Winter. Most of the sheets, guys and halyards are in medium to high tech cordage by Maffioli and shackles by Tylaska. Cordage has a traditional beige/hemp colored cover with colored fleck tracers to help the crew distinguish different lines. A local company, Regatta Service, spliced and finished the running rigging.

As of the time when this paper is being written – March 2014 – Allan, Chris and the Red Sky Craft crew are working on the final touches of BLUE MARLIN's spars, rigging and associated deck fit-out for launching in just a few more months.

**SAILING PROGRAM**

Mr. Andersin has planned a summer of getting to know BLUE MARLIN in her natural element. When she moves from the building hall of the Wooden Boat Center to the waters of the Gulf of Finland in June 2014, she will look like she was under Sir T.O.M. Sopwith's ownership in 1938, although fitted with more winches and all-bronze deck hardware. Her Endeavour Blue topsides, varnished deck furniture, wood spars and original sail plan will breathe living color into her historic Beken of Cowes photos.

Mr. Andersin will enjoy sailing with family and friends. His captain, Chris Winter, has worked with him in his various yachts over the years. BLUE MARLIN's crew will consist mainly of friends from the Finnish Six and Eight Metre fleets, including some of the Six Metre World Championship crews.

He chose to restore and adapt BLUE MARLIN into a cruiser/racer because his primary use will be for cruising in local waters and occasionally elsewhere. It may include participating gently in several local fleet racing events. BLUE MARLIN will be home-ported in Helsinki with very beautiful cruising in the adjacent Finnish Archipelago. Nearby countries such as Sweden and Estonia are also an easy sail away. Unfortunately, there is limited opportunity for racing a classic yacht of her size in Finnish events, where she will be in a class of her own for now, and the distances to current Twelve Metre regatta venues are considerable.

In 2015, nearly nine years after purchasing a decayed BLUE MARLIN in Slovenia, Mr. Andersin will start taking his magnificently restored yacht to Copenhagen and Flensburg to join the Baltic Twelve Metre racing fleet. He plans to make an annual trip thereafter to an active Twelve Metre racing venue.

The closest ones are Copenhagen, Kiel and Flensburg – the hub of classic Twelve Metre racing in Europe but more than 500 nautical miles away from Helsinki. There is occasional Twelve Metre racing in Cowes on the UK's Solent, although Cowes is about another 500 miles farther than Copenhagen. Mr. Andersin also anticipates taking BLUE MARLIN to the Mediterranean at a later time to participate in classic yacht racing and cruising there.

Wherever she sails, the restored BLUE MARLIN's beauty and grace will stand out as an outstanding example of classic yachting's golden age of the late 1930's.

83) A scene to look forward to. Near-sister TRIVIA sailing in Flensburg Fjord in 2011.

BLUE MARLIN will look much like this, although with Endeavour Blue topsides. (Pedrick)

## SUMMARY

Simply stated, BLUE MARLIN's restoration has been an extraordinary project with an excellent outcome. A terminally decayed, 70-year-old yacht that arrived at Red Sky Craft in late 2006 is emerging in 2014 more seaworthy than when newly launched in 1937 by one of the world's finest yacht builders of her day,

The BLUE MARLIN project has emphasized authenticity, while making some adaptations to improve her strength, longevity, practicality and ease of handling. As she evolved from disrepair to better than new, her original materials were kept as long as possible until their turn for replacement came up. Where a change in a type of material has been made – notably bronze for galvanized steel – it was done to improve durability while adhering to the fundamental form of Camper & Nicholsons' original construction.

BLUE MARLIN's hull shape has been restored precisely to Charles Nicholson's original lines. Camper & Nicholsons' original construction features and fundamental processes have been followed while restoring her structure within her own skin. Her new, open interior is constructed with joinery panels that were crafted in the shops of Camper & Nicholsons. New winches have been researched and designed according to period prototypes, including examples by former owner Sir T.O.M. Sopwith. Her sail plan is faithful to Nicholson's design, and fittings on her wooden mast have been treated to resemble the original galvanized steel finish.

Adaptive re-use as a classic cruiser/racer has been executed inconspicuously. Bulky additions have been hidden away, such as her propulsion system, generator and liferafts aft of the accommodations; and larger tanks, batteries and other ship's systems behind her interior joinery. Only her increased winch package is a visible concession to modernization. However, its execution is sensitive to 1930's British racing yacht style. With upgraded engineering and equipment that conform to today's ISO requirements, BLUE MARLIN is ready to meet the 21st century with increased durability and safety.

Mr. Andersin assembled a broad and talented team for BLUE MARLIN's restoration. From builder and naval architect to consultants and suppliers, experts in many different fields have brought their knowledge, passion, care and commitment to the project. This would become a landmark restoration, taking participants to higher levels of skill and effort than in their prior experience.

It's fair to admit that neither the project team nor the owner really understood at the beginning what the ambitious goals for BLUE MARLIN's restoration would ultimately require. A few examples that became unexpectedly large projects in themselves were: documenting her hull form and framing; sourcing highest-grade timber and bronze; dry-fitting and adjusting virtually every piece of framing, foundations, equipment and joinery; developing her propulsion and exhaust systems; finding space for her cruising systems; and outfitting her deck.

Nevertheless, the increased magnitude of the tasks never deterred the owner, the professional team and their staffs from always seeking and achieving the best possible result for BLUE MARLIN. It has been a fascinating project that has been on public display for six years at the Finnish Wooden Boat Center. BLUE MARLIN will continue to be publicized through stories such as told here, and by her elegant presence in harbors and regattas as she begins her second, long lifetime.

Fulfilling the reason why this project was undertaken, its outcome is, indeed, worthwhile.

## WEB LINKS, VIDEOS AND REFERENCES

Highlights are mentioned.

**Blue Marlin – Yacht Site**
bluemarlin.fi

Under "History and Re-build:" Historic videos of original construction, historic and recent photographs. Videos during project: project planning (2008), removing interior (2008), sourcing timber (2008), work in progress (2011) and caulking (2013)

**Finnish Wooden Boat Center**
suomenpuuvenekeskus.fi (English may be chosen)

Under "Blue Marlin" menu tab: History, Video Gallery and Image Gallery. 12 videos altogether. In addition to videos also on the "Blue Marlin" site, 3 particularly interesting ones are: "The Story of the 12mR Blue Marlin," with interviews of several Rhode Island Twelve Metre leaders, yacht broker Peter Koenig and others when the yacht was recently acquired (2007); "Proud New Owner of a Twelve Metre," in which Henrik Andersin expresses his goal of restoring "Blue Marlin" in the most original and proper way that can be done (2007); and "Bronze Frames," in which David Pedrick describes the why and how of the new frames (2010).

**Photo Studio Candy Store**
candystore.fi (English may be chosen)

Leo Skogström's photographic services studio. Rhode Islanders might suspect that Leo enjoyed himself in Newport in the past; he did. The "Gallery>Boats" page has a selection of "Blue Marlin" photographs.

**12mR Yacht Trivia**
12mr.de

Site for “Blue Marlin’s” sistership “Trivia” by Trivia GmbH. The “Yachts” tab has a table of nearly 170 documented Twelves, listed chronologically by country, compiled from “The Twelve Metre Register” plus further updates; also, the “Trivia” tab describes her history.

**Red Sky Craft**
redsky.fi

Allan Savolainen’s company for repairing classic boats, designing new wooden boats and boat building. Located in Kotka, Finland.

**Pedrick Yacht Designs**
pedrickyacht.com

David Pedrick’s firm for custom sailing yacht design projects that range from cruising to high-tech racing, and from new-builds to restorations. Located in Newport, Rhode Island, USA.

**IYRS School of Technology and Trades**
iyrs.org

Originally the International Yacht Restoration School, which has helped shape David’s insight and skills about yacht restoration. IYRS runs programs in Boatbuilding and Restoration in Newport; and Marine Trades and Composites Technology in Bristol, Rhode Island.

**The Herreshoff Marine Museum**
Herreshoff.org

The Herreshoff Marine Museum is the organizer of the Classic Yacht Symposium for which this paper has been written. The Museum presents the history and innovative work of the Herreshoff Manufacturing Company, hosts classic yacht regattas, operates a sailing school and offers educational programs. It also hosts The America's Cup Hall of Fame, which honors individuals who have made outstanding contributions to the world’s most distinguished yachting competition.

**Reference Books**

Although there are many superb books about Twelve Metre Class yachts through their various eras, only the most definitive set of publications is described here.

“The 12 Metre Class: The History of the International 12 Metre Class from the First International Rule to the America's Cup,” by Luigi Lang and Dyer Jones (2001)

An updated, two-volume set was published in 2010, now extended to more recent racing in the Class. The 2001 “History” volume was updated. A new, second volume is a register having a page of historical data for each yacht. These volumes were written with the collaboration of Jan Slee. All three authors are, or have been, officers of the International Twelve Metre class Association (ITMA). The set is a limited edition publication, available through LT Yachting Editions – a partnership of noted classic yacht historians Luigi Lang and Jacques Taglang. LTyachting.com

“The Twelve Metre Class,” by Dyer Jones and Luigi Lang, with Jan Slee (2010)

“The Twelve Metre Register,” by Dyer Jones and Luigi Lang, with Jan Slee (2010)

**ACKNOWEDGEMENTS**

The authors would like to acknowledge several colleagues in the BLUE MARLIN project whose contributions were essential to the restoration’s thoroughness and success. Leo Skogström has quietly orchestrated the planning, programs and displays of the Finnish Wooden Boat Center, with BLUE MARLIN as its centerpiece for the past six years. He has documented the project through his research, photography and video interviews. David thanks him for being a very kind and thoughtful host during his visits to Kotka, as well. The authors thank him in particular for the many photographs that he provided for this paper.

Our three other professional partners on the project team brought a significant range of knowledge, skills and experience. They strengthened the team and added to the integrity and quality of the result. In order of engagement, Kamu Stråhlmann made early progress in documenting BLUE MARLIN’s original construction and deformed shape, and supplied lofted 3D forms of the first timbers for reconstructing the hull.

William Collier’s passion for classic yachts and specific knowledge of Camper & Nicholsons added significant historical authenticity to all features of the deck. His influence in the design of the winches and hatches was especially valuable, and he provided insight about other design details and Nicholsons’ way of working, as well. William also provided the paper’s 1934-38 photographs by Beken of Cowes.

Chris Winter, who will be responsible for running BLUE MARLIN as her captain, brought his sailing and yacht management skills to the final planning and installing of deck hardware and systems. He has been hands-on with Red Sky Craft since 2011, working out the final, intricate details to assure BLUE MARLIN’s efficient operation above and below deck.

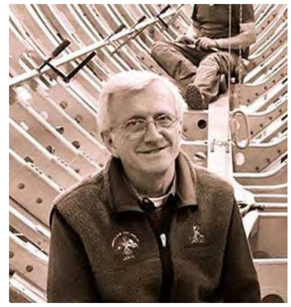
Two members of the Pedrick Yacht Designs team played a particularly large role in the firm's restoration design work for BLUE MARLIN over the course of several years. Adam Cove, now at Edson International, designed the entire structure of the yacht in 3D and nested all of the bronze parts onto plates. He also set up the ISO standards certification process for the project, developed the family of winch drums to fit onto Harken's winch internals, and designed much of the other classic-styled deck hardware. Steve Baker's attention was primarily inside the hull. A master in Rhino 3D, he configured BLUE MARLIN's original joinery pieces to suit the newly arranged interior while fitting the machinery arrangement, tanks and other bulky systems components into the yacht's limited space. He also created the compact belt-drive propulsion system.

John Lammerts van Bueren was much more than a timber merchant for the project. He takes a deep interest in the details of classic yacht restorations and offered the wisdom of his experience to Allan in many ways beyond sourcing the different species of timber for BLUE MARLIN.

While many suppliers have been involved in this substantial project, there are two whose contributions stand out. Especially with the importance of period-styled deck hardware for BLUE MARLIN's restoration, Harken's custom division and Blockmakers Ording took a special interest in meeting the project's aesthetic and engineering requirements. Their detailing and manufacturing of virtually all of the sail handling hardware has been outstanding.

The authors – as the principal designer and builder, respectively, for the BLUE MARLIN project – are especially grateful to owners Henrik and Martina Andersin. The Andersins made a brave decision to embark on this restoration in 2006 and have given years of vision, support and patience to it. Their goal was to achieve a distinctively original and proper restoration. Speaking for all who have been privileged to help them do that, we wish the Andersins many years of pleasure, pride and increased sailing friendships aboard BLUE MARLIN.

**ABOUT THE AUTHORS:**



**David Pedrick** is a naval architect and marine engineer, educated at Webb Institute. His yacht design career began in 1970 at Sparkman & Stephens, working closely with Olin Stephens on the firm's leading-edge racing yachts. In 1977 he opened Pedrick Yacht Designs in Newport, Rhode Island. Notable projects have included America's Cup winners, record-setting Maxi ocean racers, luxurious neo-classics, and sail training craft for the U.S. Naval and Coast Guard Academies. David is now working on a new neo-classic yawl and his 24th Twelve Metre project while completing restoration services for BLUE MARLIN. He is a founding trustee and former Chairman of the International Yacht Restoration School (IYRS), and is a Fellow in the Society of Naval Architects and Marine Engineers (SNAME), the co-presenter of this Classic Yacht Symposium.


**Allan Savolainen's** craftsmanship was honed at a four-year wooden boatbuilding school in eastern Finland. In 1998, he co-founded the Wooden Boat Center of Kotka as a marine trades co-op. He proceeded to restore several yachts, construct a cruising sailboat and build a tradition-inspired powerboat of his own design. Among his seven Six Metre restorations is the 1938 Sparkman & Stephens DJINN for BLUE MARLIN's owner. In 2004 he established Red Sky Craft, which provides yacht restoration, new construction, wooden spars and general yacht services. Allan has been the master shipwright and director of the BLUE MARLIN project since 2007, expanding into the new Finnish Wooden Boat Center in 2008.

# Arion: An Experiment for the Ages

**By Steve Frary & Adam Langerman**
**with recollections by Halsey C. Herreshoff**

**Figure 1 –** ARION on sea-trials, 1951.


**Figure 2 –** ARION at Marblehead Classics, 2013

## Abstract

On May 15th, 1951, ARION's graceful slide into the waters next to the Anchorage Plastics Corporation, of Warren, RI, would prove to be the shot heard round the world for the American boatbuilding industry. As the first large yacht built of fiberglass, she signifies a milestone in the revolutionary transition from wood to glass-reinforced-plastic boatbuilding- the material that continues to dominate the industry. Rather than apply this new material to a traditional design, ARION's designer, Sidney Herreshoff, drew a highly innovative ketch. ARION is a long-waterline, low-displacement, fin-keeled, double-ender that continues to be relevant today. As the culmination between one of America's foremost designers and cutting-edge boat builders, ARION was ahead of her time in many ways. Though nearly lost to time in a Massachusetts field, ARION has returned to former glory through a multi-phase restoration befitting of such an important piece of American yachting history. This paper documents the design, construction, and use of ARION through her first complete restoration, which is now culminating in 2014.

## About the Author *For complete bios see the paper on the Proceedings DVD*

**Steve Frary** grew up in Barrington, RI, and after a successful business career, returned to RI to raise his children here. His earliest memories of sailing were on his family's Pearson Ensign which served as a race boat, a day sailor, and even occasional overnight cruising. His first memories of Herreshoffs were seeing the S boat fleet racing in the upper Bay when he was 6 years old, and driving by Burnside Street wondering what those sleek wooden boats with rectangular windows in the deckhouse were. Having owned and restored a Hinckley Sou'wester 34, Steve has learned many of the hard lessons of classic yacht restoration. The approach to ARION's restoration has been to respect the significance of the yacht as not only revolutionary, but also as a classic boat.

The Classic Yacht Symposium™ 2014

# ARION: An Experiment for the Ages

By **Steve Frary**, Owner
**Adam Langerman**, Herreshoff Designs, Inc.
with Recollections by **Halsey C. Herreshoff**

1.) ARION, on launch day (© courtesy The Anchorage, Inc. – Dyer Boats)

**ABSTRACT**

On May 15th, 1951, ARION's graceful slide into the waters next to the Anchorage Plastics Corporation, of Warren, RI, would prove to be the shot heard round the world for the American boatbuilding industry. As the first large yacht built of fiberglass, she signifies a milestone in the revolutionary transition from wood to glass-reinforced-plastic boatbuilding, the material that continues to dominate the industry. Rather than apply this new material to a traditional design, ARION's designer, Sidney Herreshoff, drew a highly innovative ketch. ARION is a long-waterline, low-displacement, fin-keeled, double-ender that continues to be relevant today. The result of close collaboration between one of America's foremost designers and cutting-edge boat builders, ARION was ahead of her time in many ways. Though nearly lost to time in a Massachusetts field, ARION has returned to former glory through a multi-phase restoration befitting of such an important piece of American yachting history. This paper documents the design, construction, and use of ARION through her first complete restoration, which is now culminating in 2014.

**OWNER INSPIRATION**

Steve Frary grew up in Barrington, RI, and after a successful business career, returned to RI to raise his children. His earliest memories of sailing were on his family's Pearson Ensign, which served as a race boat, day sailer, and even occasional overnight cruiser. His first memories of Herreshoffs were seeing the S boat fleet racing in the upper bay in the 1960's. Little did he know he would become involved with Herreshoffs later in life. Having owned and restored a Hinckley Sou'wester 34, Steve learned many of the hard lessons of classic yacht restoration. Given this experience with wooden boat ownership, Steve shifted his focus to 'classic glass' starting with an Edey and Duff Stuart Knockabout and their version of the Herreshoff 12 1/2 - a Doughdish as well as a Wasque 32 downeast style powerboat. Having derived great satisfaction with the classic appeal of these small yachts, he came across ARION listed on Yachtworld. The boat caught his attention because of its modest displacement, tiller helm, long waterline and split rig, with modest cruising accommodation. And she was an original Herreshoff design made out of fiberglass! Steve was looking for a classic boat that would be a great day sailer, club racer, and occasional weekender.

After seriously considering several reproduction Buzzards Bay 25's for their enduring beauty and sailing qualities, Steve decided ARION could provide better accommodations, a longer waterline, and possibly an easier singlehanded experience given the split rig.. He was also interested in her historical significance.

The approach to the restoration has been to return ARION to her original condition or better, include essential features of a short-handed day-sailer and occasional race boat, and to respect her legacy as a classic boat. Since she was built in 1951, her peers were boats such as Concordia, Sparkman Stephens, and many of the great classic boats.

It was appealing that ARION was a Sidney Herreshoff design, built by one of the great Rhode Island boat manufacturers at the time and an innovator with plastic resin boatbuilding, Dyer Boats. Taylor & Snediker was selected to perform the restoration given their knowledge of Herreshoffs, high standards, and workmanship. The project has included refurbishment of the glass hull, adjustments to the rig to both return it to original specifications where possible, and to ensure singlehanded capabilities, as well as interior finish work and systems that were substantially incomplete when the boat was acquired in 2012. The result is an extraordinary day sailer, with exceptional performance characteristics for a 10,500 pound boat, routinely exceeding 8 knots in a breeze, while still being easily managed in 20 knots or more. As importantly, she has received more than her share of accolades around southern New England, as she holds her own with many larger classics, or modern boats, often with Steve and his young family on board. She is universally praised for her beauty, sailing characteristics, and classic appeal. With her active sailing schedule, she is again becoming recognized as the revolutionary yacht that she is.

**FIBERGLASS AS A BOATBUILDING MATERIAL**

ARION is the first auxiliary sailing yacht built using fiberglass. For clarification, ARION is not the first water-craft built using fiberglass. Nearly a decade before ARION, Ray Greene of Toledo, Ohio, built the first fiberglass boat, a sailing dinghy, using an experimental batch of polyester resin from the American Cyanamid Company and Owen-Corning 'Fiberglas' reinforcements.

The development of fiberglass as a boatbuilding material can be traced down two separate paths of innovation. Its successful use required the development of the glass-fiber reinforcements, and separately, a plastic to suspend those reinforcements.

Glass is a material that can be traced back as far as the ancient Phoenicians and Egyptians. The usefulness of glass fibers in the modern age began with furnace filters and insulation products during the early 1930s. The conception of glass fibers used in a textile application followed, and in 1936 'Fiberglas' was first used as a trademark. Owens-Corning Fiberglas would continue to improve their fiber reinforcements through heat treating and refined manufacturing. The development of the polyester resin that became a standard in modern boatbuilding did not follow until 1942.

Plastics development can traced to the early 1800s, when natural rubber first began being molded. Following World War I, improvements in chemical technology created a boom in plastics technology. Several experiments with different plastic resins in the molding of boats were made in the 1930s. Ethylcellulose laquer and melamine resin were just a few of the plastics used for one-off or short run plastic boats. The polyester resin that eventually transformed the boatbuilding industry came from the American Cyanamid Company. The story of how American Cyanamid developed their thermo-set polyester resin is not the normal story of product development through research or accidental discovery. The story of their resin begins in war-time Germany, where airplane builders were using an early polyester to bond wooden subassemblies. British intelligence obtained the secrets of the improved resin and passed it back to the Americans. 'Doc' Griffith initially took on the polyester resin for American Cyanamid. Griffith had previously perfected melamine resin, which Ray Greene had attempted to use for composite construction in 1941. Presumably there was a connection between Greene and Griffith that allowed Greene to obtain a lab batch of polyester resin to build the first polyester-resin fiberglass dinghy.

There were still major hurdles to overcome before fiberglass construction could become main-stream. Improvements continued to be made in the manufacturing of the glass-fiber reinforcements and the chemical composition of polyester resin that would allow faster curing times, room temperature curing, and curing in the presence of air. However, by the late 1940s, these challenges were largely overcome, and boat builders all over the country quickly began experimenting with small craft production.

Fortunately for ARION, two of these pioneers were Rhode Island companies. The Herreshoff Manufacturing Company built an experimental fiberglass dinghy designed by Sidney Herreshoff in 1945 (Figure 2). This was one of several early experiences of design and construction with fiberglass. During the same period, Bill Dyer, in an effort to be at the cutting edge of the fiberglass boatbuilding boom, was canvassing the country for information about fiberglass construction methods and materials. His company, the Anchorage, began producing fiberglass dinghies in 1949.

2.) Halsey Herreshoff rowing an early plastic dinghy built at the Herreshoff Manufacturing Company in 1945 (courtesy, Herreshoff Marine Museum).

**RHODE ISLAND INNOVATION**

When launched, ARION was a pioneering craft and a fitting example of Rhode Island innovation. Rhode Island may be the smallest state in the nation, but many innovations and firsts have come from within its borders. The State of Rhode Island and Providence Plantations (RI's official name) was the first colony to declare independence from British Rule. The birth of the industrial revolution can be traced to Samuel Slater's 1793 Blackstone River textile mill in Pawtucket, RI. Pelham Street in Newport was the first in America to be illuminated by gaslight in 1806. In the ship and yacht construction sector, Herreshoff and Dyer are both highly regarded as innovators.

The Herreshoff family is known for more innovations in the boatbuilding industry that any other. They have touched almost every aspect of the design and construction of ships and yachts. From the shores of Bristol Harbor came the first navy torpedo boats, powerful steam boilers and engines, the first American catamarans, countless successful racing yachts, seven America's Cup defenses, the first sail track, the first fin-keels, hollow cleats, cross-cut sails, anchors, folding propellers, and the list goes on. Notably, Herreshoff designed cleats and anchors are still manufactured today.

Bill Dyer founded the Anchorage in 1930 as a brokerage for Elco and Chris Craft, and started building his own craft in 1934. The small-craft that Dyer is most famous for, the Dyer Dhow, began production in wood during the war-time for use as lifeboats on PT boats and minesweepers (some of which were built at Herreshoff). Dyer began building fiberglass Dyer Dhows in 1949, production of which continues today. Bill Dyer's desire to adapt fiberglass construction to larger vessels was clear. About the same time Dyer Dhows first came out in fiberglass, Dyer built the largest plastic hulls yet attempted: three 36 ft navy landing craft. Soon after, Dyer convinced Commodore Verner Reed, of the Ida Lewis Yacht Club, to commission a large fiberglass sailing yacht. With Sidney Herreshoff signed on as designer, the story of ARION had begun.

**DESIGNING ARION**

The innovative nature of ARION goes beyond the material used to form her hull. While most early fiberglass boats were formed from molds taken directly from traditional wooden craft, Sidney Herreshoff's notion for ARION was a completely new and cutting edge design. In the press that followed ARION's launch, Commodore Reed stated his intended use was to, "day-sail out of Newport and participate in the occasional coast-wise race." True to her Herreshoff lineage, Sidney carved a half-model, and construction drawings were subsequently produced. ARION featured:

-Fin keel and balanced rudder.

-Narrow beam and canoe stern for low wetted surface.

- Long waterline for improved hull speed.

-Light displacement.

-Split rig for ease of sail handling.

3.) ARION design half-model (courtesy Halsey C. Herreshoff).

-Dimensions:
- Length overall: 42′-5/8″
- Length waterline: 37′-11″
- Beam: 8′-3/4″
- Draft: 5′-6″
- Sail Area: 562 sq-ft
- Displacement: 10,500lbs
- Ballast: 5,000lbs

The fin keel, especially, hadn't been seen on the water since the Universal Rule took over in 1903. Interestingly, ARION's rudder design closely resembles the rudders Capt. Nat had installed on his fin-keelers of the 1890s. The result is a fast and stable platform that is a joy to sail. The light displacement and split rig translates to low sheet loads that are easily managed, and the long waterline puts ARION's hull speed at over 8 knots. There are key indicators of Herreshoff tradition in ARION's hull shape, with her subtle reverse curve entry and exit at bow and stern, and a sweet understated sheer. While the trailing edge of her keel is as delicate as most modern fin-keel yachts.

ARION also features a center-cockpit arrangement. This allows for a more comfortable cockpit and the crew weight does not have a great impact on trim. The tiller connects to the rudder post some eight feet aft through a linkage designed by Sidney Herreshoff. An observer could easily mistake ARION as a yawl with the tiller ahead of the mizzen, but by way of the rudder post aft of the mizzen, ARION is a ketch.

ARION is often referred to as a big 'Rozinante,' a popular canoe-yawl design by L. Francis Herreshoff, Sidney's younger brother; however, a more accurate statement would be Rozinante is a small ARION. L. Francis did not lay down the lines for Rozinante until five years after ARION's launch. Rozinante and ARION do share similar profiles above the waterline, but L. Francis chose a traditional full keel underbody for Rozinante.

As part of the restoration project, we have re-measured the half-model in order to produce an accurate lines plan for display and perhaps a half-model for display in the future as well. ARION's original design half-model is currently displayed with Halsey C. Herreshoff's Model Room Collection currently on loan to the Herreshoff Marine Museum.

Unfortunately only two of the construction drawings produced by Sidney Herreshoff still exist, the sail plan and rudder details (which includes the tiller linkage). It would have been quite interesting to see the original scantlings specification. Bill Dyer stated in the press that the hull tapered from ¼″ at the sheer to a 1″ thickness on centerline to serve as the keel pad. Hull cores taken for instrument thru-hulls have revealed that the centerline thickness of the hull is closer to 3" of solid fiberglass. With no empirical data to guide them, it is obvious that a conservative approach to scantlings was taken. While overbuilt by modern standards, ARION's 47.5% ballast ratio is still respectable.

4.) Measuring the ARION half-model (courtesy, Halsey Fulton, Fish Hawk Films).

**BUILDING ARION**

ARION's hull was laminated in a female mold made of plaster and lathe. Wooden stations similar to frame-molds used in traditional construction were used to form the plaster mold. The difference here was that the molds formed the outside surface of the hull rather than the inside. No hull frames were necessary due to the rigidity and thickness of the fiberglass. The hull was layed up with successive layers of a square-weave fiberglass cloth over the course of about 10 days, a fraction of the time that a similar wooden hull would take to be produced. However, it was not reported how many hours went into producing the female mold.

The finished hull was removed from the mold and fitted with a plywood deck, covered with one layer of fiberglass, mahogany cabin sides, yellow pine deadwood, lead keel, a Sidney Herreshoff designed variable-pitch propeller, wooden rudder, and hollow spars. The interior featured a marine head forward. Aft of the head two settees double as bunks. Just forward of the companionway was a small galley to port, and chart table / ice box to starboard. The auxiliary propulsion was provided via a 25hp Gray Marine engine.

5.) Workers laminating ARION''s hull (© courtesy The Anchorage, Inc. – Dyer Boats).

6.) ARION's bare hull out of the mold (© courtesy The Anchorage, Inc. – Dyer Boats).

7.) ARION hull cores; upper core is hull centerline, lower core is from about the turn of the bilge.

8.) Deck and cockpit fitted at the Anchorage shops (© courtesy The Anchorage, Inc. – Dyer Boats).

## Recollections of ARION:

*By Halsey C. Herreshoff*

While a teenager and attending Moses Brown School, I had an abiding interest in the professional activities of my father A. Sidney DeW. Herreshoff. (He had always been addressed by workers at the former Herreshoff Manufacturing Company as “Mr. Sid” and was known by family and friends as just Sid). Of the five sons of Capt. Nathanael G. Herreshoff, Sid was not only the oldest (He participated in the trial trip of RELIANCE) but was also the one who devoted most of his career to design, engineering and construction supervision at the HMC. After the company closed following World War II, Sid retired but undertook an active practice of boat design. Notable was the new version of the 12-½ Footers (Bullseyes) and other designs for Cape Cod Shipbuilding Company. He also designed a fine 43 ft. sloop COMET for I.B. Merriman, Jr; TRADITION, a yawl for Robert Rulon-Miller; and a very innovative schooner GLORIANA for Alex Strong in addition to one-design small boats.

Also, there is the little known fact that in the early 1940s, the HMC undertook Fiberglas construction on a development basis and produced lifesaving rafts for the military as well as light weight prototype rowing dinghies for yachtsmen. So, when Verner Reed asked Bill Dyer of the Anchorage Company to obtain a design and construct a sailing yacht of fiberglass construction, it was logical for Mr. Dyer to turn to Sid Herreshoff for the design and engineering.

Typically, rather than just go with a fully conventional design, my Dad produced the highly innovative long narrow ketch ARION. It is not clear to me whether that choice followed from either the requests from the Anchorage or from perceived advantages of mating such an extraordinary design to the new evolving construction medium of rudimentary fiberglass. Probably, it was more Sid's interest in a simple, good sailing boat of design for desirable day sailing and limited cruising in Narragansett Bay and adjacent waters.

9.) ARION on early trials (photo by Norman Fortier).

Also, it is worth noting that to our knowledge, then and now, nowhere else in the world up to that time had any auxiliary sailing yacht been built. Bill Dyer and Sid Herreshoff were nevertheless confident and proved that confidence by the construction and activity of ARION to this day. The yacht is now owned by Steve Frary of Jamestown. The boat is in impressively great shape after considerable overhaul attention some 64 years since construction.

My recollections are clear but superficial regarding the evolution of this boat as I did not have a role in the project except as an observer and participant in two trial trips. I observed my father carving the design half model in the workshop of our house. In typical fashion, like that of his own father, Mr. Sid proceeded quickly and decisively as though he knew exactly in his mind's eye what was needed without any stultifying doubts. I helped along with my mother, Becky, in recording some of the offset figures as my father read from the model using the family Offset Reading Instrument. My Dad made the plans at home. The construction drawing was much simpler than that for a wood craft as there were no frames, few fastenings and a limited number of bulkheads, soles or other members for stiffening the shape and structure of the hull. He did, of course, specify the house, simple interior, and fittings. The rig was modest, given the limited stability of the narrow hull without excessive draft for the ballast. Masts had a fair amount of rake and were constructed conventionally of wood with special fittings, all designed by Sid.

It was quite apparent to me that my father relished the project both for the unconventionality of the design and for the adventure of embarking on a promising, but unproven, basis of construction. Bill Dyer and owner Verner Reed shared that perspective. A few times I accompanied my father on Saturday morning inspection trips during the construction of ARION at the Anchorage Company in Warren. Of course, my father was motivated to save weight wherever possible, but he tempered that with responsible judgment to provide sufficient scantlings to insure safe structure. Probably the uncertainties of the matter lead him and Mr. Dyer to thicken some areas more than he might have a few years later with the benefit of more on-the-water proof of the efficacy of Fiberglass. Other than that, my father was approving of the construction and, in my hearing, issued few instructions regarding details.

My interest and love of sailing inspired me to get my father to take me along on two trial trips out of Warren. Even with my then limited experience, I shared with the others; Bill Dyer, one of his sons, and Mr. Reed; the immediate satisfaction of lively trouble free sailing. The helm balance was fine, stability every bit what Sid expected, and the boat a pleasure to sail. My father even allowed me to take the tiller a few minutes off Prudence Island. There is a particular pleasure in handling any new design – a sense augmented if success and its satisfactions are present as in this case. My father, being a man of impeccable judgment but few words, did not in my memory ask for any major changes to the boat. He only addressed a few relatively obvious details, particularly regarding sail set and sheeting. Sailing ARION more than half a century ago was great. Lately, I have been similarly fortunate to have been able to repeat the sensations along with current proud ARION owner Steve Frary and Adam Langerman, my associate at Herreshoff Designs. Adam was particularly active in the planning for the overhaul of ARION in modern times.

**IN THE PRESS**

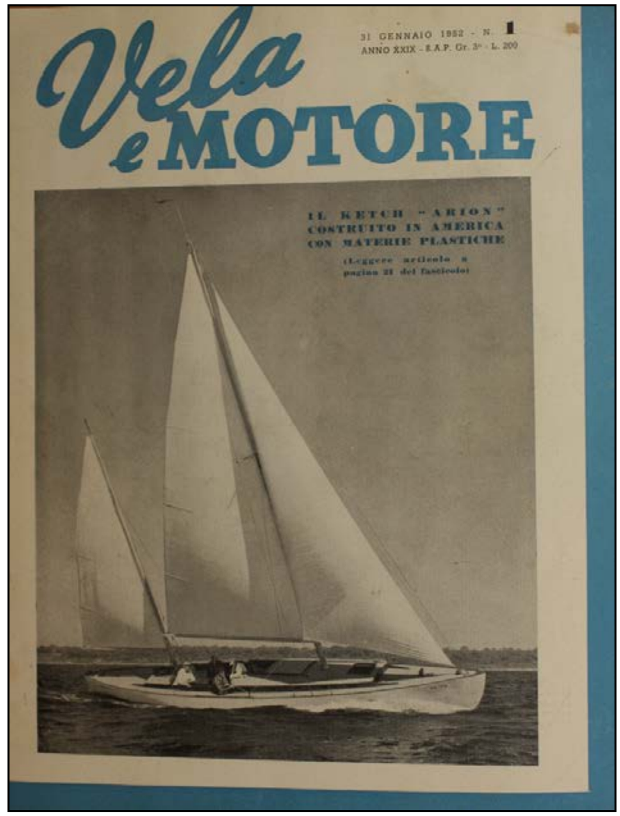
ARION garnered much attention leading up to her launch and many publications were present for the launch and early trials. The *Providence Journal* announced the launch on May 16th with an article entitled, “42-foot Experimental Craft Launched at Anchorage Firm in Warren.” The *Providence Journal* followed up with a comprehensive article after the trials on June 10th. Similarly, the *Portland Herald* printed articles on June 17th and July 1st. ARION was featured in *Motor Boating* and *Yachting* magazine during the summer of 1951. The *Boston Post* published a multi-page article titled, “First Plastic Yacht – Built in Rhode Island,” later in the season. The news of ARION was even spread to Europe, through at least one publication we know of, when ARION was featured on the cover of the Italian yachting magazine *Vela e Motore*.

In addition, ARION is featured in several advertisements for the Anchorage promoting the benefits of fiberglass construction. The DeVilbiss company also featured ARION in a full page advertisement promoting their equipment, which was used during construction.

These articles have been very helpful for use as reference during ARION’s restoration. We are fortunate that they were collected and have been preserved in the archives of the Anchorage. One example of this is the question of lifelines: none of the trial pictures show them, and there is no reference to them on drawings or in any articles. A single, albeit blurry, picture from the September 1951 *Boston Post* article gave us the necessary insight to know they were added sometime during ARION’s first season, and gave us ease of mind with our decision to add lifelines during the restoration.

**EARLY USE**

We do not know much about how Commodore Reed used ARION. Multiple reports stated the intended use as “day sailing out of Newport and an occasional coast-wise race.” Early reports indicates that ARION was entered in the Off-Soundings race out of New London, where she earned a second place finish. From there ARION’s trail goes cold until ARION was donated to the Coast Guard Academy in the spring of 1953. In a statement announcing the donation, it was revealed that “her active career ended abruptly when a back injury prevented her owner from campaigning her.” In the same article, a Coast Guard spokesmen, Captain Bowmen stated, “we’re very happy to get ARION. Her sturdiness, simplicity, and ease of maintenance are ideal for our purpose.”



10.) ARION on the cover of an Italian yachting magazine.

The Coast Guard entered ARION in that year's Newport to Annapolis race. The unfavorable light-air conditions did not suit ARION and she ended up at the back end of her class. The brand new Sparkman and Stephens yawl, BOLERO, took line honors that year. The Coast Guard continued to sail and race ARION out of their New London campus for several years, until (we believe) transfer to the Massachusetts Maritime Academy.

Details are unclear how or why ARION ended up in a field on Cape Cod, dilapidated, and full of water, but her solid fiberglass hull would prove to survive the test of time long enough to be re-discovered in the 1990s and put back into sailing service by Damian McLaughlin, who undertook the first restoration phase on the way to bring ARION back to her deserved glory.

**A MULTI-PHASE RESTORATION**

ARION was first put back into sailing trim for her 50th anniversary in 2001. To accomplish this, Damian

McLaughlin, a Cape Cod boat builder since 1970, built almost all new deck beams, a new deck, cabin sides, cabin top, new self-bailing cockpit, a new rudder, a new main mast and boom, and installed new modern deck hardware and rigging. The hull, keel, deadwood, and mizzen mast were all in serviceable condition and remained original. The hull was cleaned up and painted. Of the original internal structure only the sheer clamp, five small deck beams in the stern, two partial bulkheads and two berth frames were saved. Damian took great pride in resurrecting ARION and used her for day sailing and short cruises out of Woods Hole, MA for several seasons. The next phase of ARION's return to glory came when Steve Frary, of Jamestown, RI, purchased her from Damian in the Spring of 2012.

**Phase One - 2012**

Upon the first inspection of ARION it was obvious that there was much work left to do to return ARION to her original form. The outward appearance was remarkably good, but many details such as modern blocks and hardware, high-roach sails, and aluminum hatches would require attention. The interior was not nearly as finished as the exterior. The few systems that had been installed were not salvageable, and joinery work was incomplete and un-finished. From the outset we decided to only undertake as much work that could be done to get the boat sailing and still have some kind of sailing season that year. We knew it would be beneficial to experience ARION on the water in order to make educated decisions during the anticipated restoration. Taylor and Snediker of Pawcatuck, CT was chosen to undertake the work for their extensive classic yacht experience, attention to detail, and high level of craftsmanship. Even though they do not usually work on fiberglass boats, an exception was made for ARION because of her historical importance and pedigree.

With ARION situated at Taylor and Snediker, we got to work. Our first area of concern was the hull. The survey had not identified any moisture or major defects, but upon close inspection we found several hair-line cracks and a few large voids close to the outer skin. Digging further into these imperfections we generally found small areas of failed secondary bonding probably due to imperfect prep-work during laminating. It is no surprise that the first hull of this size wasn't perfect. Luckily the over-built nature of the scantlings prevented these imperfections from ever being a structural issue. In all, we made about 50 individual fiberglass repairs, each consisting of grinding away the affected glass and the area around it to allow tapering layers of new fiberglass to build the surface back out to fair. The hull was then faired with Awlgrip materials and top-coated with a custom Awlgrip color we deemed to be a 'classic' white. While the hull work was underway we took the opportunity to replace several underwater plastic thru-hulls with bronze thru-hulls and sea-cocks, and added sea-cocks to the cockpit drains. With confidence that the hull was good for at least another 60 years we turned our attention toward sailing features and the interior.

On deck we decided not to undertake any major work before we had a chance to sail and better understand how ARION would be used. The largest initial change on deck was to build a self-tacking jib on a roller-furler and jib-boom. Steve knew he wanted to occasionally single-hand ARION and would often be sailing with his young children, so between the tiller, running backstays, and jib-sheet there was one too many jobs while maneuvering. Eliminating the need to tend a jib sheet while maneuvering would make short-handed sailing much more enjoyable. Sidney Herreshoff, in conjunction with his son Halsey, had later developed a method to allow a jib-boom to furl with a sail attached to the clew, by letting the clew run down the spar while furling. This method has been used on many of the full-keel Herreshoff Alerion 26s and Halsey's own racing daysailer, STREAKER, with great success. While this wasn't an original feature of ARION, we strived to use period correct hardware, fittings, and materials to represent what would have been done in 1951. We knew Merriman hardware had been used from newspaper articles, so we chose a Merriman pattern for the jib-boom pedestal and had it cast in bronze. The jib-boom is a round tapered spar built using Herreshoff scantlings. Initially J.M. Reineck reproduction Herreshoff blocks were used, but these were later replaced with custom Merriman style blocks when we decided to replace all the modern blocks and fittings still remaining. We had to use modern aluminum track on the jib-boom so that the clew would run smoothly while furling. To hide its appearance, the track was custom anodized to resemble tarnished bronze. We also gave the deck a fresh coat of paint to match the newly brightened topsides. In addition to the new self-tacking jib, we had North Sails build us a new main and mizzen sail with roach and batten profiles matching what Sidney had specified in 1951, built with narrow panels to match the original suit pictured during trials. We knew there was a lot more work needed on deck, but were satisfied these improvements would get us sailing. At the same time, more extensive re-work was happening on the interior.

ARION's interior, as received, was mostly unfinished. With a big-picture plan in mind, we chose the high priority items that could be tackled quickly and have the most practical impact. The largest addition to the interior in 2012 was a marine head and holding tank. ARION was originally equipped with a head forward, separated from the salon with a curtain, and we chose to put ours in the original position. The holding tank was installed out of sight under the forward v-berth. We reconditioned a period correct Wilcox Crittenden Junior head, and installed it just as one would have been in 1951. The other major improvement to the interior that year was beginning the galley project.

The galley was the least finished part of the boat. At the time we didn't know how much, if at all, the galley would be used, or if we would choose to start from scratch later, so we decided to do as little as possible to create a functional galley and minimize the potential for work that would be discarded in the future. To accomplish this we covered the exposed drawers in the galley face with two large teak sliding doors, added a teak face to a remaining drawer, and replaced the existing laminate counter top with a varnished teak veneer. Two top-loading storage compartment tops were also replaced with teak. In the galley and throughout the interior, we replaced painted bulkhead and settee edge trim with varnished teak. These teak accents give ARION's interior the feel of a classic yacht. During this time the main focus of the work continued with the goal of getting us sailing.

With getting on the water as the priority, we made many other small, but necessary improvements. These included building companionway weather-boards, installing an electric and manual bilge pump, navigation lights, primary fuel filter, raw water filter, anchor chain pipe, anchor chocks, new wiring, circuit panel, battery switches, and batteries. For racing and cruising, we added a small touch-screen chart plotter to the cockpit bulkhead and a low profile ultrasonic wind instrument at the masthead. We also made a major repair to the original mizzen mast. A pocket of rot where a fitting had once been installed had not been visible to us until the spar was delivered with the boat. A large dutchmen was scarfed in place to ensure the original spar could continue to be utilized. With all this work completed by mid-August we were ready to squeeze all the sailing we could out of the remaining season. We were proud of what had been accomplished by the shipwrights at Taylor and Snediker in such a short time and we were ready to go sailing.

Our ultimate sailing goal had been to participate in the Herreshoff Regatta in Bristol. Following a family unveiling for Steve's young children (ARION had been a secret until then) we sailed for Bristol from Stonington, CT the day before the regatta. We arrived in Bristol at sunset just as the pre-regatta announcements were being made. The announcer happened to be Halsey Herreshoff, who recognized us immediately and let the whole crowd know we had arrived. ARION had returned to her home on Narragansett Bay. Given the conditions and wind angles, our first and only tack of the day occurred as we entered Bristol Harbor. We still had much to learn about sailing this innovative ketch.

Learn we did. Light and fluky conditions for the Herreshoff Regatta were a disappointment to say the least. We found better conditions the following weekend and managed a first at the Museum of Yachting Regatta in Newport, and finished mid-fleet in a pursuit race around Prudence Island in October. With each event came a new tutorial in how to maximize the potential of ARION. We also learned that we were probably pushing the boat harder than anyone had in a while when the masthead of the 10-year old "new" main-mast snapped off during a blustery day sail. We sent the mast to Taylor and Snediker, who quickly turned the mast repair around and kept us sailing late into the season.

The weather that fall was cooperative and allowed for some great fall / winter sailing. One particularly memorable sail was on December 4th, 2012. Sailing north from Jamestown we met up with two Herreshoff S-boats, also fresh out of restorations. It was a perfectly clear crisp fall day with a strong north-west breeze. Flat water and blast-reaching towards Bristol, ARION was alive in her ideal conditions. We were particularly satisfied to be along for the ride and sharing the bay with sister Herreshoff designs. Lucky for us, the S-boats had Cory Silken shooting their trials and was able to capture the memory of that day on film (SD card).

11.) December 4, 2014. SQUAW, PAPOOSE, and ARION reveling during a fall sail (Courtesy, Cory Silken).

ARION was in the water into January of 2013 until being placed back into the capable hands of Taylor and Snediker. Given the sailing and racing experience of the previous fall, we were much better prepared to make important restoration decisions. Most importantly, ARION had demonstrated exceptional sailing characteristics for short-handed and family day sailing, racing, and was just roomy enough for an occasional over-night. With this knowledge in hand, we began to map out the plan for the second phase of the restoration.

**Phase Two - 2013**

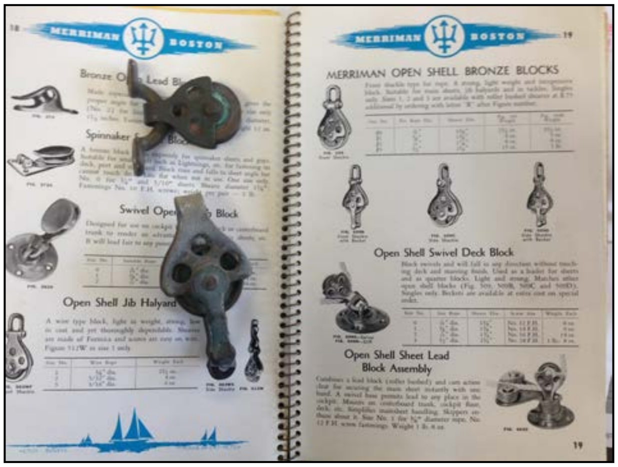
Although we had an earlier start to the winter work in 2013, with the sailing experience, the work list had also grown substantially. Once again we knew in order to enjoy another season on the water we would have to prioritize and leave some items for future work. One of the big lessons we took from sailing the previous fall was that there was a lot of room for improvement of the deck hardware and its layout. We also learned that ARION's narrow nature made getting around on deck precarious while underway in a breeze, and we discussed the practicality of adding lifelines. Increased safety and being able to allow Steve's kids to explore the deck while underway were important considerations. At that point we hadn't realized that ARION had actually been outfitted with lifelines in her first season, so there was much discussion before we decided to pursue them. An easy decision for the 2013 project was to begin to address some of the aesthetic issues. The painted main hatch was replaced with varnished teak, and the aluminum forward hatch would also be replaced with a proper teak hatch. In addition, we continued to strengthen the systems and mechanical components with a new, larger, fuel tank, bronze engine controls, and bronze engine instrument panel. We finished the electrical panel installation with a teak housing, and tightening up the fit of the tiller linkage and rudder bearings. We also installed a small two-burner stove in the existing galley, which required a complete re-work of the old propane system to bring up to code.

The single decision to proceed with lifelines and a pulpit was followed by many questions regarding stanchion material, size, placement, and style. After referencing our 1950 Merriman Brothers hardware catalog and researching what ARION's peers were sporting, we decided on a Concordia style stanchion and base. The bronze Concordia stanchions have an elegant look to them, the size seems to fit ARION's delicate nature, and the fact that they were designed to be easily removed gave us peace of mind that if we did want to go lifeline-less during a regatta we could. We used several rounds of mockups to perfect the placement, height, and pulpit design. The lifelines forward would have to dip lower for the jib-boom to clear when eased. We were able to get this just right with the mockup. Once again the craftsmen at Taylor and Snediker were up to the task of patterning, casting, and finishing more custom hardware for us.

12.) Conordia style stanchion base for ARION.

We used a similar process to make decisions about deck hardware and blocks. One of the newspaper articles from 1951 referenced Merriman Bros hardware so that catalog became our primary reference. We were also able to enlarge a few of the 1951 sea-trial photos just enough to make out what style block was used. The Merriman catalog called them "Open Shell Bronze Blocks." With short-handed sailing in mind, we decided to lead halyards, reef lines, and control lines to the cockpit. This left little need to exit the cockpit while sailing, offering peace of mind on a narrow boat. We tested our hardware layout using a complex mockup, complete with stub-masts and booms, and went to work putting together a block list. We scoured marine consignment stores, Ebay, and other sources for authentic blocks, but realized we still had to make a large portion ourselves. For these, we were able to use original blocks as templates. Our new shells were water-jet cut from bronze plate. The sheaves were turned from solid stock, and we assembled them at the Herreshoff Yacht Fittings machine shop. Taylor and Snediker also fabricated bronze deck organizers and turning blocks to complete the package.

We did final installation of the mast base blocks, deck organizers, and clutches in the water with the spars in place to ensure proper leads and organization. New bronze jib leads and track on deck to replace the black anodized aluminum tracks complimented the new blocks. A few pieces of modern hardware remained. We decided to keep the Harken mainsheet traveler and use modern clutches for practical purposes. At the same time the new hardware was installed, we wrapped up a few other details like cockpit line bags, and winch handle holders. For 2013 we were re-commissioned just in time to be on the dock at Mystic Seaport for the launch of the Charles W. Morgan.




13.) Merriman catalog and original blocks.

14.) Pulpit and lifelines proved their value on the first day of use.

15.) ARION's new deck hardware and blocks.

An earlier commissioning in 2013 meant more time for day sailing, racing, and a short family cruise. The racing season began in Marblehead at the Corinthian Classic Yacht Regatta, where good breeze, a new overlapping jib, and reaching courses lead us to another podium finish. That weekend was particularly important for ARION. Halsey Herreshoff, who was racing with us that weekend, presented Steve's six and seven year old children with a new tiller for ARION. Halsey had carved the new tiller to match his father's original drawing and replaced a modern looking tiller that did not fit ARION's character. ARION was one step closer to being complete. The following weekend we were denied entry at the last minute because our hull did not meet the regatta eligibility requirements (it was not wood). Ironically, a near replica of ARION was there and was happily accepted. I will touch on this subject later. We made the best of the situation by having a great day sail in Nantucket Sound, even testing out a new spinnaker during the non-spinnaker event. Nantucket also made a great starting point for a family cruise back to Narragansett Bay. At the Herreshoff Regatta the next weekend, we were welcomed back to the fleet and had a fantastic weekend of sailing that lead to a second in class. At the Museum of Yachting Regatta we were reminded again that we were pushing the boat pretty hard with another breakage. With one loud pop, the jib and head-stay were over the side, and some quick maneuvering was required to secure the rig from further damage. Our race ended only a few minutes after the start. The head-stay tang on the mast had parted.

A quick trip back to Taylor and Snediker, a new, sufficiently strong, head-stay tang on our main mast along with thorough inspection of the rest of the mast hardware, and we were back in business for some Fall sailing. Another successful season learning more about ARION's strengths and weaknesses lined us up for the third and final winter of the restoration.

16.) ARION

**Phase Three – 2014**

Between day sails, racing, and cruising, ARION traveled over one-thousand nautical miles during the sailing season of 2013. Our new deck hardware layout and blocks had been a success, and the aesthetic improvements we envisioned were well underway. The last major deck improvement was replacement of the aluminum aft hatch with a teak slider. The next major area for improvement was comfort and amenities down below. The obvious lack of volume meant we had to make the most of the space available. Shelves that had been added over the settees were head and shoulder knockers when trying to utilize them as bunks. Moving these just two inches higher off the cushion made a significant difference. This small change essentially took the settees from unusable as bunks to a comfortable place to sleep. Similarly, in the v-berth, a low shelf cut the useful sleeping space in half. A few inches of adjustment again made a big difference, without sacrificing usefulness of the shelf. In the bow, moving the shelves gave us the opportunity to install a forward bulkhead for a chain locker, that the boat has never had. Further aft, in the galley, we decided a small built-in refrigerator would be an efficient use of space, and free up valuable real estate we had been filling with coolers and ice. We were also able to add a few other small, but important amenities like a pressure water pump and small hot water tank to improve comfort on board.

We are planning another full season for ARION in 2014.

**FINAL THOUGHTS**

ARION was ahead of her time in many ways. An important piece of yachting history, ARION has been a well deserving candidate for being returned to her former glory because she still has a useful purpose. At ARION's launch, Theodore F. Jones, general manager of the Anchorage, stated, "ARION was built to prove a point." Time has certainly proved his statement correct. In 60 years, the AC72s of 2013 will probably look slow, but it is doubtful there will be any of them sailing around. Building ARION in 1951 was a major achievement for fiberglass boatbuilding, and would set the stage for mass production of sailing yachts several years after. The first production sailing yachts hit the market until 1957 when Ray Greene introduced the Sparkman and Stephens designed 25-ft pocket cruiser, the New Horizons 26. Pearson, of Rhode Island, followed in 1959 with the Carl Alberg designed 28-ft Triton class. Some 175 New Horizons and more than 700 Pearson Tritons were subsequently produced. These successes signaled the opening of the flood gates for fiberglass sailboat construction.

**IS ARION A CLASSIC YACHT?**

We believe ARION is emblematic of the Herreshoff tradition of innovation in yacht design, engineering, and construction. The result is a simple, elegant yacht that is revolutionary, fast, and beautiful. ARION's legacy, in part, is that she connects Herreshoff's profound impact on traditional yacht design and boat building to the modern era, whereby many Herreshoff innovations continue to influence the industry to this day. The question remains: Where does ARION fit in among the yachting community? Given her heritage, pedigree, and beauty there is no question, ARION is a classic.

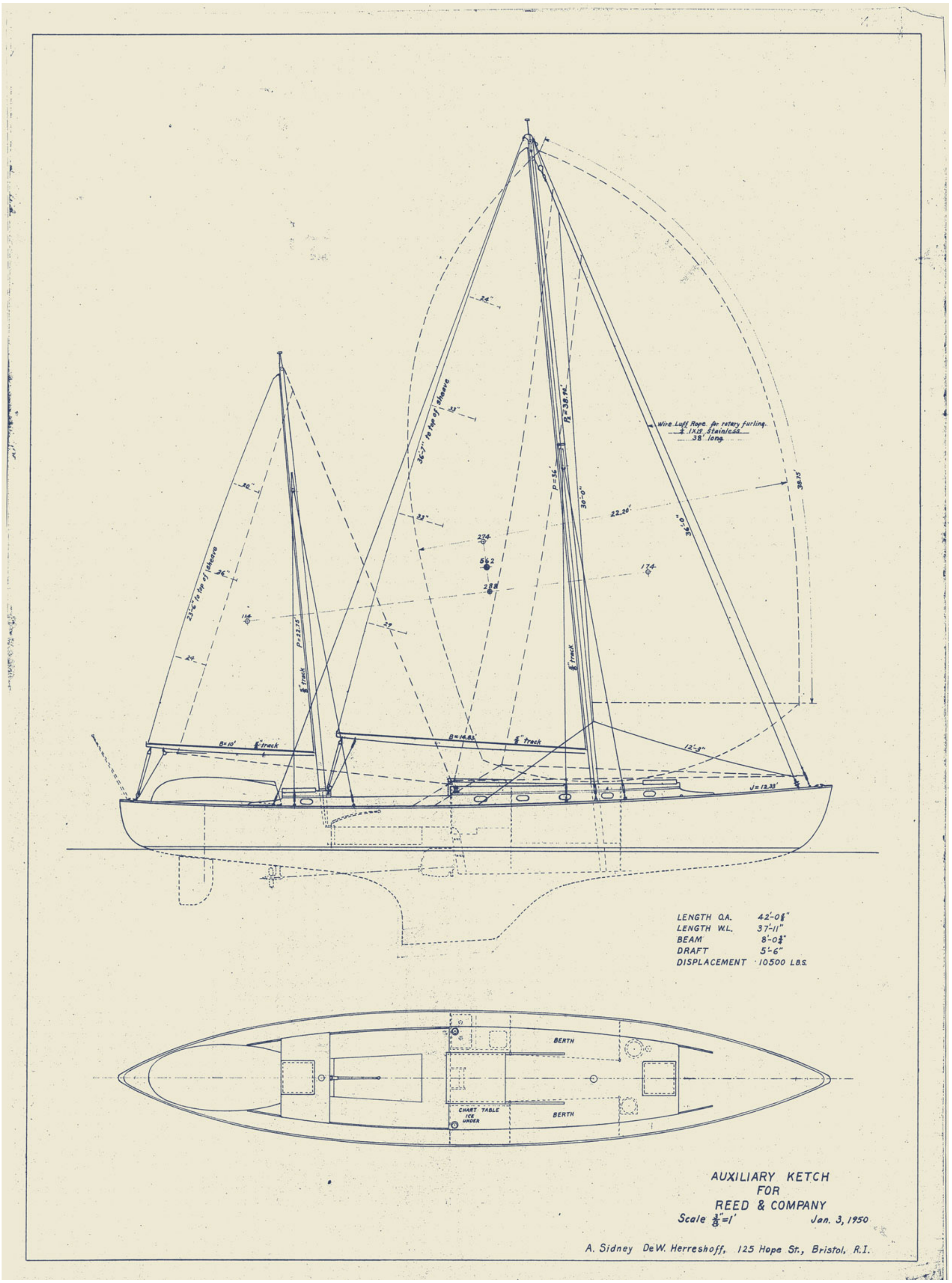
**ABOUT THE AUTHORS:**


**Steve Frary** grew up in Barrington, RI, and after a successful business career, returned to RI to raise his children. Steve has had a lifelong passion for sailing, learning to sail in Blue Jays at the Barrington Yacht Club and on his family's Pearson Ensign. He has extensive cruising and racing experience, served as crew on the BILL OF RIGHTS for three seasons in the early 1980's, and enjoyed many opportunities to sail on BAMBINO and RUGOSA. He is a graduate of the Williams College- Mystic Seaport Program in American Maritime Studies, Amherst College, and The Amos Tuck School of Business at Dartmouth. He is currently the proud owner of three Herreshoff designed boats, and serves on the Herreshoff Marine Museum Board of Directors.

**Adam Langerman** has been following his passion for the water his entire life. Since graduating from Webb Institute with a B.S. in Naval Architecture and Marine Engineering in 2004, he has logged over 25,000 miles racing and cruising classic yachts between the Mediterranean, Caribbean and the US East Coast. Adam's most significant sails have been ocean passages on the 1926 NY40 - RUGOSA and the 163ft Schooner ELEONORA, as well as dozens of races on the Herreshoff schooners ELEONORA and ELENA. Adam is a principal in the firm of Herreshoff Designs Inc.

**Halsey C. Herreshoff** of Bristol, Rhode Island is a naval architect and marine engineer, builder of yachts, and member of the Bristol Town Council. Educated at Webb Institute of Naval Architecture with an advanced degree from Massachusetts Institute of Technology, Mr. Herreshoff enjoys a distinguished career in his field. More than ten thousand vessels have been built to his designs, and he has provided engineering consultation to government, industry, and private clients. He is a principal in the firm of Herreshoff Designs Inc. that continues the longest continuous yacht design service in America.


17.) ARION racing in the Corinthian Classic Yacht Regatta, 2013.




18.) ARION's Sail Plan (courtesy Herreshoff Designs, Inc.).

# The 2014 CYS Commemorates the great Herreshoff year of 1914

**Author Halsey C. Herreshoff**
Herreshoff Designs Inc.

**Figure 1 –** December 1914; Sid Herreshoff trials the first H12½

## Abstract

Significant in the pantheon of Herreshoff Manufacturing Company (HMC) constructions are three notable one-design classes, Newport 29s, Buzzards Bay 25 Footers and Herreshoff 12½ Footers. All of these classes were conceived in 1914. CYS 2014 focuses upon the centenary of each. This paper provides perspective upon how concept, design and construction evolved mostly in just that one year for which we celebrate the centennial. Key to this is the eclectic genius of Nathanael Greene Herreshoff leading in all aspects of the legend. Also, attempt is made to right the conventional neglect in proper appreciation of the magnificent craftsmen of the HMC and the company's remarkable efficiency through organization now deemed way ahead of its time. The purpose of this paper is primarily as an introduction and perspective for the outstanding detailing papers of each class contained in the CYS 2014 DVD.

## About the Author

**Halsey C. Herreshoff** of Bristol, RI is a naval architect and marine engineer, builder of yachts, and member of the Bristol Town Council. Educated at Webb Institute of Naval Architecture with an advanced degree from Massachusetts Institute of Technology, Mr. Herreshoff enjoys a distinguished career in his field. More than ten thousand vessels have been built to his designs, and he has provided engineering consultation to government, industry, and private clients. He is a principal in the firm of Herreshoff Designs Inc. that continues the longest continuous yacht design service in America.

The Classic Yacht Symposium™ 2014

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**Halsey C. Herreshoff**
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Figure 1- December 1914; Sid Herreshoff trials the first H12½

**ABSTRACT**

Significant in the pantheon of Herreshoff Manufacturing Company (HMC) constructions are three notable one-design classes: Newport 29s; Buzzards Bay 25 Footers; and Herreshoff 12½ Footers (each cited by design waterline length). All of these classes were conceived in 1914. CYS 2014 focuses upon the centenary of each. This paper provides perspective upon how concept, design and construction evolved mostly in just that one year for which we celebrate the centennial. Key to this is the eclectic genius of Nathanael Greene Herreshoff (NGH), leading in all aspects of the legend. Also, attempt is made to right the conventional neglect in proper appreciation of the magnificent craftsmen of the HMC and the company's remarkable efficiency through organization now deemed way ahead of its time. The purpose of this paper is primarily as an introduction and perspective for the outstanding papers of each class contained in this CYS 2014 DVD.

**INTRODUCTION**

It is appropriate for the 2014 HMM Classic Yacht Symposium to feature highly important Herreshoff one-design classes that were introduced a century ago in 1914. These were:

1. The Newport 29 Class of cruiser-racer sloops.
2. The Buzzard Bay 25 Foot Class of day-sailing sloops.
3. The Buzzards Bay Boys Boats later dubbed Herreshoff 12½ Footers in reference to their waterline length.

Only four of the Newport 29s were built. One was lost in the hurricane of 1938. The other three continue strong after reconstructive surgery generally by the firm of MP&G. DOLPHIN, long sailed by John Lockwood and his family, probably won more prizes than any other Herreshoff yacht. The Off Soundings Club habitually penalized DOLPHIN for past victories, but John kept winning with DOLPHIN anyway. Subsequently that record of racing success was extended by significant races won by DOLPHIN in the Mediterranean off the coast of southern France. For this class, also, modern clones have been built to successfully sail and race. One of those designed by Adam Langerman and me at Herreshoff Designs, IOLANTHE, sails Long Island Sound under owners Bob and Bill Yaro.

My father told me that Captain Nat Herreshoff considered the Buzzards Bay 25 yacht model shape his favorite. Nevertheless, only five of these yachts were built despite their beauty and superb racing performance. Quite a few reproductions of the Buzzards Bay 25s have been produced here and there. These perpetuate the virtues of this splendid design with frequent racing victories.

The 12½s are considered the first truly assembly-line yachts constructed; the Herreshoff Manufacturing Company produced 364 models. Subsequent boats to this design, some authorized and others copied, number in the thousands, a great many of which continue to sail and race.

**BACKGROUND: RE. DESIGN**

The design story is <u>all</u> Captain Nathanael Greene Herreshoff (NGH). Born in 1848, educated at the Massachusetts Institute of Technology in its infancy, and blessed with amazing experiences, he might well be considered to have reached the pinnacle of his abilities in 1914. That assertion would not have been accepted by this 66-year-old gentleman who had expressed concern with the vagaries of age as early as 1903, just before his triumph in design/construction of RELIANCE swept the America's Cup races of that year. Other notable accomplishments in the background of Capt. Nat were:

1. Success during employment at Corliss Engineering Company with special kudos for superintending assembly and start-up of a giant Corliss steam engine to power the 1876 Philadelphia Exhibition Hall commemorating the centenary of the Declaration of Independence.
2. Design and engineering for the earliest United States Navy torpedo boats including the trailblazing USS CUSHING, Seagoing Torpedo Boat #1.
3. Key advice to the Secretary of the Navy for the subsequent larger-faster naval vessels leading eventually to destroyers.
4. Design and racing of GLORIANA, considered by many the forerunner of the modern yacht. With Capt. Nat at the helm in 1891, GLORIANA won all eight races of the new 46 ft. Class serving to spoil that class while elevating him to the top rank of American yacht designers.
5. Design and construction of yachts for six consecutive defenses of the America's Cup (RESOLUTE, constructed in 1914, won the Cup in 1920).
6. Design and construction of much admired New York Yacht Club one-design 30 footers and 50 footers (waterline length). (NY 40s followed in 1916, two years after 1914, the year we celebrate.)

Perhaps even more significant to the papers to follow regarding the three centennial classes is Capt. Nat's lifelong association with smaller craft – both for business and for pleasure. This factor was exemplified by his 1912 ALERION III, a personal day sailing boat of extreme elegance for use in Bermuda and on Narragansett Bay. For that latter locale, NGH sailed about every good summer afternoon, most frequently solo. In fact, in correspondence regarding negotiations for our three subject classes, Capt. Nat frequently referred to the virtues of the ALERION III design. From observation of the Herreshoff design half models, the 12½ footer and the Buzzards Bay 25 are seen to have a clear family resemblance to ALERION III. Furthermore, the Newport 29 is a direct expansion (4/3) of the modified ALERION model in the Herreshoff Collection, similar, but not identical in shape, to the ALERION-sized SADIE on display at the Herreshoff Marine Museum.

I am pleased to pass along the above facts gathered over a lifetime of association not only with boats but listening to my Dad, Sid Herreshoff; our late curator, Carlton Pinheiro; and advice resulting from wonderful research by recent Museum curator John Palmieri. Facts thus acquired point toward the genius of Captain Nat, but, perhaps, fail to include the whole NGH story- one of learning, precision, marvelous work ethic, dynamic action and readiness always to do even better. In an effort to capture a proper sense of those virtues of my grandfather, I wrote the following as forward to the 1998 book RECOLLECTIONS, a publication by the Museum of writings by NGH himself:[1]

*The extraordinary accomplishments of Nathanael Greene Herreshoff lead one to wonder how he did so much so well, and how he viewed the importance and satisfactions of his unparalleled record. Sixty years following his death (*Written in 1998*), we have little guidance toward this inquiry, for Captain Nat devoted himself to his work, said little publicly, and in the fashion of New England gentlemen of his generation, abhorred the notion of bragging or self-promotion.*

*Aside from his private diaries and revealing correspondence with author W. P. Stephens, Nat Herreshoff wrote rarely either for publication or even for introspection. This volume (*RECOLLECTIONS*) joins in one compendium all that is available from the record.*

*The fascination of this read goes beyond the facts revealed and techniques indicated to the makeup of the "Wizard of Bristol". Just as in life Captain Nat was precise, efficient and practical, his writings are precise, brief and direct. Of all the impressions indicated herein, the dominant value is insight to the clarity and directness of a genius working without distractions of fact or mind.*

I recommend reading of this volume RECOLLECTIONS.

**BACKGROUND: RECONSTRUCTION**

Customarily today, too little is recognized about the amazing workmen of the Herreshoff Manufacturing Company of Bristol toiling in a near perfect environment of opportunity, organization, and quest for ever better products-all under the leadership of J.B. Herreshoff, President, and N.G. Herreshoff, designer and ultimate supervisor of construction works. In this latter capacity NGH made twice daily tours of all work. He had an instinctive genius, not only in technical matters but also for the proper management of workers. He would not personally direct a craftsman in such way as to undermine any foreman; instead he habitually beckoned over a foreman for new instructions. This advice was often accompanied by a small sketch by the master produced using a stubby pencil on a slip of paper. Such instruction advanced during the mid-morning tour would generally be totally accomplished by the time of Capt. Nat's mid-afternoon inspection, enabling NGH's thought to move on to a next idea (and perhaps another sketch for completion by next morning). Unprecedented was this total control of Capt. Nat from a blank design paper, to carving of the design half model, supervision of all construction aspects, to first trial trips of the yacht afloat.

Two particular points of emphasis are in order. First, the brilliant craftsmanship and loyalty of the men of the Herreshoff Manufacturing Company – some employed as many as 40 or 50 years. Secondly, the efficiency of the operations enabling construction of a Cup Defender in 100 days and of a small yacht over just a few short weeks. A good example punctuating that last point is that two men could plank a 16 foot long 12½ footer in one day utilizing master planks to govern shape to fabricate new planks. One workday is no more than the time for production of a modern fiberglass hull. Of course, different skills are involved in the two projects – wooden construction required greater craftsmanship for screwing through the thin cedar planks into narrow steam bent oak frames and meeting accurate rabbets of stem, wood keel, and horn timber. Quality and accuracy can go hand-in-hand with efficiency and speed – not counter to each other as might be expected, but only with astute experienced craftsmen such as those at HMC.

**PROCESS**

For construction of a boat in any of the subject three classes, a similar tried-and-true technique, long ago developed by Nat Herreshoff, was used. Upon completion of his design half model, accomplished in perhaps two evenings at his home, Love Rocks, Capt. Nat read from the model combinations of height and offset at every frame position of the yacht to be built. I still own and both Adam Langerman and I use the NGH "Offset Reading Instrument." This device designed by my grandfather and built by Brown and Sharpe in 1876 demonstrates extraordinary precision and convenience. "Offsets" recorded in pencil in a small book were presented to the chief loftsman of the Herreshoff Manufacturing Company.

From those figures, molds defining the two dimensional inside geometry of frames were made. The molds were accurately set in place for upside-down-construction of the hull. That choice is far superior to the more conventional right-side-up construction technique. This is because working downward provides better light, better ergo-metrics for the fit and bending of planks plus advantage in applying the bronze screws downward from planks to frames. Also, both in the process of fairing plank edges and in fairing the finished plank surfaces, up-side-down has the advantages of supporting the men doing the planing and in visually assessing the needs of

[1] Herreshoff, Nathanael G. *Recollections and Other Writings,* Edited by Carlton J. Pinheiro. Herreshoff Marine Museum, Bristol. RI. 1998

those steps. In the case of larger boats like a NY 50 it was generally a team of 30 or so men in the hour before quitting time working hand planes together that the plank fairing process was accomplished totally.

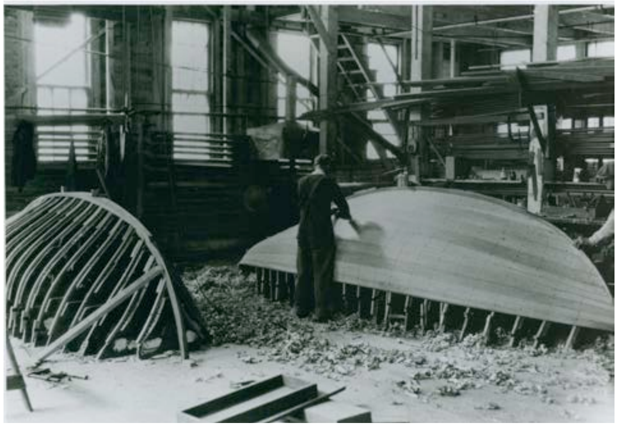

Figure 2- H12½ hulls on molds. (HMM Archives)

Addition of stem, inner oak keel and horn timber to the stern completed the hull skeleton. Vital to that process was the shaping of proper rabbets to meet planking with identical faying surface geometry. Next, utilizing a nearby steam box, the tapered white oak frames in soft condition were strapped to each successive mold, port and starboard. After frame fairing, the cedar planks were roughed from the labeled master planks and adjusted by spilling from a previously installed adjacent plank. Screw fastening generally from the middle of a long plank was accomplished fore and aft to insure universal contact with no membrane error. Then, plank fairing by hand plane, sanding, and prime painting of the hull preceded turn-over. The Herreshoff construction shops were fitted with overhead cranes facilitating turn-over of larger hulls, but for a 12½ footer manual turn-over was easy enough and quicker. The hull was set in a perfect vertical plane suitable for accurate placement of future elements.

The multiple production 12½s were moved along during subsequent work enabling respective teams of men to repeat well learned elements of the construction; this, of course, is similar to the production line process of modern automobile construction. Here sawn deck beams, decking, coamings, deck house decking, if any, were applied.

A significant feature of all our subject boats was the hallmark scroll shaped rail of oak or later mahogany. While it is generally thought that particular detail is just decorative, actually the purpose is strengthening the rail edge against damage by an efficient weight conscious method.

The cast lead keel, cast and machined bronze fittings, cast anchors, spars, sails, and further elements were produced in other shops simultaneously. Needed materials were nearly always at hand when needed, shop foremen were familiar with each process, and very skillful workers plied their respective trades. This is a prime reason why yachts could be built remarkably quickly and completely at Herreshoff. And, of course, for repetitive one-design boats such as those that are the subject of this CYS, organization and training were vital for the particularly efficient processes that evolved.

**THREE CENTENNIAL CLASSES**

Fascinating and revealing are the records establishing construction of craft of the subject three classes at the Herreshoff Manufacturing Company a century ago. Statistics of the three classes are summarized in the Appendix.

**NEWPORT 29 CLASS BOATS**

Figure 3- Newport 29 MISCHIEF (HMM Archives)

As stated in the beginning of this piece, the Newport 29 Class boats were eminently fine for day sailing, cruising and racing, especially excelling in the later. It is not precisely known why Capt. Nat designed them based upon his smaller ALERION III. Doubtless his satisfaction with the ALERION made him comfortable expanding moderately and substituting fixed keel for the keel-centerboard of the ALERION. For years in my Dad's Model Room at 125 Hope Street in Bristol, there was a separate piece of wood laid upon the deck of the

ALERION model to represent the keel extension of the larger boat. This piece fits perfectly to the original model to serve as design of the keel extension and its dimensions of lead ballast. After the Model Collection was conveyed to me by the family and before I first began to loan the collection to the Herreshoff Marine Museum, I glued that extension piece to the model; that is the way it can be observed today.

There is more to the hull shape progression story. After Capt. Nat first sailed ALERION III in the windy water domains of Bermuda, upon his return home, my father asked his father how he liked the new boat. My Dad told me the reply was “Fine, but she is awful damn wet, but I’ll fix that.” He did not actually change ALERION III, but when asked to produce a near sistership, which is the SADIE, now a property of the Museum on display here, he did make significant changes. The underbody of SADIE is nearly identical to that of ALERION, but the bow is drawn out longer by 6”, there is more wave shedding flair forward and the on-deck beam of SADIE was made 4” more – all these changes to produce the same fine sailing small yacht but making her less wet for the crew sailing in a chop – “I’ll fix that.”

The Newport 29 Class boats are scaled up by the proportion 4/3 from the ALERION size. Since that long ago time, there has been speculation as to whether Npt. 29s are ALERIONS or SADIES. Both aficionados and builders of copies and sailors have adamantly stated one way or the other; none of them are entirely correct. Notes in pencil on the back of my original ALERION design model and reference to Captain Nat’s design notes solve the riddle (with thanks to John Palmieri). The actual fact is that Capt. Nat did apply the scale of 16” to the foot for the #727 Class instead of 12” to the foot, making the Newport 29 boats 4/3 larger than the original ALERION III underbody. He again altered the ALERION lines by bow extension, more forward flair, plus greater on-deck beam amidships and aft. His design notes reveal that these changes were along the lines of the thinking for the earlier SADIE changes but not necessarily scaled exactly the same as for SADIE. Of course, the geometry of the original keel-centerboard boats was modified to a deeper full keel without centerboard and with completely outside low ballast. Also Capt. Nat shortened the stern overhangs of the four Newport 29 boats. It is unclear why he did that, but the result seems not to have harmed the dynamic racing successes of those boats. For successor copies such as ROGUE built by Seth Pierson and the Yaro boat designed by Adam and me, the sterns were extended further aft.

Modern builders, like me, find it extraordinary that these, not simple boats were designed and built so quickly at HMC. John has uncovered the sequence for the # 727 Newport 29 Class of four boats:

- Jan. 24th 1914, NGH notes, *“Nos. 727 & 728—737 cruising knockabouts to be built from #718 (ALERION) model but increased by the ratio of 3 to 4.”* But, authorization to proceed was not given until March 26 with a request for boats to be completed for the coming summer season.[2]
- From his diaries we glean brief notations: *6/14/1914 “Trying (*sailing*) 29’ cruisers”* (The same day of trials for SADIE.) and *6/15/1914 ”The two 29 ft cruisers were delivered.”* (First two Newport 29s)

So design, construction, and delivery of complete boats occurred in just three months.

**BUZZARDS BAY 25 CLASS BOATS**

Figure 4- BB25 BAGATELLE (HMM Archives)

H. Nelson Emmons, cousin of Robert Emmons of RESOLUTE and 12½ fame, was the key force in initiation of the Buzzards Bay 25 Class.

Prior to 1914, members of sailing classes of Marblehead Massachusetts and Buzzards Bay locales wanted to find a new one design sailing class of boats to be *“An ideal boat for pleasure sailing and racing”* to be more than 30 ft. long overall. We are given to understand that observation of the very interesting, but not entirely

[2] Quote is NGH writing on the back of the half model

practical, SONDER boats was an input to their thinking. Apparently there was considerable speculation based upon the experiences and tastes of those North Shore and Buzzards Bay gentlemen. This even occasioned controversy among them as to just what to seek. One point that all agreed upon during those recession years was that the new boats should not cost more than $2,000.

Mr. Emmons, familiar with Herreshoff yachts and somewhat acquainted with Nathanael Herreshoff, was easily able to persuade the group to direct their desires toward Bristol for design and construction. In the fall of 1913, Nelson Emmons wrote to Capt. Nat to convey the design consensus of the likely purchasers of boats of the proposed class. Attention now to the correspondence forward and returned reveals a lot about the forthright and practical candor of Mr. N.G. Herreshoff.

The Emmons letter suggested a boat of some 21 ft. WL length with very long overhangs and some other properties dubious in the opinion of Herreshoff. Mr. Emmons did in his letter say to Capt. Nat *"You have such infinitely greater knowledge of the designing of boats than anyone else, and also making rules for their design and construction, that we prefer to ask your advice on the question of a new class for Buzzards Bay before doing anything."*[3]

Captain Nat's reply by letter is classic: *"I don't want to criticize the North Shore people, but I cannot imagine anyone preferring a boat such as you describe (WL 21' 6", OA 35 ft., B 7'6", D 5 ft.) except if it is racing under waterline measurement. It is strange they cannot realize how much better in every way a boat with more waterline and shorter overall is a better sea boat in rough weather, always pleasant to sail, easier handling, less cost, stronger and consequently longer lived."*

He went on to describe his ideal boat and the basis for it: *"My ideal boat for Buzzards Bay must comply with about the requirements I found in my winters at Bermuda and which I made a special study (of) ….stronger winds at times with rough seas, many days with light airs and smooth water – capable of passing over many shoal places…The boat I built (ALERION III) …proved a great success (but) is perhaps somewhat smaller than you would prefer for the Bay."* He developed these prescriptions into an initial design a little smaller than the eventual BB25 but with the same *"High freeboard, good flare forward and sufficient forefoot to insure going into a sea without pounding with a small cabin for two and not very expensive*." [4]

[3] H. Nelson Emmons ltr. of Oct. 29, 1913 to NGH
[4] NGH response to H. Nelson Emmons dated Nov. 2, 1913

**BUZZARDS BAY BOYS BOATS – HERRESHOFF 12½ FOOTER**

Figure 5- ROBIN the first H12½ set up in the HMCo North Construction Shop, December 1914. (HMM Archives)

My father always told me that the origin of the "Buzzards Bay Boys Boats" was the desire of members of the RESOLUTE America's Cup Syndicate for a small, safe sailboat suitable for their respective sons to learn to sail. One can imagine that while sailing RESOLUTE in practice and trial races, the gentlemen of the afterguard raised the subject numerous times luring Capt. Nat into the debate. In 1974, my father, A. Sidney DeWolf Herreshoff, wrote about the origins of 12 ½ Footers:

*"While managing the campaign for RESOLUTE during the trials in the summer of 1914, Robert W. Emmons got my father (Nathanael G. Herreshoff) to design a small ballasted sloop rigged boat that would be suitable for teaching small boys how to sail and to become familiar with the characteristics of the type of larger boat to which they would later graduate,*

*Mr. Emmons had a summer home on Toby's Island at the head of Buzzards Bay. He had several friends from the vicinity of Boston who also had summer homes at the* *head of the bay. Thus, there were plenty of children who could make good use of such a boat there. At first, the class was known as "Buzzards Bay Boys Boats."*

*The order for the first of these boats was received by the Herreshoff Manufacturing Company in the autumn of 1914. The first boat was ROBIN, HMC Building No. 744 built for Stuart Duncan at the price of $420. There were 19 boats in the first fleet with building numbers running consecutively to No. 762."*[5]

In typical fashion, Nat Herreshoff had devised a solution considering all aspects of the request including the fact of strong winds and rough seas on Buzzards Bay where many of the families resided. His model and design represented innovation to a new type of boat, but one related to ALERION III and some other vessels of NGH experience or observation. At that time, the prestige of NGH was such that the potential customers just immediately accepted the proposed design toward authorizing construction.

Thus was developed the class that became the most extensive and famous of all Herreshoff one-designs. Bob Emmons was key toward establishing production of those first boats. Sid Herreshoff took the trial sail of ROBIN, during the 1914-1915 winter and was immediately approving. (Figure 1)

A most amusing sequel to the first construction of these boats was told to me by Davis Taylor, the former publisher of the Boston Globe. Davis's father, also an early publisher of the Globe, was also part owner of the Red Sox and later was involved in the unfortunate sale of Babe Ruth to the New York Yankees. But he was an ethical businessman highly respected by his colleagues and friends. So, as Davis Taylor relates about those "Golden Days" of Boston gentlemen, Mr. Taylor senior simply went through a Friday evening train from Boston to Cape Cod and buttonholed particular acquaintances who were sailors with sons. He did not ask these gentlemen if they wanted a BB Boys Boat, but simply assigned numbers of a particular boat, as "Joe, yours will be Number 14" and so forth through the cars of the train ride. Probably, the cost of $420 was trivial to those prosperous businessmen, and they just went along. Thusly many of the early run of 12½s was purchased for the summer of 1915.

My own experience with 12½ Footers was in a family boat named MINX. My mother purchased the MINX as a wrecked 12½ after the 1938 Hurricane. My father rebuilt MINX in our family workshop at home. I was five years old when first sailing MINX and quickly learned to sail, though I had to sit cross legged on the aft deck at the tiller since my feet would not reach the cockpit sole. Racing soon followed, partly because my wise mother realized that the only way to learn to sail properly is to learn to race. We were always highly motivated to win by any means possible – elated when successful – depressed when failing. So from the Emmon's children, to young Herreshoffs to modern children at the Herreshoff Marine Museum Sailing School, 12½s have been great training vehicles!

Since the "Marconi rig" was not in general use until 1920, the Buzzards Bay Boys Boats were all gaff rigged in early days. Even in my learning years racing MINX against other Marconi rigged 12½s, a gaff rigged 12½ turned up requesting to race in our class. I told that supplicant that he could only compete in a few trial races. Then, after we beat him every time, we accepted his gaff rigged boat as a fully qualified member of our class. Marconi is faster to windward, but some gaff riggers are faster to leeward, notably the Herreshoff NYYC 30 Footers.

**SIGNIFICANCE OF THE HERRESHOFF CENTENNIAL CLASS PAPERS**

The above review is provided just as an overall perspective upon the three iconic Herreshoff classes initiated one hundred years ago. Our celebration of that fact, here in 2014, is made all the more significant by the continued joy in sailing restored boats of the classes each summer. Given the current fine condition of most of these boats, there is every reason to expect lengthy continuation of such pleasures.

The papers on each class have considerable merit toward detailing the facts and reasons that are ever so interesting and satisfying in retrospect. In keeping with the established traditions of CYS, these papers combine technical detailing with human endeavors focused upon the Newport 29s, Buzzards Bay 25 footers and the 12 ½ footers.

[5] See *Herreshoff 12½ Footer* in the CYS 2014 DVD for the complete text of Sid Herreshoff's May 12, 1974 remarks about the H12½.

**ABOUT THE AUTHOR:**


Author Halsey C. Herreshoff standing by the portrait of his Grandfather Captain Nathanael Greene Herreshoff in their Model Room

**Halsey C. Herreshoff** of Bristol, Rhode Island is a naval architect and marine engineer, builder of yachts, and member of the Bristol Town Council.

Educated at Webb Institute of Naval Architecture with an advanced degree from Massachusetts Institute of Technology, Mr. Herreshoff enjoys a distinguished career in his field. More than ten thousand vessels have been built to his designs, and he has provided engineering consultation to government, industry, and private clients.

He is a principal in the firm of Herreshoff Designs Inc. that continues the longest continuous yacht design service in America

## APPENDIX

### Dimensions and Scantlings of Five Herreshoff Yachts

This data has been taken directly from pages of the design notes of Captain Nathanael Greene Herreshoff. While one may refer to the "Herreshoff Rules for Construction" written by him for the New York Yacht Club about 90 years ago, perhaps more convenient is direct reference to the below. Use of this data would need to be accompanied by first-rate construction techniques in order to insure effective execution of these proportions established for lightweight construction with safe strength.

| **ALERION III** | **SADIE** | **CLASS** | **Newport 29** | **BB 25** | **12½ Footer** |
|---|---|---|---|---|---|
| 718 | 732 | **HMC #** | 727 | 733 | 744 |
| | | | | | |
| 26' 0" | 26' 6" | **LOA** | 36' 5" | 32'0" | 15'6" |
| 21' 9" | | **LWL** | 29' 0" | 25'0" | 12'6" |
| 2' 0 ½" | Added 6"Fwd | **Overhang Fwd** | | 4'0" | |
| 2' 2 ½" | | **Overhang Aft** | | 3'0" | |
| 7' 6 ½" | 7' 10 ½" | **BEAM** | 10' 6 ½" | 8'9" | 6'0" |
| 3'7" | Same | **DEPTH to Rabbet** | 5' 2 ½" | 3'5" | |
| 2'5"/5'9" | 2' 7 ½" | **DRAFT** | 5' 4" | 3'0"/6'9" | 29 ½" |
| 5,730# | 6.169# | **WEIGHT** | 15,970# | 7,175# | 1,575# |
| 2,830# | 3,269# | **BALLAST** | 6,880# | 3,310# | 730# |
| 135 sq ft | | **WETTED SURFACE** | | 184 sq ft | 66.6 sq ft |
| | | **SAIL AREA** | 728 sq ft | | 140.5 sq ft |
| | | **Frame Spacing** | 12" | 10" | 7 ½" |
| 1 7/8" | Same | **Keel** | 2 7/8" | 1 7/8" Oak | 1 3/8" Oak |
| 2 5/8" | Same | **Stem Sided** | 3 ¾" | 2 7/8" | 1 5/8" Oak |
| 1 1/16@Head | Same | **Timbers** | 1 7/16"@Head | 1 3/16"@Head | 13/16" Sq. |
| 1 ¾" Square | Same | **Clamps** | 2 3/"8 X 3 ½" | 1 7/8"X2" | 1 3/8" X 1 7/8" |
| ¾"(13/16"C) | Same | **Planking** | 1 1/8" Cedar | 7/8" Cedar | 7/16" Cedar |
| | | **Transom** | | | 5/8" Oak |
| 1" X 1 5/8" | Same | **Deck Beams** | 1 3/8" X 2 1/4" | 1 1/8"X1 5/8" | 5/8" X 1 1/4" |
| ¾" | Same | **Deck** | 15/16" Cedar | 13/16"Cedar/Can | 7/16" Cedar/Can |
| | | **Cabin Beams** | | ¾X1 1/4 @ 6" | |
| | | **Cabin Deck** | | ½" + Canvas | |
| ¾" X 6" Mah. | Same | **Coaming** | | 13/16" Mahog. | 7/16" Oak X 4" |
| | | **Ceiling** | | 3/8" Cypress | |
| | | **Floors** | | 1 3/8 & 1 1/8 Oak | |

*Photo Above:* Herreshoff 12½ Footers ready to ship from the Herreshoff Manufacturing Company



# The Restorations of the Boats of the Herreshoff *Buzzards Bay Twenty-Five* Class

**Author Edward F. McClave**
MP&G LLC, Mystic CT

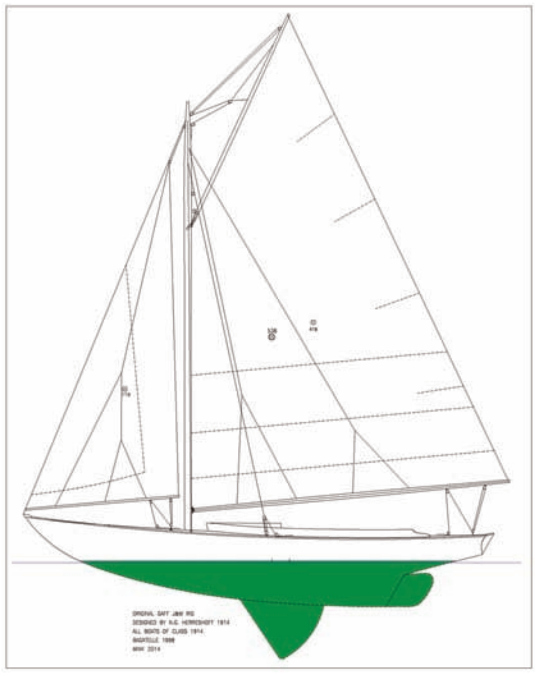

**Figure 1 –** Buzzards Bay 25 #733 original sail plan

## Abstract

With the completion of their restoration of MINK No. 733 in 2014, MP&G will have restored all four of the remaining original 1914 *Buzzards Bay 25*s over the course of about 22 years. Each of these four restorations was guided by different strategies. This paper will give an overview of the four different restoration philosophies. Preceding the overview is a discussion of the Herreshoff hollow-bowed boats beginning with the 1912 ALERION III. The unusual class history of swapping rigs among the boats is presented as an interesting sidebar.

[Refer to the companion paper, "The Restoration of HMCo 733 550 Sail Rating Class *Buzzards Bay 25* MINK- A DIFFERENT APPROACH" by Andy Giblin for details of the MINK restoration.]

## About the Author

**Ed McClave** has been building wooden small boats and restoring yachts by Herreshoff and other builders since 1974, and as a founding partner of MP&G, since 1981. He received his B.S. in Mechanical Engineering from Rensselaer in 1972 and his M.S. in Ocean Engineering from URI in 1991. He has been a member of SNAME since 1989.

The Classic Yacht Symposium™ 2014

# The Restorations of the Boats of the Herreshoff *Buzzards Bay Twenty-Five* Class

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BAGATELLE- The Third BB25 in 1914[2]

**ABSTRACT**

With the completion of their restoration of MINK No. 733 in 2014, MP&G will have restored all four of the remaining original 1914 *Buzzards Bay 25*s over the course of about 22 years. Each of these four restorations was guided by different strategies. This paper will give an overview of the four different restoration philosophies.

[Refer to the companion paper, "The Restoration of HMCo 733 550 Sail Rating Class *Buzzards Bay 25* MINK- A Different Approach" by Andy Giblin for details of the MINK restoration.]

**INTRODUCTION**

Beginning with our restoration of ARIA (ex-WHITE CAP) in 1992, and culminating with our restoration of MINK in 2014, MP&G has restored (or in one case completed the already-begun restoration of) all four of the remaining original boats of the Herreshoff Manufacturing Company's Beverly Yacht Club *Buzzards Bay Twenty-Five* Class. However, the goals and strategies of those four restorations were in no way identical to one another. In this paper, we describe the different approaches that guided those four restorations.

## THE HERRESHOFF HOLLOW-BOWED BOATS

### Rating Rules

The design of sailing boats has for a long time been influenced by the rating rules used to handicap boats of different designs racing against one another. These rules must necessarily penalize the things that make boats fast, and reward the things that make boats slow. They do this by placing functions of speed-enhancing characteristics in the numerator of, and functions of speed-limiting characteristics in the denominator of, a rating formula that usually produces a number that roughly approximates the boat's length. When racing, boats with the shorter rated lengths are given a time allowance relative to the boats with the longer rated lengths, according to a predetermined time-allowance table. Designers are thus forced to compromise desirable characteristics against rated length.

A boat's potential speed under any condition depends on the ratio of its power to its resistance. In light winds and at lower speeds, this is the ratio of the sail area to the wetted surface; in heavier winds and at higher speeds it is the ratio of sail area to weight. A boat's highest possible speed, when there is enough wind to generate the power to achieve it, is limited by its waterline length.

Before the turn of the 20th century, the rating formulae tended to be very simple - using a function of the sail area and the waterline length to produce a rated length. Since sail area was penalized, the way to achieve a high ratio of power to weight was to build the boat very lightly. One way to achieve a high ratio of power to wetted surface was to use a deep but short and narrow fin to support the ballast. And since the waterline length, also penalized, was measured with the boat floating upright, the way to increase the potential top speed with a minimal effect on the rating was to shape the hull with long end overhangs having wide U-sections so the waterline length was as short as possible when floating upright, but so that it increased as much as possible when the boat heeled.

These rules encouraged technical innovation - with a premium on extra-light hulls, builders experimented with techniques of lightweight hull construction. Extremely light rigs with very light hardware also became common. The boats dictated by the sail-area-and-waterline-length rules were fast and exciting, but they were also uncomfortable and unseaworthy, and they were often structurally deficient and short-lived, given the materials and construction techniques available at the time.

Just after the turn of the century, the members of the New York Yacht Club approached Nat Herreshoff with a request to develop a new rating formula that would encourage racing sailboats that would be more comfortable, more seaworthy, and longer-lived than the sail-area-and-waterline-length boats. The resulting formula, now known as the Universal Rule, measured and penalized not only the waterline length but also the overall length, thus discouraging long overhangs. And it included the displacement in the denominator of its formula, discouraging extremely light hulls which were likely to be structurally weak. The resulting boats were long, narrow, deep and heavy. They sailed extremely well to windward, they were much more comfortable and more seaworthy than their predecessors, and their greater weight allowed more freeboard and more robust construction. Their great stability allowed large, tall rigs with plenty of power. But their weight and the sophisticated construction necessitated by tall rigs and heavy ballast keels made them expensive. The Universal Rule became immediately and widely popular - the racing sailboats of the Herreshoff Mfg. Co. from about 1905 on were predominantly Universal Rule boats.

### Construction Design

At the time when these sail-area-and-waterline-length rating rules became influential, the Herreshoff Mfg. Co. (HMCo) was building mostly steam launches and steam yachts. These boats were long and narrow, with substantial machinery weight concentrated amidships. To improve performance, Mr. Nat Herreshoff was making the hulls lighter, and to make the hulls stronger and stiffer to resist the longitudinal hull bending caused by the concentrated midship weight he was applying construction techniques like double-planking and metal diagonal strapping.

The construction design principles developed for the lightweight steam vessels translated directly to the racing sailboats of the day. These sailboats had shallow, light hulls with large rigs and concentrated ballast weight amidships. By the 1880s Herreshoff's had begun to enter the racing sailboat business, taking advantage of the structural strategies developed for high-performance steam vessels. The steam-yacht technology of double-planking and metal diagonal strapping of both hulls and decks transferred directly to sailboat construction, and combined with the innovative use of metal reinforcements at the highly-stressed joints between lightweight hulls and extreme fin keels, Herreshoff's had a head start on other sailboat builders.

### ALERION III and her Descendants (See Appendix)

Then, in 1912, Mr. Nat Herreshoff took a completely different tack. For his own use, he designed the day-sailer ALERION III. This boat was unique in that she was designed without regard to any rating formula for handicapping racing sailboats. Therefore Mr. Herreshoff did not have to compromise desirable characteristics under the influence of a rating formula. ALERION is a keel-centerboard boat 25' long, had a long waterline with short overhangs, a relatively wide stern, generous beam and freeboard, and a high, flaring bow with hollow waterlines. She has a roomy, deep, non-self-bailing cockpit. She originally had a simple gaff jib-and-mainsail rig, but Capt. Nat later switched her to a sliding-gunter rig, probably to facilitate shipping, because the spars of the sliding-gunter rig would all fit inside the hull for transportation to Bermuda. ALERION does not look anything like a sail-area-and-waterline-length boat nor does she look like a Universal rule boat, either.

People in the yachting fraternity took notice of ALERION, and soon, orders for similar boats began to come in. In 1914, Mr. Herreshoff designed, and the HMCo built, an entire range of boats based on ALERION. There was SADIE, a near-replica of the 1912 ALERION, built over the same molds, but reflecting subtle changes made to ALERION's half-model. SADIE is a bit wider than ALERION, with a slightly longer bow, and slightly heavier. There was the *Newport Twenty-Nine Class* of 36-foot racing-cruising boats. This class was also built to ALERION's half-model, incorporating the changes made for SADIE, adding the additional modification of a full keel, and scaled up to produce a boat 36 feet overall. For the young adults of the Beverly Yacht Club, there was the Herreshoff *12½'* class of racing and daysailing boats, and for the adults of the same club who needed a larger boat with higher performance, there was the Buzzards Bay 550 sail-rating class, now generally known as the *Buzzards Bay Twenty-Fives*. Two years later, for the Seawanhaka Yacht Club, the 21-foot overall Herreshoff 16 or *Fish* class debuted, a slightly larger version of the 12-½ scaled up from the 12½ half-model with different scale factors in each dimension. In the end, one half-model from 1912 and two more related ones from 1914 defined what have come to be referred to as the "Hollow-Bowed Boats"- ALERION, SADIE, the *12½ footer* class, the *Newport Twenty-Nines*, the *Buzzards Bay Twenty-Fives*, and the *Fish* Class.

At MP&G, we have been closely associated with the hollow-bowed boats since our inception. Beginning in the early eighties, we have either restored or finished previously-started restorations of seven boats of the *Fish* Class, three *12½s*, SADIE, both of the remaining original 1914 members of the *Newport Twenty-Nine* class, and all four of the remaining *Buzzards Bay Twenty-Fives*. The four *BB25*s each had a few interesting wrinkles, as described below.

## THE *BUZZARDS BAY TWENTY-FIVES*

Herreshoff's delivered four *Buzzards Bay Twenty-Fives* in the spring of 1914 – No. 733 MINK, No. 734 VITESSA, No. 736 BAGATELLE, and No. 738 WHITE CAP. Their dimensions are listed as LOA 32' ; LWL 25'; Beam 8'-9"; Draft 3'. A fifth boat, No. 741 TARANTULA, was built later that year, listed as "for stock", with slightly different dimensions shown in the construction list - Beam 8'-6"; Draft 5', implying that she might have had a full keel. TARANTULA also appeared in records racing with the class at the Beverly Yacht Club before WWI, but has not been heard from since. Speculation remains about whether she was actually different in dimensions from the four other boats or whether the notation in the construction list is in error. The spar plan calls for five identical rigs.

## THE RESTORATION STRATEGIES of MP&G

The typical MP&G restoration is what we call a sailing restoration. It is a very extensive rebuild, with the goal of giving a boat, typically already 80-100 years old, an entirely new life with an expectancy at least as long as its previous one. A sailing restoration usually involves the use of molds to restore the original sectional shape of the hull, setting the backbone profile and the sheer back to the original curves, and usually returning boats, which may have been altered, sometimes many times during the courses of their lives, to their original rigs and configurations.

We practice traditional methods, retaining the modular plank-on-frame construction philosophy of the boats, and using adhesives only to make up individual components, not to connect components to one another. For example, we will glue up an individual plank full-length from shorter segments to eliminate troublesome planking butts and to improve grain alignment, but we will not glue the plank to the keel, to the frames, or to the floor timbers. We do regard the old hulls that come to us as valuable collections of destructive test information. Since these were lightly built boats and they obviously lasted a long time, most of the construction techniques worked, and we try hard to duplicate these. But in the few cases where the original techniques did not work, we do not hesitate to make changes appropriate to the original construction philosophy.

For example: we use kerfs in tightly bent frames to prevent breakage when we find that the originals broke due to excessively severe bends; we fit longer and/or stiffer mast steps and sometimes intercostal frames and floor timbers into boats that show structural problems or loss of hull shape in the mast area. These particular changes, and others, are usually techniques that Herreshoff also used, sometimes in custom boats but not in less-expensively-built class boats, or sometimes in later years but not earlier.

We aim for structural consistency, and this usually requires replacing a lot of the structure. If the goal of the restoration is to give the boat an entirely new life, then no components that only have twenty usable years left in them will be retained if replacing them in twenty years would require the removal or disruption of new parts of the structure. If the owner wants to get twenty more years out of an old cabin, that's fine - it can be replaced without disturbing the rest of the hull. But if a keel, or a stem, or some floor timbers only have twenty years left in them, they have to be replaced.

We also use paint extensively during the reconstruction process to seal various parts against entry of water or to slow the response to moisture content changes. The original boats were painted only after they were substantially complete. We paint during the process to ensure that critical surfaces like the end grain of floor timbers, frame heels, frame heads, deck beam ends, tops of deck beams, the inside of the planking, the back side of the ceiling, and many other surfaces, (many of them end-grain surfaces), that would not be accessible once the hull is complete, are all painted. We also replace any fasteners of materials having inherently limited lifetimes to ones with longer life expectancies.

However, our four *Buzzards Bay Twenty-Five* restorations have not necessarily fit into this pattern of the typical MP&G sailing restoration. What follows is a brief description of the four different restoration strategies applied to the four individual boats of the class.

## FOUR BOATS, FOUR STRATEGIES

### ARIA - 1992

ARIA (ex-WHITE CAP) was tired and no longer sailing by the late 80s. By an agreement between her owner, the Herreshoff Museum, and another donor, we performed what we call a "museum restoration".

While our business revolves around restoring old boats to entire new sailing lives, that process usually entails replacing a lot, sometimes almost all, of the original structure. I mentioned above the value of old boats as repositories of destructive test data about which construction techniques worked and which did not. We feel strongly that very original, particularly interesting examples of some early boats should not be restored, but should be preserved in museums so future generations can also have the benefit of observing first-hand the effects of age on the particular construction techniques

The intention with ARIA was to make the boat a presentable and interesting exhibit, showing her in her original configuration, without replacing any original material or affecting her value as an historical artifact.

ARIA's cabin had been altered from the familiar Herreshoff pointed cabin to a rectangular house at some time in her past. She had also been through a few rig changes, but, surprisingly, had ended up, after some trading between boats of the class, with an original gaff rig from another boat of the class. We filled in the enlarged hole in the deck by adding to the existing deck planks and then built a new cabin in place on the restored deck. Since ARIA was intended to be a display-only restoration, we did not replace any deteriorated structure. She was cosmetically spruced up to look like she would have looked in her early years. She is on display in the Hall of Boats at the Herreshoff Marine Museum. Her original boom and gaff have been retained so she can eventually be displayed with a stub mast and a mainsail and jib furled on their booms.

ARIA's restoration was not extensive enough to allow any restoration of sectional shape or any adjustment to the sheer. And, in a museum restoration of that type, changes in the hull shape over the course of a boat's lifetime due to aging processes are in fact interesting pieces of destructive test data that should be retained.

### BAGATELLE - 1998

BAGATELLE came to us as an empty shell after she had been reframed by John Hall, Walter Ansel, and [Stuart McCormick?]. The reframing was very well done, and in place of the original brass plank-to-frame screws, they had fastened her with copper rivets. These are longer-lasting than brass or bronze screws and they weaken the frames less, but they also make repairs more difficult, especially in a boat with long runs of ceiling trapped under bulkheads and inside joinerwork. She was going to be a sailing restoration, so we continued the process, replacing her original longleaf pine garboards and first broad planks. We then laid a new deck - white pine planks laid parallel to the sheer, - with white oak covering boards, as the original, but with stainless steel and bronze fastenings in place of the original galvanized steel, and with the addition of edge-fastenings between the deck planks for improved torsional stiffness.

BAGATELLE's's original cabin had been altered, with an addition to make it longer aft, a companionway slide, and a skylight in the top. Since the original, even if extensively restored, would have been cosmetically substandard, we built a new cabin off the boat on a jig that we based on the original plans.

The principal concession to appearance was to use traditional cotton canvas for the deck covering. Since the mid '80s we have been unable to obtain deck canvas that will last for the long haul, so on many restoration we have used synthetic fabrics. However, BAGATELLE's owner wanted the appearance of real canvas, which cannot be obtained with any synthetics, so we used it, with the understanding that when it needs to be replaced, it will be an expensive job, requiring the lifting of the cabin, the toe rails, and all of the deck hardware.

As with a typical MP&G extensive sailing restoration, we controlled BAGATELLE's sectional shape during the process with internal molds conforming to the original offsets, and we set the sheer to its original curve.

BAGATELLE came to us with a Marconi yawl rig designed by Dunham & Timken in Mystic in the 50s for a former owner who had bought her with what we believe was a modified version of the Sidney Herreshoff-designed Marconi sloop rig when that owner purchased her in the early '50s. BAGATELLE's new owner wanted the original gaff rig. He was able to obtain the original Herreshoff mast that had been in ARIA (since ARIA was by then an indoor exhibit and will eventually be exhibited with only a stub mast). We built a new gaff, main boom, and jib boom, and she now sails with the rig originally designed for the class in 1914.

**VITESSA - 2001**

VITESSA (ex-ANITA, ex-VITESSA) came to us as an empty shell with no deck or rig, very little original hardware, and in need of a complete structural rebuild. She was the typical MP&G full sailing restoration. We replaced all of the frames and floors, retained most of the planking, with considerable repairs, laid a new deck, and built a new cabin over same form we had built for BAGATELLE's cabin. Realizing that the useful corrosion lifetime of small-gauge (No. 12 in this case) silicon bronze screws below the waterline of a boat used in salt water is typically much shorter than the expected useful life of the rest of a fully restored hull, and that refastening is often damaging to the frames, we and the owner decided to use custom-made nickel-copper (Monel) screws, which will last more or less forever. (While Monel screws may cost two or three times as much as the standard silicon bronze screws, the increase in the overall cost of the project due to using Monel screws is but a small percentage. The other long-life alternative fastening – copper rivets as used in BAGATELLE - is very labor-intensive and at least as costly as Monel screws.)

VITESSA's new owner was not young, and he was not enthusiastic about sailing her with the high-performance original gaff rig. He was able to buy the 1950s masthead-foretriangle yawl rig that had come with BAGATELLE, which was in storage since we had converted BAGATELLE to the original gaff rig. We set VITESSA up to accept this rig. This continued the long tradition of rig-swapping between the boats of the class (see sidebar – "Musical Rigs").

**MINK – 2013**

If the sailing restorations of BAGATELLE and VITESSA were straightforward fastballs and the museum display restoration of ARIA was a curveball, then the restoration of MINK, now nearing completion, was a spitball. In fact, it is just as much an experiment as a restoration.

MINK's owner has established two guiding principles for her restoration. First, he wants to duplicate as closely as possible the experiences of the original owner. Second, he wants to retain original material whenever possible, even if the effort to restore a given part is more expensive than replacing the part with a new one, and, in some cases, even if the restored part would not be quite as strong or have quite as long a life expectancy as a new one. These two principles occasionally came into collision with one another. Obviously, the original owner did not experience having a boat with a hundred-year old, extensively-restored keel - he had a boat with a brand-new keel. As I said, a spitball. In these cases, the owner acted as the judge and the rulings were made quickly and decisively.

So, we did it like they did originally. If the original boat experienced broken frames in the tight curves back in the quarters, leading to hard spots in the outside planking, then MINK's owner wants to experience the same thing. If the heads of the original steel nails that fasten the deck planks to the deck beams began to rust after twenty years, causing bumps in the deck canvas, this owner wants to experience that also when his boat is twenty years past her restoration. And instead of lifting the cockpit or cabin floorboards and seeing the typical MP&G painted bilge, he wants to see bare unpainted floors, frame heels, and planking, just as did the original owner, even if the painting would have enhanced the boat's longevity, prevented drying out during winter storage, and protected vulnerable end-grain surfaces.

And we went to great lengths to preserve original material. In a typical sailing restoration, we replace components of the hull if replacement would be less expensive than restoring the original component to its original strength or if it would not be possible at all to restore it to its original strength. MINK's owner wanted to retain as much original material as possible, even if restoring it was more expensive than replacing, and even, in a few non-critical cases, if the restored part might not be fully as strong as the original.

For example: when we restored BAGATELLE, she came to us as an empty shell. Her original cabin existed, but it was in poor condition and had been lengthened and otherwise altered. Neither we nor her new owner had any interest in trying to restore it at great expense only to end up with something that looked old and patched-up anyway. So we ignored the original cabin (which was originally not in our possession, anyway) and we built a rigid form over which to build an entirely new cabin, dimensioned according to the original plans. This allowed us to build BAGATELLE's cabin and coamings (and, a few years later, VITESSA's as well) virtually complete, in another location (coincidentally, in a shop owned by ARIA's former owner), so as not to interfere in space or schedule with the restorations of the hulls.

After we had finished the restoration of BAGATELLE, her original came into our possession. This cabin was still lying outside our shop as we began the MINK restoration, and we and her owner realized that it might be possible, after some considerable restoration, to re-use the original forward part of BAGATELLE's original cabin top on MINK. Her owner found this idea very attractive; we, not so much; but the plan proceeded. This is when we found that BAGATELLE's original cabin had not been built all that closely to the dimensions shown in the original construction drawing, so our BB25 cabin-building form, which we had used for BAGATELLE and for VITESSA and which we still had, would have to be modified to accommodate new coamings/cabin sides bent to match the dimensions of BAGATELLE's original top. As I said, a spitball.

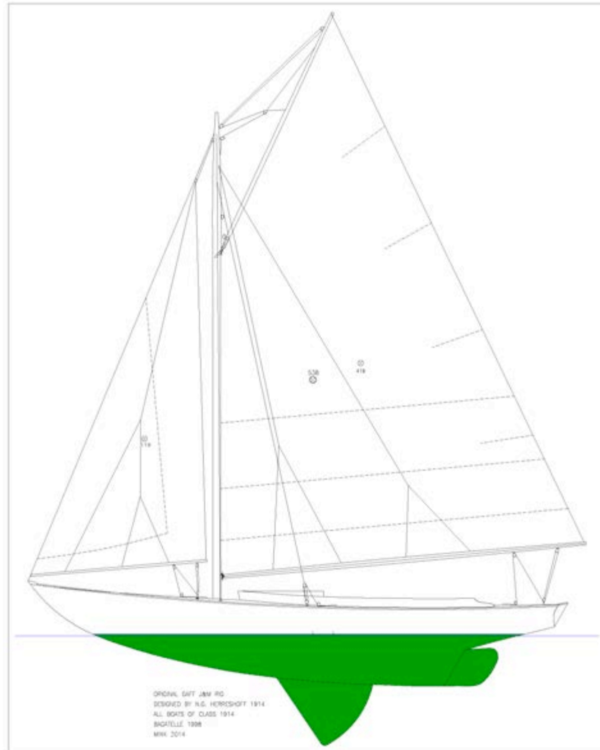
For details of the restoration of MINK please see Andy Giblin's paper "The Restoration of HMCo 733 550 Sail Rating Class Buzzards Bay 25 MINK: A Different Approach".

**A SIDEBAR – THE "MUSICAL RIGS" OF THE *BUZZARDS BAY TWENTY-FIVE* CLASS**

For some reason, the four original boats of the BB25 class have a history of swapping rigs among them. The gaff rig designed for the class in 1914 was the state of the art at the time. Not much organized sailing was done during the U.S. involvement in World War I (1917-1920). By the early 20s most newly designed racing yachts had Marconi rigs, the gaff rig was being looked on as somewhat antiquated, and the BB25s were no longer racing exclusively as a one-design class.

In the 20s, there was brisk competition in the R-class and in the 6-meter class (these are both development classes where hull and rig designs were rapidly evolving). So there was a ready supply of cast-off Marconi rigs that were just about the right size for a BB25.

I will attempt to trace the interesting evolution of the rigs in the BB25 class, to the extent that I know it. There's no doubt more to the story that I don't know.

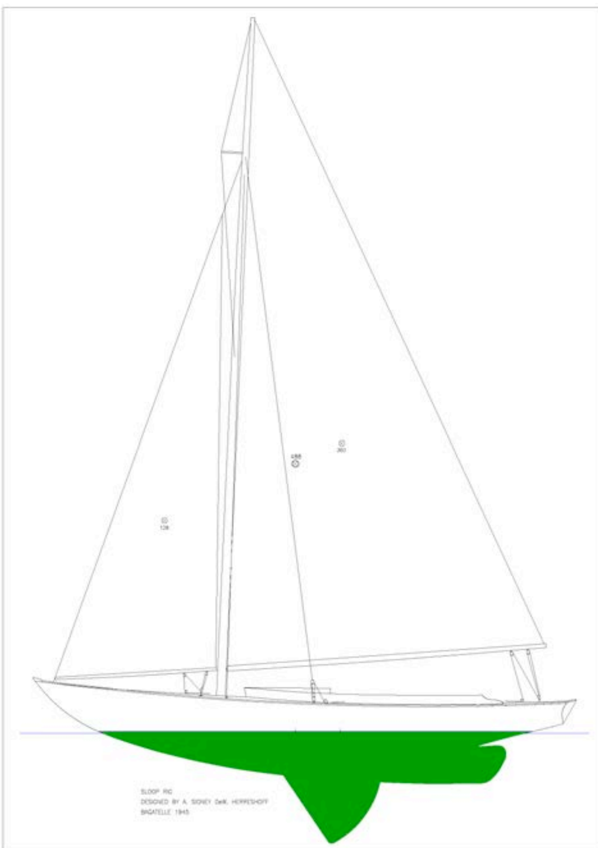



Buzzards Bay 25 HMCo 733 Original sail plan

MINK retained her original gaff rig until fairly late, probably in the late 30s. At some point, she was dismasted, and the bottom of her mast was replaced. The cut-off bottom end, about 6' long, was retained by the boatbuilder who did the repair and it became a lamp post in his granddaughter's house. Sometime after this repair her owner had S&S design a marconi sloop rig, and the original gaff rig (with the repaired mast) was stored. MINK sailed with this S&S rig until her deteriorating condition temporarily suspended her sailing days in the early 90s. One of the MP&G partners purchased MINK as a restoration candidate in 2001, and she is now in the final phase of a complete restoration by MP&G. MINK will sail this summer (2014) with a new gaff rig built to the original specs by MP&G, Stonington Boat Works, and Wilson Sails.

ARIA had been re-rigged at some point with a 6-meter rig (or at least with a 6-meter-like rig). In the 40s, her owner traded this rig to the owner of MINK for MINK's by-then-surplus original gaff rig. Presumably the 6-meter rig would have offered higher performance than the marconi rig MINK had at the time, but it appears that MINK never sailed with it. ARIA sailed with MINK's gaff rig, with the repaired mast, for many years, amassing an enviable racing record, until her deteriorating condition ended her sailing days. After MP&G restored ARIA in 1992 for display at the Herreshoff Museum, her gaff and boom (formerly MINK's original) were stored with the intent that she eventually be displayed with her gaff and boom supported in the furled position by a stub mast to be built (this phase of the ARIA project is still awaiting funding).

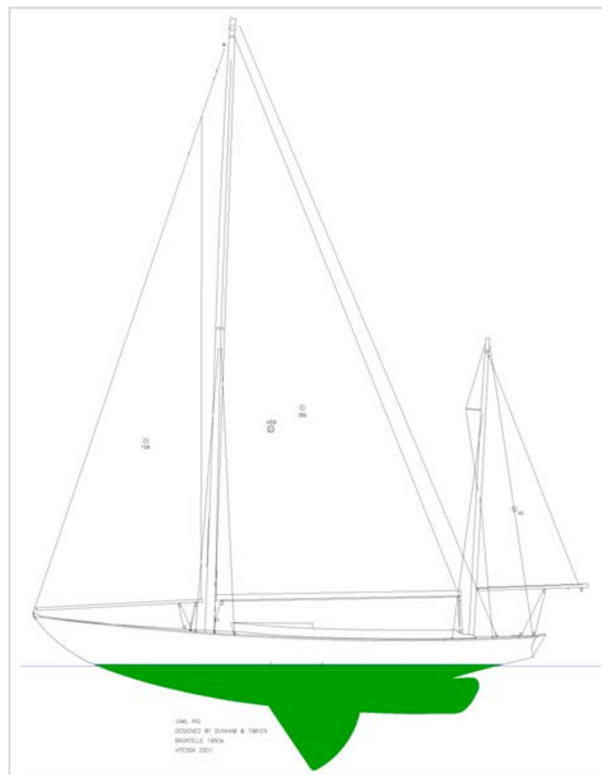
BAGATELLE sailed with her gaff rig, apparently, until 1945, when Sidney Herreshoff designed a fractional marconi rig for her then-owner "Ike" Merriman. This rig was unusual in that it had jumper stays and used the original running backstays, had no fixed backstay, and did not have any lower shrouds or spreaders. The 25s originally had only single shrouds on each side, leading over short spreaders, and thus only a single chainplate on each side. It appears that this rig was designed to drop in without any major hull modifications. Spreaders on the upper shrouds would have required lower shrouds to support their compression loads, and lower shrouds would have required an additional pair of chainplates. So, no chainplates, no lower shrouds, no spreaders.




Buzzards Bay 25- Sloop sail plan with jumper stays

BAGATELLE was brought from Buzzards Bay to Westerly, RI. in the early 50s. A member of the family who bought her stated that she had the Sidney Herreshoff-designed marconi rig at that time. Pictures show her, however, with a rig with spreaders at about that time, so it is likely that someone retro-fitted the extra chainplates that would be needed to support lower shrouds and spreaders.

BAGATELLE's new owners only sailed her once with that rig, however, and that was the delivery trip from Massachusetts to Rhode Island. They immediately had a completely new marconi yawl rig designed by Dunham & Timken in Mystic CT. This rig was unusual for its type in that it had a masthead foretriangle to allow her to race with large overlapping jibs and large spinnakers. BAGATELLE had a long and illustrious racing career in southeastern CT and southwestern RI under this rig. In the 70s she changed hands again, and her new owners, who did not race her, retained the rig but used a boomed jib like that of her original rig. When we completed BAGATELLE's restoration we re-rigged her with the original gaff sail plan, using a newly-built gaff, boom, and jib club, and with ARIA's (originally MINK's) mast, which was not going to be needed for ARIA's indoor display at the HMM. Her marconi yawl rig was placed in storage.

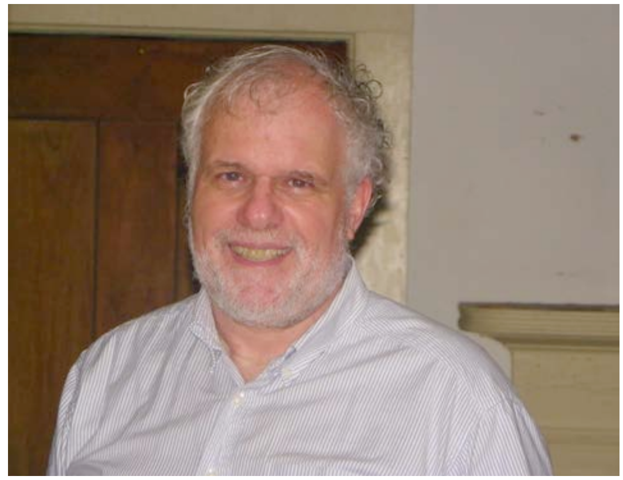



Buzzards Bay 25- Yawl sail plan

VITESSA, then sailing as ANITA, with a 6-meter-type fractional marconi rig, came to Connecticut in the mid-70s, then moved to Maine with her then-owner, Maynard Bray. In tired condition, she was hauled out in the 80s for eventual restoration. In 2000, she was sold to a new owner who brought her to MP&G for restoration. As part of this restoration, we rigged her with BAGATELLE's former marconi yawl rig, which had not been used since BAGATELLE's restoration. She has sailed with this rig for a number of years on Cape Cod, and now, under new ownership, in Maine.

In the process of building MINK's new gaff sloop mast, MP&G, at her owner's request, experimented with using the traditional horsehide glue, which would have been the glue used by Herreshoff for spar construction at the time the BB25s were built. The test spar was a short section representing the lower end of the gaff mainmast. This test piece was intended to eventually serve as the stub mast for ARIA's display at the Herreshoff museum. But then, the family of the boatbuilder who had done the repair on MINK's original gaff mast gave the butt of that mast (no longer serving as a lamp post) to ARIA's former owner, and that original butt will eventually join the gaff and boom with which it started its existence in MINK, as ARIA's stub display mast. Does anybody need a newly-built short section of the bottom end of a BB25 mast? It would make a great lamp post.

**ABOUT THE AUTHOR**



**Ed McClave** has been building wooden small boats and restoring yachts by Herreshoff and other builders since 1974, and as a founding partner of MP&G, since 1981. He received his B.S. in Mechanical Engineering from Rensselaer in 1972 and his M.S. in Ocean Engineering from URI in 1991. He has been a member of SNAME since 1989.

**APPENDIX: ALERION III and Descendants[3]**

**ALERION III (HMCo 712) – NGH half-model with modifications for SADIE (HMCo 732 and the full keel Newport 29 (HMCo 727)**

**Buzzards Bay 25 (HMCo 733) – NGH half-model**

**Buzzards Bay Boys Boat (HMCo 744)- NGH half-model**

[1] All figures property of the author unless otherwise stated

[2] Photographer unknown. Herreshoff Marine Museum archives

[3] Half-model images sized to fit paper width. Photos of half-models courtesy of Halsey C. Herreshoff

The Classic Yacht Symposium™ 2014

# The Restoration of HMCo 733
# 550 Sail Rating Class Buzzards Bay 25 MINK
## A Different Approach

**Author Andy Giblin**
MP&G LLC, Mystic CT

**Figure 1 –** MINK as received for restoration

## Abstract
MP&G has been very fortunate to be employed restoring classic boats and yachts with most being built by the Herreshoff Manufacturing Company. Over the decades MP&G has developed their own techniques and approach to meet the requirements of the project and satisfy the wishes of the owners. [Refer to "The Restorations of the Boats of the Herreshoff Buzzards Bay Twenty-Five Class" by Ed McClave for a discussion of the class design and the four different restoration strategies followed by MP&G.]

MINK is different. The MP&G approach to restoration that emphasizes an authentic appearance as well as additional strength and longevity was not exactly what the new owner of MINK wanted. Quite simply, the owner wanted to experience MINK exactly as her first owner might have on the day she was delivered. Departing from time-proven techniques, the paper explores this new challenge. The author describes the policies and decisions made in applying a "classic automobile" approach to the restoration of MINK.

## About the Author
**Andy Giblin** grew up sailing, racing and working on boats in Noank, Ct. After graduating from URI in 1985 with a B.S. in Fishery Technology and Aquaculture Andy joined the crew finishing the 1907 Herreshoff Cutter NEITH where he met his future partners Ed McClave and Ben Philbrick. Crewing and later skippering NEITH he earned a Coast Guard license with sail endorsement. Andy then joined Ed and Ben in Stonington, CT in the late 1980's forming McClave Philbrick and Giblin specializing in the rebuilding of Herreshoff sailboats. In 2000 a new larger shop was built in Mystic, CT and the name of the business was changed to MP&G.
Andy lives in Noank with his wife, and business manager, Mary and teenage daughter Sarah. The first boat Andy ever sailed on was his father's [Jim Giblin] 1914 Buzzards Bay 25 ARIA now in the Herreshoff Marine Museum Hall of Boats and one of MP&G's projects.

The Classic Yacht Symposium™ 2014

# The Restoration of HMCo 733
# 550 Sail Rating Class Buzzards Bay 25
# MINK
# A Different Approach

**Andy Giblin**
MP&G LLC, Mystic CT

**ABSTRACT**

Departing from techniques developed over decades of restoration work on Herreshoff built boats, the author explores a new challenge. This paper describes the policies and decisions made in applying a "classic automobile" approach to the restoration of the Buzzards Bay 25 MINK.

[Refer to the companion paper "The Restorations of the Boats of the Herreshoff *Buzzards Bay Twenty-Five Class*" by Edward McClave for a discussion of the class design and the four different strategies followed by MP&G in restoring boats of the class.]

**INTRODUCTION**

At MP&G we have been very fortunate to be employed restoring classic boats and yachts, with most being built by the Herreshoff Manufacturing Company (HMCo). Over the decades we have developed our techniques and approach to meet the requirements of the project and satisfy the wishes of the owners.

A brief description of that evolution follows with a detailed description of a somewhat different approach for MINK.

## A PROGRESSION OF WORK

In the mid-to-late 1980s when Ed McClave, Ben Philbrick and I started working as a group our projects were primarily structural rebuilds of mostly smaller Herreshoff boats; the early and sporadic stages of the New York 50 SPARTAN project being a notable exception. The classes represented were the 12½, Fish and 15-footer classes. The goal for these boats was to return them to active racing with structural longevity as a priority. The overall hull shape was often deemed acceptable and the rig and hardware if not authentic were serviceable. The major problems were usually due to worn out transverse structure [frames and floors] and decks that were weakened by the effects of rusting steel nail deck fastenings. These structural elements were usually completely replaced and the scope of the project was relatively limited by budgets and by owners' requirements.

As the interest in classic yachts and classic-yacht racing in general increased so did the size and scope of our projects. As we evolved into working with owners who asked for and supported more complex projects our approach began to include the restoration of hull shape to the original design utilizing interior molds derived from the original offsets. Interior and exterior deck arrangements as well as rigging, fittings and hardware were expected to have an authentic appearance. This period also coincided with the diminishing number of available project boats with only limited structural problems. In other words, most of the boats that were coming into our shop were wrecks or well on their way.
From our earliest projects we had developed and implemented methods and techniques to address the structural shortcomings we observed in these very old boats that we regard as destructive test subjects. We wanted to understand and try to mitigate the reasons the boats were retired from use. These methods were intended to be consistent with the technology of the time period of original construction and typically similar to those employed by HMCo on very lightly built racing boats and larger yachts.

In the last ten years a number of our customers have come to value these boats for their history and provenance as much as for their sailing abilities. Along with this evolution of appreciation the project requirements have also evolved to include a priority on the retention of original materials even at a cost premium over replacement. The appearance of all hardware, fittings, rigging, sails and even the construction of components such as skylights, toe rails and trim is to appear exactly as original; if any of the original materials can be saved every effort is expected. Even paint finishes are specified to evoke an authentic aesthetic by altering shades and reducing gloss levels. Any methods or changes that we might employ in the pursuit of strength and longevity are required to be unnoticeable.

So just when we thought we had the best approach all figured out, our jigs and notebooks from previous projects at the ready, and some level of efficiency anticipated, the MINK project came along.

## PROJECT GUIDELINES AND POLICIES

See Appendix I for examples of detail to convey the restoration strategy; Appendix II for a list of components we plan on saving for re-use; and the accompanying Figures illustrating the details.

The currently evolved MP&G approach to restoration that emphasizes an authentic appearance as well as additional strength and longevity was not exactly what the new owner of MINK wanted. Quite simply, he wanted to experience MINK exactly as her first owner might have on the day she was delivered. We were expected to think more like curators than like builders and engineers. He wanted a "museum approach", but required a "like new" structure to allow him to sail and race.

While we are not familiar with or experienced in what seems to us to be the bizarre and overly obsessive world of classic automobile collecting and racing, MINK's new owner is. He comes to the project with what is, to us, a very different approach to restoration.

We have worked on museum-exhibit boats in the past; ARIA (ex-WHITE CAP), a sister-ship of MINK in the Hall of Boats at the Herreshoff Marine Museum, is a fitting example. Since much of her original structure is remarkably intact she makes an excellent exhibit of original HMCo construction, however this approach necessitates that she not be sailed again. In MINK's case the owner expected to sail, but also wanted to save as much original material as possible and reconstruct her without any alteration to her "as built" configuration. No allowances were made for changes that would increase structural strength or longevity. While these requirements were somewhat unexpected and we were a little skeptical that a car-collecting philosophy could be successfully applied to the restoration of a 100-year-old sailboat design that relied on a lightweight, mechanically fastened wooden structure, we agreed to give it a try.

To attempt to achieve these expectations the owner and MP&G developed the following policies:

1. As much as possible, MINK was to be completed to an "as built" configuration. If there were discrepancies between original

construction and the original drawings or lists the "as built" took precedence.

2. As much original material as possible was to be reused as long as it was structurally acceptable. Any new materials required were to be as originally specified.

3. All manufacturing flaws or perceived mistakes were to be duplicated or incorporated i.e. shims, misaligned holes etc.

4. When replacement of a component was required it was to be an exact replication with no modifications for strength or longevity.

5. Original hardware was to be reused and rebuilt if necessary and replica hardware purchased as a last resort. Hardware that was made should be manufactured by the same process i.e. cast rather than machined if done so originally. Alloys used were to be as originally specified, if possible.

6. Paint and finish appearance was intended to emulate that of the original and to attempt to avoid the "new boat look".

The following expands on the above policies as they relate directly to how we proceeded:

1. We have seen many instances where there are small but meaningful differences between the construction plan and additional plans and lists relevant to the design, and the configuration of the structure of the boat as it arrived to our shop. This was probably of no real consequence at HMCo as these issues were likely addressed during the construction process. A notable example is that of MINK's full-length plank keel which in the construction plan showed a butt in the cockpit area. At least two of her sister-ships had butts in their keels originally.

2. Most of our customers want to save original material. They want as much of a Herreshoff-built boat as possible rather than someone else's interpretation. We don't like to throw out original parts and pieces but replacing rather than restoring individual components is often the less-costly approach. We also don't want one single component to constitute a "weak link" in the structure. Our objective in the past was to enable the boat to have a longer "sailing life" than it did originally by addressing those issues that clearly limited the lifetime. We accomplish this by employing the methods and techniques I referred to in the introduction. In MINK's case the length of her original "sailing life" was considered acceptable (please refer to Ed McClave's paper "The Restorations of the Boats of the Herreshoff *Buzzards Bay Twenty-Five* Class" for more specifics regarding our approach and our definition of a boat's "sailing life"). For MINK we put a great deal of effort into repairing her original full-length plank keel and retaining other components we might have otherwise replaced.

3. The reality is that these boats were manufactured products built by working people for a price and to a schedule. The fact that they are still in existence and have reached the point of "preciousness" is a testament to how incredibly well they were designed, engineered and constructed; nonetheless there were humans involved along the way, whose level of perfection was inevitably flawed. This aspect of the boats, only visible to the few of us lucky enough to get paid to dismantle and take the time to study their construction, is one of my favorite parts of the process. This is not to get satisfaction in finding a builder's flaws but rather in recognizing that quite possibly the workman at HMCo might have shared the same challenges of quality, price and schedule that we do in the present and on occasion might have even had a bad day. Some notable examples are shims that we will reuse, found under floor timbers and aft deck knees. Some of the roves of floor-to-frame rivets were partially sliced away during the beveling of the frames – these will be reused and installed accordingly.

4. Structural considerations have always had first priority in our projects. Our usual work employs methods and techniques that will hopefully extend the sailing life of the boats. Specific strategies are listed in Ed McClave's paper prepared for this symposium. In MINK's case we restricted ourselves to using only the practices of HMCo, essentially restarting the clock on MINK's sailing life. One significant example of restraint on our part was replicating the use of and location of the original butt blocks. If a plank warrants replacement we often scarf it full length, eliminating the often-troublesome butts, but sometimes reinstalling the butt block, mostly for the sake of appearance. Full-length deck planks are particularly beneficial for strength and can add to the longevity of the deck canvas. In MINK both the hull planking and decking will have their original mechanically fastened butts.

5. As is to be expected for a car enthusiast, the hardware is of particular interest. MINK's owner, accustomed to hunting down original parts for cars, wanted us to do our due diligence before ordering or making replica hardware. Many projects require the purchase of hardware and we either make it ourselves, have it produced locally, or purchase available pieces from J.M. Reineck & Son. For MINK, which unfortunately arrived with very little, we will likely "beg, borrow and steal" to try to find original HMCo-produced hardware. The rigging blocks we manage to find will be disassembled and rebuilt with the appropriate attachments, some of which will have to be purchased new, and reassembled in good working order. Only after exhausting the available supply are we to purchase new. Even then, the plan is to continue to search for originals after the restoration is finished, to eventually replace the replicas. When new hardware is made it is expected to be of the originally specified alloy and produced as original i.e. cast as opposed to machined (we would normally prefer machined parts to ensure strength and fatigue resistance). The turnbuckles present us with a challenge in that they are delicate castings with soldered wire terminals. The plan is to have prototypes made and destructively tested, including wire pull tests, and then to proof-test the final products. We have accumulated the original HMCo turnbuckle drawings and casting cards from The Hart Nautical Collections, MIT Museum and had X-Ray fluorescence testing done to original examples to determine the original alloy. Jim Reineck is undertaking the production of these. Wherever practical Naval Brass {as close as possible to the original Tobin Bronze} will be used for components such as chain plates that are made of wrought material. This alloy will also be used for ballast and trunk bolts.

6. Regarding paint finishes, there has been a recent trend for owners requesting "toning down" the shine and brightness of finishes. The owners of earlier projects including SPARTAN and AMORITA had specific requests to customize the paintwork to appear more consistent with what the finishes might have looked like in the time period the boats were built. Generally the gloss of the paint is reduced and the color tinted to resemble a linseed oil /white lead paint. The varnish is selected for its amber color rather than the more-modern clear finish. The most notable aspect of the paintwork on MINK will be the lack of it. We have observed that many of the HMCo boats we have worked on were not painted where it couldn't be seen, suggesting that the painting was done towards the end of construction. We typically find only a "wash" of thin paint in the bilge, behind the ceiling and inside the watertight bulkheads. Our guess is this was intended to act as a primer sealer and done shortly after the boat was removed from the molds and rolled over. As Ed mentions in his paper we consider the painting of all surfaces, especially faying surfaces, to be a very important factor towards maintaining the condition of structural components, especially in the bilge. MINK is to have only those parts painted that were so originally, to complete the "authentic aesthetic" we are trying to achieve.

**CONCLUSIONS**

The MINK project represents a challenge to MP&G. Our usual approaches- structural and longevity for a sailing result or curatorial for a museum restoration - are usually applied to different boats. In the case of MINK they are to be applied to the same boat, and here the two approaches often come into conflict. This requires us, at times, to restrain from what we think might be best for longevity and stick to what was done originally. We often find ourselves asking the same question the owner asked us the first time we talked "how long did it last in the first place?" His answer was, and still is "long enough".

**ABOUT THE AUTHOR:**

**Andy Giblin** grew up sailing, racing and working on boats in Noank, Ct. After graduating from The University of Rhode Island in 1985 with a B.S. in Fishery Technology and Aquaculture Andy joined the crew finishing the 1907 Herreshoff Cutter NEITH where he met his future partners Ed McClave and Ben Philbrick. Crewing and later skippering NEITH he earned a Coast Guard license with sail endorsement. Andy then joined Ed and Ben in Stonington, Ct. in the late 1980's forming McClave Philbrick and Giblin specializing in the rebuilding of Herreshoff sailboats. In 2000 a new larger shop was built in Mystic, Ct. and the name of the business was changed to MP&G.

Andy still lives in Noank with his wife, and business manager, Mary and teenage daughter Sarah. The first boat Andy ever sailed on was his father's [Jim Giblin] 1914 Buzzards Bay 25 ARIA now in the Herreshoff Marine Museum Hall of Boats and one of MP&G's projects.

## APPENDIX I

### EXAMPLES OF DETAIL TO CONVEY THE RESTORATION STRATEGY FOR MINK

**An example of the approach-**
**List of documented details employed in replicating floor timbers (Figure 1)**

- White oak and of original dimensions
- Record and duplicate whether square or hex nuts were used for bolts through plank keel and replicate. Make custom nuts to match dimensions of originals
- Try to copy bolthole location (some were very close to the surface so the washer overhangs the face).
- Duplicate location of floor-to-frame rivets (some were very close to the plank, requiring the rove to be cut as on #32)
- Copy limber hole size and location, even if minimal
- Drill lifting line holes to intersect ballast bolts in the floor timbers where it occurred.
- Reinstall original shim under floor # 4
- Reuse original roves where possible, but with new rivets (Figure 2)

## APPENDIX II

### LIST OF ORIGINAL COMPONENTS TO BE RETAINED IN THE RESTORATION

- Plank keel (Figure 3)
- Deadwood and ballast (Figure 5)
- Stem
- Two pairs of forward frames, three forward floor timbers, re-riveted
- Centerboard bed logs and sides, reassembled
- Hull planking: most of stbd. side, eliminate previous port side repairs, keep original segments and return to original butt pattern (Figure 4)
- Butt blocks: most all hackmatack butt blocks above garboard
- Sheer clamps (Figures 6 & 7)
- Transom framing
- Transom knee
- Stern quarter knees
- Minimum of 30% of original decking
- Original inside sealing “whitewash” (Figure 8)
- Centerboard trunk bed logs and sides (Figures 9 & 10)
- Re-use of original nuts and roves where possible
- Rudder shaft and tiller head
- Re-use of HMCo blocks and hardware (Figure 11)

Figure 1 Floor timber with ballast bolt intersecting lifting holes

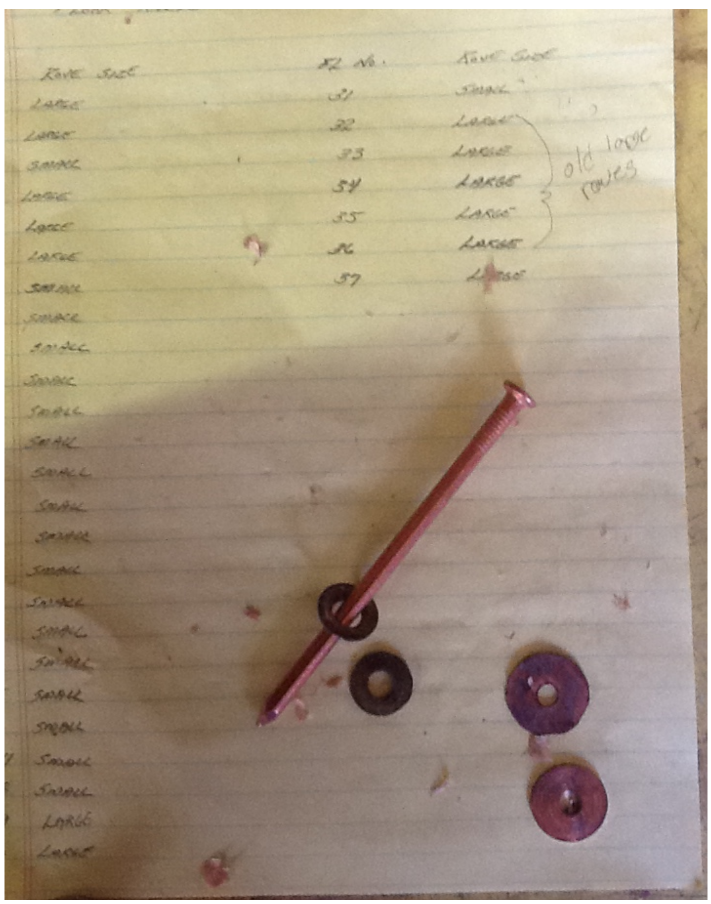



Figure 2 Showing different size roves used

Figure 3 Keel rocker patterns in place and structure bent to fit

Figure 4 Reuse of original planking

Figure 5 Deadwood and drawing. Discrepancies were noted, but deadwood was reassembled "as built"


Figure 6 Sheer clamp showing shim that was placed under the deck beam prior to bolting. The same shim will be reinstalled.

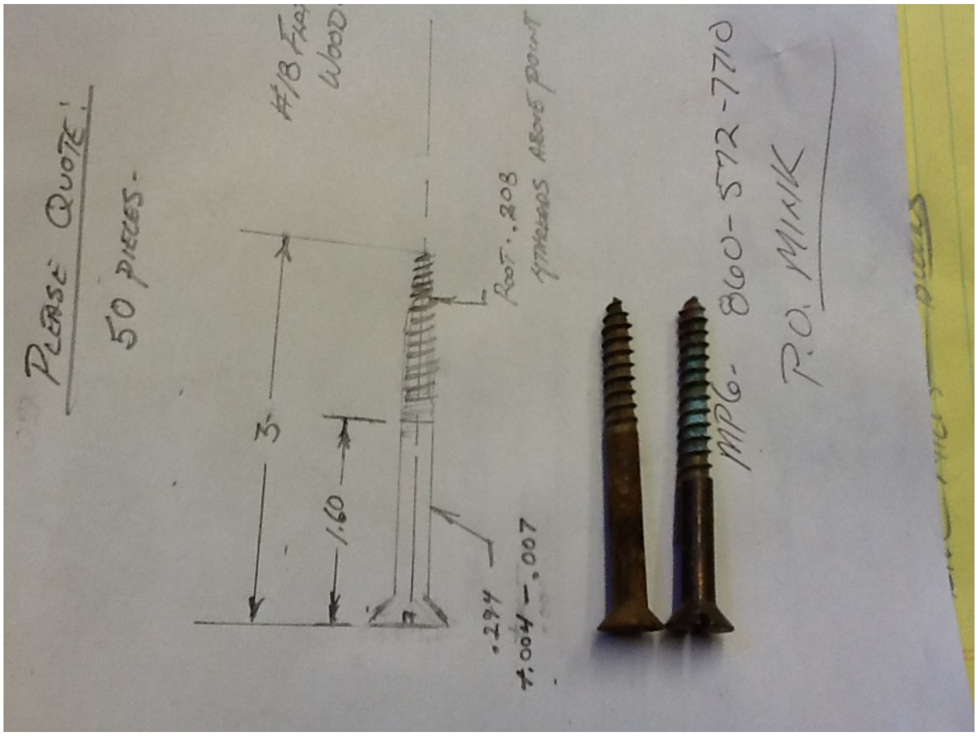



Figure 7 Screw with extra long shank used to fasten deck beams to clamp in comparison with standard length screw. Long shank screws will be purchased for the restoration.

Figure 8 Showing original "whitewash" used as a sealer/primer. Photo is of the area inside a watertight bulkhead in a 1914 BB15 (HMCo #731) that is being restored alongside MINK. The finish is typically found in all areas of the hull not finish painted. MINK will get the same treatment.

Figure 9 John Taylor drilling repaired centerboard trunk sides for through bolts

Figure 10 Riveting of original trunk sides re-using original roves


Figure 11 Original blocks prior to rebuilding

# Newport 29 Cruising Class

**Author Chris Wick**
CRF Group

**Figure 1** – MISCHIEF 1914


**Figure 2** – MISCHIEF recent classic regatta

## Abstract

The four original Newport 29s are a derivative of Nat Herreshoff's own ALERION III. Two, DOLPHIN and MISCHIEF, were built from the original ALERION/SADIE design, while the following two, COMET and PADDY, were stretched out about 14 inches aft. After building and launch, the Newport 29's have had varied careers, though having had several owners, each has had at least one devoted, long-time owner who has guaranteed its long term survival. The author, owner of MISCHIEF for 41 years, presents the story of the class, information on each boat (the original four and two later versions that followed) and the basis for the class reputation as a "racing machine".

## About the Author

**Chris Wick** grew up cruising the New England coast with his family and admired the Herreshoff 12½'s he saw in Buzzards Bay at an early age. After moving to Mystic and making friends with some other Herreshoff fanatics, he was presented by them with the opportunity to purchase MISCHIEF while still in graduate school in California. It has been a wonderful partnership ever since. He serves the Herreshoff Marine Museum on the Board of Directors, the Boat Preservation Committee, and the committee organizing the Classic Yacht Symposium.

The Classic Yacht Symposium™ 2014

# Newport 29 Cruising Class

**Chris Wick**
CRF Group

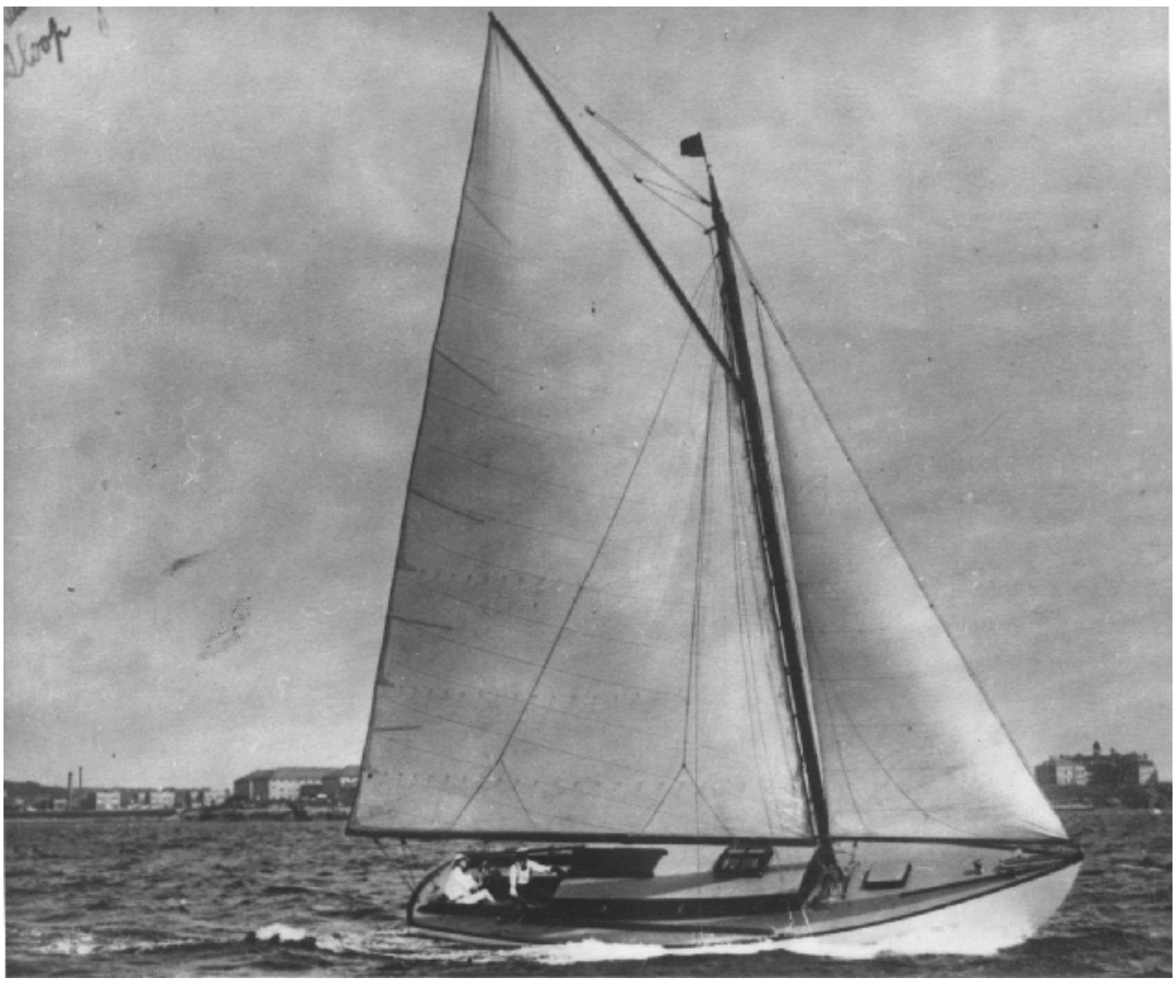


Figure 1- MISCHIEF in 1914 Photographer unknown. Courtesy of Hugh D. Auchincloss

**ABSTRACT**

The Newport 29s are a derivative of Herreshoff's own ALERION III. Two, DOLPHIN and MISCHIEF, were built from the original ALERION/SADIE design, while the following two, COMET and PADDY, were stretched out about 14 inches aft. After building and launch, the Newport 29s have had varied careers. Though having had several owners, each has had at least one devoted, long-time owner who has guaranteed its long term survival.

## INTRODUCTION

1914 was a busy year for the Herreshoff Manufacturing Company. Among the many boats built that year were three 'classes' that have become icons in the sailing world, the H 12½, the Buzzards Bay 25, and the Newport 29.

## The NEWPORT 29 CRUISING CLASS

The Newport 29s are a development of Nathanael's own ALERION, which he designed in 1912 for use in Bermuda. Since ALERION was a centerboard design and the 29s were to be full keel boats, he carved a keel which was placed underneath the ALERION half model and then the lines were taken off the combined model.

The Newport 29s are about 36' Length Overall, 29' Waterline, 10.5' Beam and 5.5' Draft. I say 'about' 36' because the overall length was changed after DOLPHIN and MISCHIEF were laid down, and COMET and PADDY were actually about 14 inches longer.

On the design, (Figure 3) they are designated as the 'Newport 29 Cruising Class.' Since they were not ordered together as a class to go to one venue, like the NYYC 30s, the Buzzards Bay 25s, or the Fishers Island classes, they were not designated as a racing class.

The boats were Jib and Mainsail boats, gaff rigged sloops with a large gaff mainsail and a small self-tacking jib on a club.

Figure 2- Nat Herreshoff's half model of ALERION with deck plate he glued to create SADIE with longer overhang, greater beam on deck and greater forward flare. Shown with the glued Newport 29 keel extension.
Courtesy Herreshoff Marine Museum.

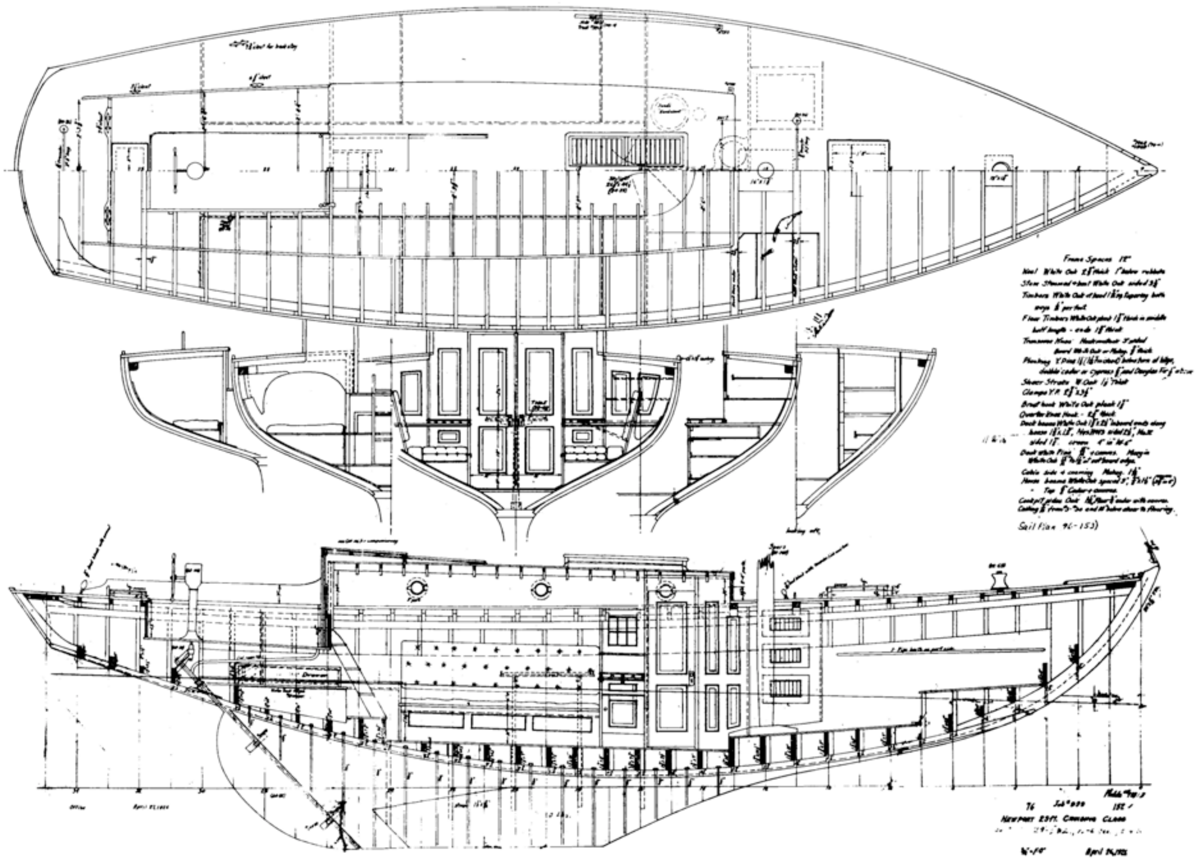


Figure 3- Newport 29 Construction Drawing as revised in 1926 for PADDY.
Courtesy of Curator Hart Nautical Collections, MIT Museum

**INTERIOR LAYOUT**

The layout of the interior is quite simple. Starting from forward, there is a small forepeak with a pipe berth on the port side, and an icebox behind that, next to the mast. Next aft is an enclosed head, also to port, and a small galley on the starboard side.

The main cabin consists of two settees with a table between. The backs of the settees convert to berths for sleeping at night. Two quarter berths complete the original interior accommodations, with a water tank between the berths under the cockpit. (Figures 4 & 5)

All the boats now have an engine under the cockpit and the water tank has been moved to the forepeak to help balance the weight of the engine.

Figure 4- MISCHIEF looking forward from the companionway. ©Franco Pace

Figure 5- MISCHIEF looking aft from the galley. ©Franco Pace

ROGUE and IOLANTHE have more modern cruising accommodations. (Figure 6)

Figure 6- IOLANTHE's more modern main salon looking forward. Courtesy J. Antonucci

**THE BOATS**

DOLPHIN is Herreshoff Manufacturing Company (HMCo) Hull Number 727. She was ordered by O. G. Jennings on September 27th, 1913. Two years later she was sold to Arthur B. Brayton; in 1919 she went to W. Barklie Henry, only to be purchased by Arthur Adams another two years later. She was still in his ownership at his death. In 1943 W. B. Lockwood purchased her from the estate for his two sons who were still in the U. S. Navy. The Lockwood family would own her for more than fifty years and be responsible for much of the reputation of the class. After Robin Lockwood decided to part with her, she became the property of H. Howard Knox, who raced her successfully until his death when she was acquired by Hunt Lawrence and became the showpiece of the Oakcliff Sailing Center's fleet.

DOLPHIN became known for racing in the Long Island Sound, Fishers Island Sound, and Block Island Sound area. Over the years she amassed quite a trove of race trophies. (Figure 7)


Figure 7- DOLPHIN in 1949 Off Soundings with Marconi rig. ©Mystic Seaport, Rosenfeld Collection

MISCHIEF (HMCo 728), the second Newport 29, was also ordered on September 27th, 1913. She was built for Mrs. E. B. Auchincloss as a present for her son, Hugh D. Auchincloss (then 17). MISCHIEF lived in Newport for the first few years, and then was sold to T. S. Hathaway of New Bedford, MA. After a few years, he died, and willed her to his nephew, Horatio Brewster, also of New Bedford, who had sailed with him for many years. Horatio Brewster owned MISCHIEF for at least 28 years, mooring her in Padanaram, MA, and sailing her successfully. He converted her to Marconi rig in 1929 and also installed the first engine at about the same time. (Figure 8)

In the 50s Horatio sold her to Arcady and Geneva Semenoff who moved her to Annapolis and sailed her on the Chesapeake. They felt that she was over canvassed and cut six feet off her mast. Apparently, she lived a quiet life there until purchased by David Cabot of Avondale, RI, in 1967. David returned her to the New England area and raced her locally in Connecticut and Rhode Island. After several years of ownership, circumstances forced him to sell her.

I purchased MISCHIEF from David in 1973 while I was still in Graduate School. For the first few years, in addition to sailing her myself, I raced with John

Lockwood on DOLPHIN, getting a feel for the boats and some advice from the master.

Figure 8- MISCHIEF in 1931 Bayside-Block Island Race. ©Mystic Seaport, Rosenfeld Collection

After many years of planning, I finally had a new mast built in 1985, restoring the six feet that had been cut off in the Chesapeake. A couple of years later, I replaced the deck, having noticed how much it was moving and disturbing the canvas. We replaced the original planked and canvassed deck with a two-layer plywood deck covered in fiberglass. The cabin top was planked and canvassed as original.

Finally, in November 2001, MISCHIEF was hauled out and moved to McClave, Philbrick, and Giblin's shop in Mystic, CT where she was taken apart and her hull restored to nearly original condition. The interior was then rebuilt by Jeff Hall of North Stonington. All this took almost 18 months; MISCHIEF was relaunched in July 2003.

During the 41 years that I have owned her, I cruised with my family when the children were younger, and also raced her locally against other wooden boats, managing to fill several shelves in my house with silverware and other trophies. She is a wonderful boat to sail.

COMET (HMCo 737) was built a little later during the year 1914. Her order included some of the modifications that had been made for SADIE to the original ALERION model, so she measures about fourteen inches longer overall. She was ordered by Cornelius Vanderbilt who owned her for nearly ten years when purchased by Isaac Merriman.

In 1932 she passed into the ownership of the Zachers, L. Edmund and Edmund II, of New London, CT, who installed a Lathrop gas engine in 1934, then evidently changed the rig to Marconi in 1935. However, she was wrecked on Groton Long Point in the 1938 hurricane.

PADDY was ordered in March 1926 by William K. Vanderbilt of Newport and was built with a Marconi rig. After five years she was sold to Gordon C. Prince of Beverly, Mass. In 1934 she went to Charles Gulden of Beverly, Mass, only to pass to John Lee Merrill of New York one year later. In 1941 she was owned by Charles Oshei who kept her until 1958 when George Byers appears as owner. George was one of those long time owners who have meant so much to the class, keeping her until later when purchased by Ben Baker (part-owner and donor of the Fishers Island 31 TORCH to the Herreshoff Marine Museum), She was renamed TEASER and totally restored by Steve Ballentine in Onset, MA.

Figure 9- TEASER in 1962. ©Mystic Seaport, Rosenfeld Collection

ROGUE was built by Seth Persson of Old Saybrook, CT in 1953 for Dan Morrell from lines taken off TEASER in the early 1950s by Sidney Herreshoff. Dan had actually sailed on COMET in the mid 1930s when she was owned by his old schoolmate, Ted Zacher, and when the time came for him to build a boat for himself, he went to Sidney Herreshoff for permission to build a Newport 29.

She was rigged as a sloop to a sail plan by Sparkman & Stephens of New York that included a short bowsprit.

Figure 10- ROGUE in 1954. ©Mystic Seaport, Rosenfeld Collection

Some time later, she was re-rigged as a yawl to designs of sailmaker Ed Raymond of Hathaway, Reiser, and Raymond of Stamford, CT (Hathaway had been a sailmaker at HMCo). This was done to make her easier to sail for the TransAtlantic race of 1960, although she did not participate because of a death in the Morrell family. Later she was sold to Michael Jackson of New Hampshire and subsequently to her present owner, Seville Simonds of Clinton, CT, and Fishers Island. (Figures 10 & 11)

Seville restored the sloop rig and has been quite successful racing her since.

Figure 11- ROGUE at Fishers Island. Chris Wick Photo

IOLANTHE was built for Bob and Bill Yaro by Brion Reiff of Brooklin, ME, in 2009. She is based on the Newport 29 design using cold molded construction methods, to designs provided by Herreshoff Designs. (See *Reviving the Newport 29 Class* by Robert D. Yaro, Classic Yacht Symposium 2010 Proceedings.)

Figure 12- IOLANTHE arrives in Bristol. Chris Wick Photo

**RACING**

The reputation of the Newport 29 as a racing machine is largely based on the record of DOLPHIN, who amassed a collection of trophies that might be deserving of a page in Ripley's Believe it or Not.

As an example, DOLPHIN raced for many years in the Off Soundings Club's annual regattas. In the period between 1957 and 1964 she was awarded the Kenneth B. Millett trophy seven times, only ceding it in 1960 to ROGUE. She went on to win it five more times between 1967 and 1976. The Millett trophy was awarded to the boat in class A-2 with the best combined scores in both the spring and fall regattas (not counting penalties). Other boats have won this trophy multiple times, but none more than five.

In 1954, DOLPHIN, TEASER, and ROGUE all competed in the Off Soundings Regattas. The class (A-2) included three Owens 40's, two Concordia 39 foot yawls, a 42 foot Alden Yawl, two other Alden yawls, two Casey yawls, and an assortment of other boats. The final outcome had DOLPHIN in first, TEASER second, and ROGUE fourth.

DOLPHIN also has been noted for carrying a large penalty in many years of competition. In fact, in the year 1961, she competed with a 32.7% penalty, while TEASER had 33.5% and ROGUE had 34.0%.

In 1979, DOLPHIN again won the Millett trophy, this time competing against four Hinckley Pilot 35s, four

Tartan 34s, a Tartan 37, a Morgan 38, a Luders 36, an Ericson 35, and a Little Harbor 36.
MISCHIEF, on the other hand, was raced in Block Island Sound while living in New Bedford and South Dartmouth. We know that she won the Bayside-Block Island Race in 1930. After that we lose track until she returned from the Chesapeake with David Cabot. He raced her in Off Soundings between 1966 and 1972, with some notable successes.


Figure 13- MISCHIEF at rest. ©Franco Pace

Between 1980 and 1995, MISCHIEF participated in many Classic Yacht Regattas, almost always finishing in the money. In fact, in 1985, she scooped the whole fleet, garnering Elapsed and Corrected Fleet trophies as well as Class first and first Herreshoff.


Figure 14- MISCHIEF during a Classic Yacht Regatta in Newport. Photo Ted Kelley of PhotoBoat

In 1981, DOLPHIN and MISCHIEF both participated in Class E with DOLPHIN winning her class and second in fleet, while MISCHIEF was second in the same class and third in fleet (the Herreshoff 1902 BAMBINO won her class and the fleet). The Buzzards Bay 25 ARIA also won class F and took fourth in fleet. It was quite a day for Herreshoff designs.

**CONCLUSIONS**

The Newport 29s were built for individuals for cruising use. They have since become known as fast, powerful sailers who can hold their own with many of the newer, lighter classes and have a creditable record of having done just that for many years. Some of the new rating rules have made it much harder for them to compete, but they maintain a reputation for fast, comfortable sailing. I purchased MISCHIEF in 1973 based solely on the reputation of DOLPHIN (interestingly, W. B. Lockwood purchased DOLPHIN after having seen MISCHIEF earlier).

Their power and ability to carry a large rig can be attributed to a 7,000 lb. ballast keel combined with the beam originally designed for a centerboard boat, which gives them very high form stability. Their short ends minimize hobby horsing in a seaway.

Figure 15- MISCHIEF making the most of a nice breeze. ©Franco Pace

**ACKNOWLEDGMENTS**

Many thanks to the staff at the Herreshoff Marine Museum and the staff at the G. W. Blunt White Library at Mystic Seaport.

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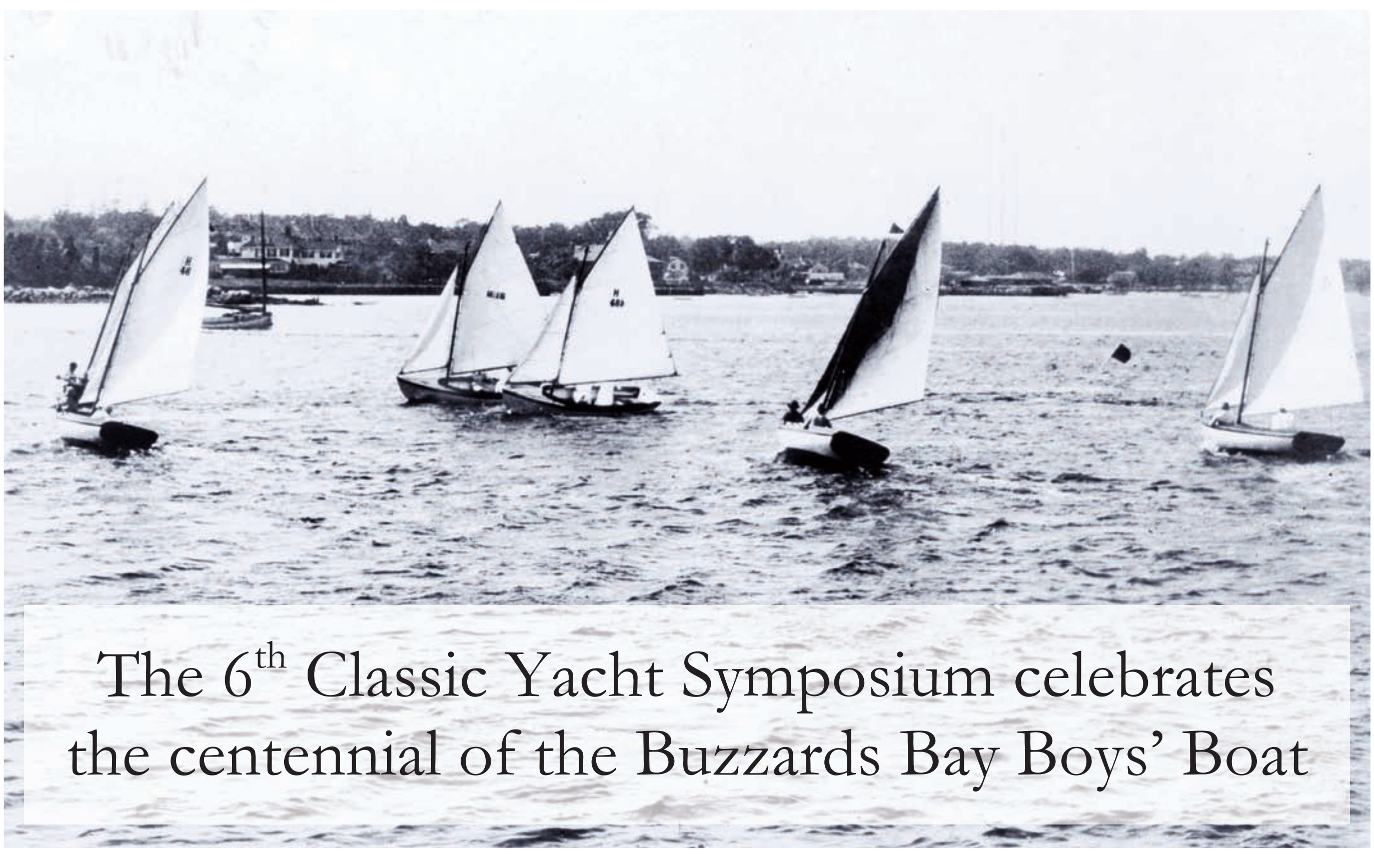
**ABOUT THE AUTHOR:**

**Chris Wick** grew up cruising the New England coast with his family and admired the Herreshoff 12½'s he saw in Buzzards Bay at an early age. After moving to Mystic and making friends with some other Herreshoff fanatics, he was presented by them with the opportunity to purchase MISCHIEF while still in graduate school in California. It has been a wonderful partnership ever since. He serves the Herreshoff Marine Museum on the Board of Directors, the Boat Preservation Committee, and the committee organizing the Classic Yacht Symposium.



# The 6th Classic Yacht Symposium celebrates the centennial of the Buzzards Bay Boys' Boat



# The Herreshoff 12½ Footer
# Evolution Of The Class

**Author Steve Nagy**
The Herreshoff Registry

**Figure 1** – H12½ early coaming ogee

**Figure 2** – H12½ standard coaming ogee

## Abstract

To authentically restore a classic yacht, one must know how it was originally configured. Quite a few of the original Herreshoff 12½ footers have missing builder's plates. The hull number on this plate is needed to reference the builder's record and determine the original owner, name, and configuration.

Configuration and construction of the 12½ footer evolved over the 100 years since Captain Nat completed the design. This paper examines how the construction of the boat changed over the years, looking at things like seat configuration, transom construction, and hardware changes. It draws on documentation, observations of working boat builders, and study of existing boats. With an understanding of how this evolution took place, a restorer or owner can fairly accurately estimate the age of a boat.

The Herreshoff Registry offers an online database containing entries for each of the 364 12½ footers built by the Herreshoff Manufacturing Company. If an owner or restorer uses the information in this paper and references the provenance supplied in the Registry, there may be enough evidence to specifically identify the subject boat.

## About the Author

**Steve Nagy** has been an avid Herreshoff fan for 15 years. After acquiring a 12½ in 2004, he began researching the history of the class and authored a paper on the topic for the first Classic Yacht Symposium in 2005. The 12½ was traded in for a Buzzards Bay 15, ELF, which was restored and re-launched in 2006. Though ELF now has a new owner, Steve has maintained his interest in the history of the Herreshoff Manufacturing Company and its boats. He runs the Herreshoff Registry, which is an online resource for Herreshoff owners, builders, and aficionados.

The Classic Yacht Symposium™ 2014

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**OVERVIEW**

Nat Herreshoff designed the 12½ footer in 1914. It has been in continuous production since then, and is nearly universally acclaimed as one of the finest small boats of all time. He was 66 years old by then, and had all the experience from a full and legendary career of designing and building yachts. He had already accumulated five of his never-matched record of six consecutive America's Cup defenses, and six consecutive victories.

Many of Captain Nat's most popular designs were derivatives of his personal boat, ALERION, which boasted a hollow bow. Not only is the hollow bow strikingly handsome (Fig. 1), but it smoothly parts the oncoming water, leaving behind a fine flow with minimal turbulence. The 12½ is one of these ALERION-derivatives.

The model, # 716, was carved in October 1914 after Nat was approached by Robert Emmons. Emmons, manager of the RESOLUTE cup defense syndicate, was a member of the Beverly Yacht Club. He and some of the club members were looking for a racing class that could be used to teach youngsters the art of sailing and be able to stand up to the chop of Buzzards Bay. Nat responded with the 12½. This same model was later used for the 16-foot waterline Fish by scaling up from 1/10 to 1/12.

The Herreshoff Manufacturing Company took the first orders for the 12½ footer in 1914 and built 364 wooden hulls through 1943. Following the closing of HMCo production, the Quincy Adams Yacht Yard (QA) was licensed by HMCo. to build the design. Quincy Adams used the Herreshoff builder's plate, and built 51 hulls from 1943 through 1948. The Quincy Adams boats had hull numbers from 2000 - 2050, and were planked with mahogany rather than the white cedar used by HMCo. They also frequently exhibit something of a reverse sheer forward (Fig. 2), possibly due to a weakening of their laminated stems.

In 1947, Cape Cod Shipbuilding (CCSB) acquired the rights to the design. CCSB built 34 wooden hulls between 1948 and 1950, starting with sail number 2054. They then switched construction to fiberglass. You can still get a new fiberglass 12½ from Cape Cod Shipbuilding today. Cape Cod Shipbuilding also brought out a modification of the original, designed by Nat's oldest son, Sidney. Called the Cape Cod Bullseye, it is a fiberglass version of the 12½ hull with a small cuddy cabin.

Another company, Doughdish, Inc., is building a fiberglass version of the 12½. As Cape Cod's rights prohibit anyone else from using the trademarked named "Herreshoff 12½", the boat is called Doughdish. The molds were created by taking the lines from three original wooden hulls. Bill Harding, the creator of the Doughdish, took great pains to ensure his boat was an exact replica of the original, even eschewing the weight reductions afforded by fiberglass construction to ensure the Doughdish is authentic in every way (other than building material). In fact, the Doughdish is allowed to compete against the original wooden boats in association regattas, while the Cape Cod Shipbuilding 12½ is not.

If you look at a 12½ out of the water, you can't help but notice the shape and subtle reverse curves of her underbody (Fig. 3). It is thanks to this shape that the boat can ghost along so well in only the lightest breath of air while the other boats in the water stand still. The helm balance is perfect. They may be slow by today's standards and somewhat clumsy in confined spaces, but they are well mannered, roomy, dry, and seaworthy.

**HULL CONSTRUCTION**

Throughout the HMCo construction run, the same basic hull was used. There were 22 steam-bent white oak frames per side and 10 cedar planks per side. Many of the planks were formed using multiple lengths of lumber joined by butt blocks (Fig. 4). It is a common assumption that the 12s were built during quiet times in the yard and whatever cedar lumber was available in the stockpiles was used for the planking.

One hull construction technique that changed was the use of a back rabbet. The original boats were "bald-headed", which often resulted in a leaky garboard-keel seam. Sometime between 1930 and 1938 (hulls 1170 and 1450), a back rabbet was introduced, presumably to cure the leaking issue. This switch is not documented, and we are trying to more accurately identify when it occurred.

Quincy Adams used mahogany planking and laminated stems. Cape Cod Shipbuilding always used full-length cedar planks, eliminating the need for butt blocks.

In 1936, marine plywood was introduced to replace the cedar planking used for the decks and bulkheads. Touted by HMCo as an improvement to increase hull strength, it again appears to be a cost-saving feature. Also in 1936, the coaming, trim and transom were switched from white oak to mahogany.

Between 1939 and 1941, 5 – 7 boats were built with a different configuration. These were hull numbers 1500, 1501, 1502, 1503, 1504, and possibly 1509 and 1510. Known as the "Improved Model" or the "Fishers Island Model", they had mahogany trim, a Marconi rig, wider side decks, copper flotation tanks under the seats, a flush after deck, and an over-the-transom tiller (Fig. 5). There is a story that Sidney designed these changes to the standard configuration to make the boat more resistant to capsizing after his father had a mishap in Bermuda with a standard 12½.

The seat configuration changed twice during HMCo. production. The first twenty boats had a rowing thwart and two after seats (Fig. 6). Starting with hull 768 in 1915, the seats were changed to two-piece removable cedar benches (Fig. 7) that ran the length of the cockpit on either side. In about 1936, they were changed to one-piece, fixed mahogany benches (Fig. 8).

**TRANSOM**

During the course of the HMCo production run, several changes were made to the transom construction. If using the transom as a vintage indicator, one must be cognizant of the fact that it may very likely be a replacement. The transoms on the 12½ had a tendency to deteriorate, and nearly all restorations require them to be replaced.

On the earliest boats the transoms were 5/8 of an inch thick and had an apron piece on the inside around the perimeter. These planks of these transoms were pinned together with wooden dowels. They also had light vertical framing on the interior side that came up through the after deck (Fig. 9). The sternposts were cut off below the level of the after deck, which was flat across without crown. These transoms had about one inch of radius athwartships.

In the early twenties, possibly at the time the Haffenreffers took over, the transoms were made ¾ of an inch thick and the dowels were changed to iron rod. The vertical frames inside the transom were eliminated and the sternpost was extended through the after deck below the tiller cut out (Fig. 10). The apron piece on the inside of the transom was eliminated in the mid-to-late 1920s. Much of the rot found in these transoms can be attributed to "iron sickness" from the metal drifts.

In late 1936, the coaming, trim and transom were changed from white oak to mahogany. The transom was changed to a thickness of 7/8 of an inch thick and flat across with no radius. This meant that the rudder post had to be made wedge shaped in order to make the rudder line up properly. The bottom end of the sternpost had to be widened to about five inches to do this.

**RIG**

HMCo offered three different rigs of the 12½ over the years. The first boats were delivered with a gaff rig. Most of the boats delivered to the Buzzards Bay area were similarly equipped throughout the HMCo production run. In the builder's record, it was commonly referred to as "J&M", or Jib and Main, and there were 208 entries for this rig.

The Marconi rig first appeared in 1926 on hull 987. This was generally referred to in the builder's record as "Leg-O-Mutton". There were 59 entries in the builder's record for this rig. The boats built for Maine were typically equipped with a Marconi rig.

In the 1930s, Sidney Herreshoff was experimenting with the "wishboom" rig, also referred to by HMCo as the "modernized" rig (Fig. 11). The wishboom was designed for ease of handling, and HMCo advertised it as an improvement for the 12½. It never really caught on, however, and there were only 4 entries in the builder's record for this rig (1240, 1241, 1280, and 1282).

Though the rig cannot be used to identify the vintage of a 12½, it can be used as good indicator as to where the boat was originally delivered.

**HARDWARE**

Of all of the H12½ characteristics, the hardware is the most useful, and at the same time the most bedeviling. Just about every other feature was standard … a buyer need only specify which rig and the rest was determined by the factory. There was a period of time in the 1930s, however, that there were some optional hardware choices. Consequently, it can be difficult to make deductions about vintage based on hardware.

The early boats had hardware cast in bronze by HMCo. In later years, the company subbed out the casting of its patterns. Starting in about 1935, stainless steel fittings were offered as an upgrade from bronze. (Fig. 12). Another option was chrome plating. Several examples exist, but we have yet to find documentation that delineates when the option was available.

The earlier boats had a two-piece, hinged mast partner (Fig. 13). The opening bail made the task of stepping the mast much easier. In 1936, starting with hull 1293, the mast partner was switched to a one-piece casting, presumably to reduce manufacturing costs (Fig. 14).

The traveler also changed in 1936 after hull 1293. The older one was a straight rod that terminated at each end in a ball shaped socket attached to a mounting flange (Fig. 15). The later one was a rod that had a 90-degree bend at each end attached to a mounting flange (Fig. 16). The knob on the original style had a tendency to snag the mainsheet, which was mitigated by this change.

There were also two styles of bow chocks. The later style was introduced in 1936 after hull 1293. Examples of later boats with the earlier chocks exist, however, so this is not a clear indication of vintage. Refer to Figures 17 and 18.

On boats built after 1939, a bronze boom crotch socket was let into the after deck (Fig. 19).

The builder's plates used by the Herreshoff Manufacturing Company included the hull number of the vessel. The Company used several different styles over the years, and three types were used on the H12½. On the earliest boats, up through 1924, the plate was rectangular, mounted to the starboard of the mast partner, and made of German Steel, a bronze alloy (Fig. 23). In 1924, possibly with the advent of the Haffenreffers, the plate was changed to a small oval of bronze, also mounted to the starboard of the mast partner (Fig. 24). The third style, used after hull 1293, was a large bronze oval mounted in the center of the transom (Fig. 25). The Quincy Adams boats used this last style plate.

**FIRST TWENTY**

The first 20 boats were ordered in 1914 and delivered to the Beverly Yacht Club in time for the 1915 season. These are somewhat different than the others, and can be readily identified. All but 744, 750, 754, 755, and 765 have been accounted for. The following characteristics are specific to the first 20 boats, numbers 744 – 765.

- The coaming ogee is stretched longer than on the other boats (Figs. 20 & 21).
- The interior is configured with rowing thwarts (Fig. 6).
- The tiller socket is metal rather than wood (Fig. 22).
- The mast is 2-7/8" in diameter at the mast partner rather than 3-3/8"

**MANUFACTURING EVOLUTION**

After John Brown Herreshoff died in 1915, Nat added the duties of business manager to his existing design, engineering and construction responsibilities. In addition to being 66 years old, he didn't have the business acumen of his brother. By 1917, the company's finances were in trouble. Nat sold a controlling interest in the company to a syndicate of investors, including James G. Swan, A. Loring Swasey, Charles Adams, Harold Vanderbilt, Junius Morgan, George Nichols, and Robert Tod. Despite their wealth and yachting experience, however, the syndicate was unable to turn the company around and put it up for auction in 1924.

Thanks at least in part to the urging of one company manager, Tom Brightman, Rudolph Haffenreffer submitted a higher offer than the other auction bidders (mostly liquidation firms) at the auction and took over ownership of the Herreshoff Manufacturing Company. Haffenreffer, owner of Narragansett Brewing and a successful entrepreneur, installed a management team led by his business-trained sons. With eyes focused on restoring profitability, the new owners made changes to the operation and were able to keep HMCo. going until 1947.

One of the interesting changes the Haffenreffers made was the practice of building boats, especially the 12½ and S-Boats, for inventory. This is fairly evident after studying the builder's log and the original contracts of many of these boats. The Haffenreffers apparently believed that the efficiency of a production run in quantity more than offset the use of funds tied up in inventory. In some cases, it appears that finished, or nearly finished, stock was on hand for two or three years before being sold. Another change is that boats were built to the order of brokers or for customers through brokers: F. B. Barden; Sparkman and Stephens; John Alden; Stanley; and Eldred.

Another Haffenreffer change was subbing out some of the hardware fabrication. As evidenced in the casting pattern cards, HMCo cast their own hardware for years. In early 1935, they began to sub some of this work out. Most of the hardware on the 12½ after this time was cast from HMCo patterns by suppliers rather than manufactured in house.

As can be expected, the popularity of the H12½ enabled HMCo to raise the price of the boat steadily from $420 in 1914 to $1100 by 1928. After the Depression struck, prices had to be lowered starting in mid-1931, and went all the way down to $690 in 1937 before rebounding somewhat through 1938. From there, they drifted downward again. World War II may have had something to do with this, though this is only speculation as demand was reasonably good at that time.

**BUILDING MOLDS**

There are three sets of HMCo. molds for the 12½ known to exist, and all were conveyed to CCSB at the end of 1947. One set is on a strongback in a storage area at Mystic Seaport known as "Aladdin's Cave" (Fig. 26). Another set is stacked up and displayed at the Herreshoff Marine Museum. Presumably, CCSB has the third set.

**MODERN VERSIONS**

The 12½ has been in continuous production since 1914. HMCo built 364 hulls through 1943. Quincy Adams built another 51 through 1948. Cape Cod Shipbuilding built 34 wooden hulls through 1952 before switching to fiberglass. They have been building fiberglass boats ever since.

In 1973, a somewhat more authentic fiberglass reproduction known as the Doughdish appeared. Now owned by Ballentine's Boat Shop, the Doughdish is also in current production.

If a new, wooden 12½ is on your wish list, Artisan Boatworks will build you an authentic reproduction (Fig.27). It is so authentic that Alec Brainerd, proprietor of Artisan, insists that each of his craftsmen initial the underside of the foredeck in pencil, just like the HMCo builders did 100 years ago.

A popular derivation from the original design is the Haven 12½. The Haven was designed by Joel White in 1986. It has a centerboard rather than a full keel, and a wider, shallower aft section to counter the balance differences. There are many examples of the Haven out there, and they are built by both professional and amateur builders. By all accounts, she behaves very similarly to an H12½.

**IDENTIFICATION GUIDE**

It is quite common for a Herreshoff boat to be missing its builder's plate. Some of the plates were probably lost as a result of storm damage or misplaced during a varnishing session. But others are not where they belong purposely. And the missing plate phenomenon is common to Herreshoff boats in general, not only the 12½'s. In one case, a 12½ was sitting overnight at a gas station while repairs were being made to her trailer. A thief made off with the plate, but nothing else. In another case, a savvy owner had a replica plate built for his boat, and he has the original at home for safekeeping. In another case, a new owner found a previous owner from 50 years prior. That prior owner still had the plate and considered it a cherished keepsake.

This section summarizes the information presented above and was prepared to help owners of a Herreshoff 12½ with a missing builder's plate determine the vintage of their boat. One must be very careful in assessing one of these boats as over the years, many of the identifying characteristics have been changed during repairs or restorations. Many of the indicators are details that could have been changed and may throw off your identification.

**Step 1: Is it a Herreshoff Manufacturing Company boat?**

- If the boat is fiberglass, it is NOT an HMCo boat. It would be manufactured either by Cape Cod Shipbuilding or Doughdish, Inc. after HMCo went out of business.

- If it is wood but has a centerboard, it is NOT an HMCo boat. Most likely, it is a Haven 12½, which is a modification of the original drawn by Joel White.

- If your boat is wood and does not have a builder's plate, it could possibly be built by a private builder. More likely, however, it was built either by Cape Cod Shipbuilding, Herreshoff Manufacturing Company, or Quincy Adams Shipyard.

- If the boat is planked in mahogany, it is a QA boat. 51 QA boats were built between 1943 and 1948. Many, if not most, were built in the "Fishers Island" style, but without the copper flotation tanks (see Step 2). They used HMCo builder's plates with numbers 2000 – 2050. QA also used laminated stems. Over the years, these stems tend to weaken and give the boat a slight reverse-sheer forward of the mast.

- If the boat is planked in cedar and employs butt-blocks, it is an HMCo boat. HMCo boats were built between 1914 and 1943. In most, but not all cases, HMCo did not use full-length planks and joined them with butt blocks. CCSB built 34 wooden boats between 1948 and 1952. CCSB used full-length planks and did not use butt blocks.

**Step 2: Is it an HMCo standard configuration or "Improved Model"?**

- HMCo built a total of 364 12½ footers. Of these, 5 – 7 of them were "Improved Models", also known as "Fishers Island Models". The improved version had mahogany trim, a Marconi rig, wider side decks, copper flotation tanks under the seats, a flush after deck, and an over-the-transom tiller. Unless your boat is one of the few unidentified vessels that have these characteristics, you have a standard configuration. These boats were built between 1939 and 1941. Hull numbers are 1500, 1501, 1502, 1503, 1504, and possibly 1509 and 1510.

**Step 3: Is it one of the first 20?**

The first 20 are different than the others, and can be readily identified. These 20 were ordered in late 1914 and delivered for the 1915 sailing season in Marion, MA. The following characteristics are specific to the first 20 boats, numbers 744 – 765. Only 744, 750, 754, 755, and 765 remain unaccounted for.

- The coaming ogee is stretched longer than on the other boats
- The interior is configured with rowing thwarts
- The tiller socket is metal rather than wood
- The mast is 2-7/8" in diameter at the mast partner rather than 3-3/8"

**Step 4: Was it built before or after 1936?**

- At the beginning of 1936, HMCo switched from using white oak to mahogany for the coaming, transom, and trim work.

**Step 5: What are the details?**

Getting closer is still possible, but it requires an examination of some of the finer details. At this point, it is probable that changes may have been made over the years that will contaminate your evidence, so very careful examination is required.

- The deck and bulkheads were planked cedar prior to about 1936 and plywood thereafter. The sternpost terminated below the after deck on boats built prior to the early 1920's, and protruded above the deck thereafter.

- Until the early 1920s, the transom was made of 5/8" oak. At that time, a switch was made to ¾" oak. In 1936, the transom became 7/8" mahogany.

- The traveler was changed after hull 1293. The older one was a straight rod that terminated at each end in a ball shaped socket attached to a mounting flange. The later one was a rod that had a 90-degree bend at each end attached to a mounting flange.

- A bronze boom crotch socket was let into the after deck on boats built after 1939.

- The mast partner was hinged up until hull 1293, when they switched to a one-piece casting.

- The bow chocks were also changed after hull 1293, at least in some cases. Refer to Figures 17 and 18 for photos of the two styles.

## THE HERRESHOFF REGISTRY

The Herreshoff Registry is an online resource for Herreshoff owners, builders, and aficionados. In offers an active discussion forum and features a searchable database that contains information for each of the 1100 sailing vessels built by the Herreshoff Manufacturing Company. If an H12½ owner or restorer uses the information in this paper and references the provenance supplied in the Registry, there may be enough evidence to specifically identify the subject boat.

HMCo built 364 12½s. To date, 176 have been found, 12 are known to have been destroyed, 42 have been found but without a known hull number and several leads are being actively researched. This means that only 37% of the production run is unaccounted for.

The Registry can be found online at http://www.herreshoffregistry.org.

## ACKNOWLEDGMENTS

Quite a number of people were instrumental in gathering the data and providing the insight necessary to compile the information presented in this paper and in the Herreshoff Registry. The author wishes especially to acknowledge the following colleagues for their contributions and assistance:

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## ABOUT THE AUTHOR:

**Steve Nagy** has been an avid Herreshoff fan for 15 years. After acquiring a 12½ in 2004, he began researching the history of the class and authored a paper on the topic for the first Classic Yacht Symposium in 2005. The 12½ was traded in for a Buzzards Bay 15, ELF, which was restored and re-launched in 2006. Though ELF now has a new owner, Steve has maintained his interest in the history of the Herreshoff Manufacturing Company and its boats. He runs the Herreshoff Registry, which is an online resource for Herreshoff owners, builders, and aficionados.

# Appendix - Construction Evolution Table

| Component | Characteristic | Indicator | Vintage |
|---|---|---|---|
| | | | |
| Planking | Wood Species | Cedar | HMC or CCSB boats |
| | | Mahogany | Quincy Adams Shipyard |
| | Joints | None | CCSB, QA |
| | | Butt-Blocks | HMC |
| | Bulkheads & Decks | Cedar Planked | Earlier boats (until 1936) |
| | | Plywood | Later boats (after 1936) |
| | | | |
| Trim | Wood Species (transom, coaming, sheer strake) | Oak | HMC boats 1914 – 1936 |
| | | Mahogany | QA, CCSB, HMC boats 1936 – 1943 |
| | Coaming Ogee | Stretched | First 20 boats |
| | | Normal | All but first 20 boats |
| | Bench Seats | Removable | Earlier boats |
| | | Fixed | Later boats |
| | Rowing Thwarts | Yes | First 20 boats |
| | | No | All others |
| | Side decks | Wide | Improved or Fishers Island model, #1500 - #1504 |
| | | Standard | All others |
| | Copper flotation tanks | Yes | Improved or Fishers Island model, #1500 - #1504 |
| | | No | All others |
| Rigging | Rig Type | Gaff | Available all years |
| | | Marconi | First available in 1924 |
| | | Wishboom | #1240, #1241, or #1280 |
| | Mainsheet | 2-part | Earlier boats |
| | | 3-part | Later boats |
| | Boom Sailtracks | Yes | Later boats |
| | | No | Earlier boats |
| | Lazy Jacks | Yes | Earlier boats |
| | | No | Later boats |
| | Jib Downhaul | Yes | Earlier boats |
| | | No | Later boats |
| | Jib Club attachment | Earlier config | Earlier boats, through #1202 |
| | | Later config | Later boats, from #1206 |
| | | | |
| Transom | Thickness | 5/8 " Oak | Earliest HMC boats, until early 1920's |
| | | 3/4 " Oak | Early HMC boats, early 1920's until 1936 |
| | | 7/8 " Mahogany | QA, CCSB, HMC boats 1936 – 1943 |
| | Vertical Stiffeners | Yes | Earlier boats, until early 1920's |
| | | No | Later boats, after early 1920's |
| | Transom margin apron | Yes | Earlier boats, until c. 1928 |
| | | No | Later boats , after c. 1928 |
| | Radius | Yes | Earlier boats, prior to 1936 |
| | | No | Later boats, after 1936 |
| | Sternpost | Above deck | Earlier boats, until early 1920's |
| | | Below deck | Later boats, after early 1920's |

| Component | Characteristic | Indicator | Vintage |
|---|---|---|---|
| Hardware | Bow Chocks | HMC casting patterns 4763,4764 (Fig. 17) | Earlier boats, through #1293. |
| | | HMC casting patterns 12428, 12429 (Fig. 18) | Later boats, after 9/1936. Contradictory examples do exist, however. |
| | Boom Crotch Socket | None | Earlier boats, prior to 1939 |
| | | HMC casting pattern 12483 | Later boats, after 1939 |
| | Builder's Plate | Rectangle (Fig. 23) | Used until 1924 |
| | | Small oval (Fig. 24) | 1925 – 1930 (through # 1173) |
| | | Large oval (Fig. 25) | 1931 – 1943 (#1174 - #1518) |
| | Mast Partner | Opening (Fig. 13) | Earlier boats, through #1293 |
| | | One-Piece (Fig. 14) | Later boats, after 1931 |
| | Traveler | Earlier config (Fig. 15) | Earlier boats, through #1293 |
| | | Later config (Fig. 16) | Later boats, after #1293 |
| | Metal Tiller Socket | Yes | #744 - #765 (1914) |
| | | No | #768 - #1518 (1915 – 1943) |

FIGURES REFERRED TO IN TEXT


Figure 1 – The Hollow Bow of a 12½ Footer.


Figure 2 – A Quincy Adams 12½ Footer

Figure 3 – A 12½ Footer Out of Water

Figure 4 – Butt Block

Figure 5 – Improved Model

Figure 6 – Original Seat Configuration

Figure 7 – Two-Piece Bench Seats
(Note that open forward bulkhead is not original)

Figure 8 – One-Piece Bench Seats

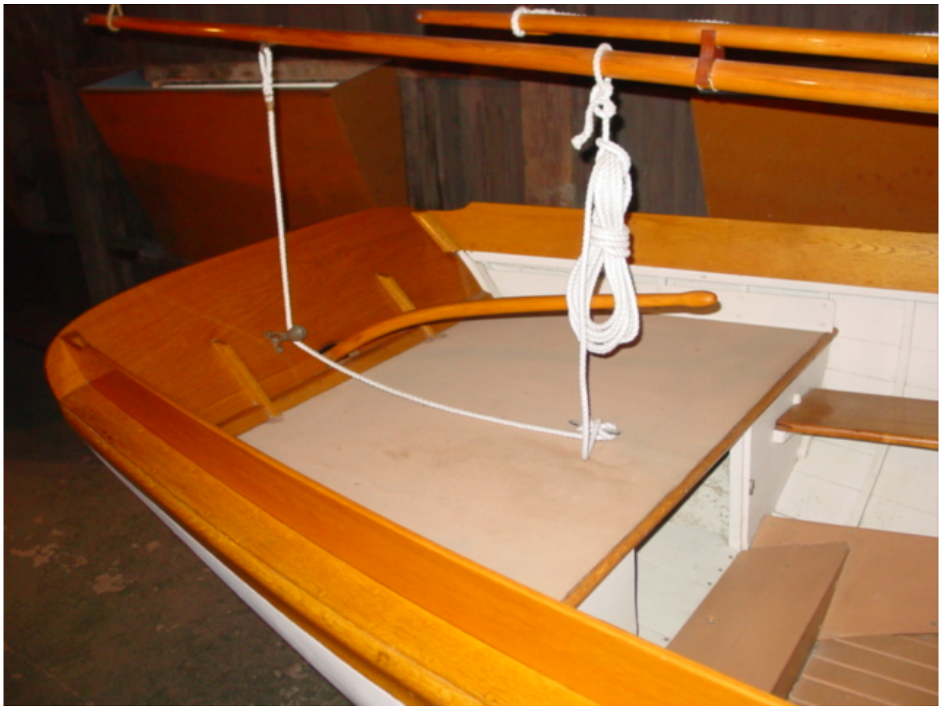


Figure 9 – Transom Vertical Stiffeners

Figure 10 - Above-Deck Sternpost

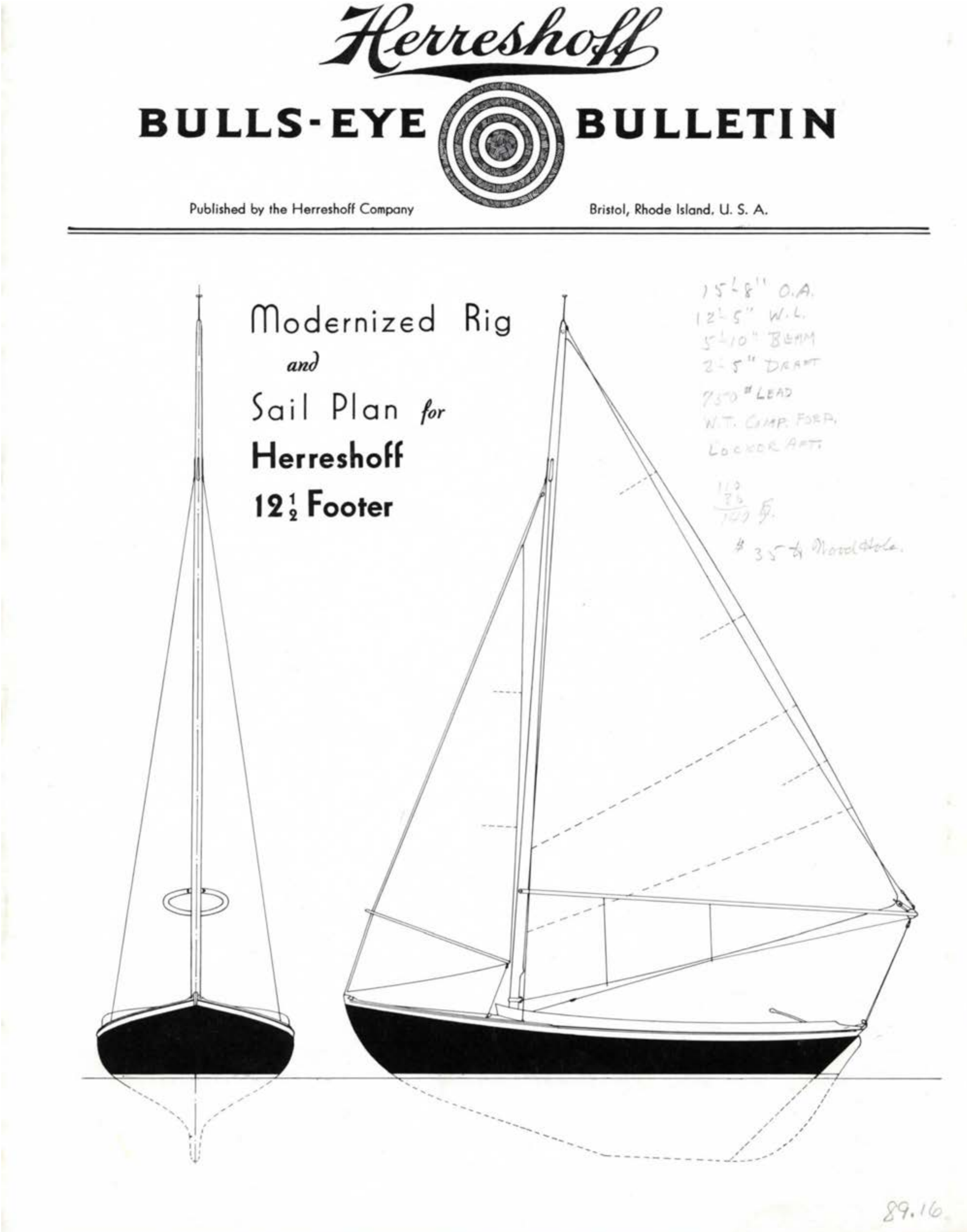
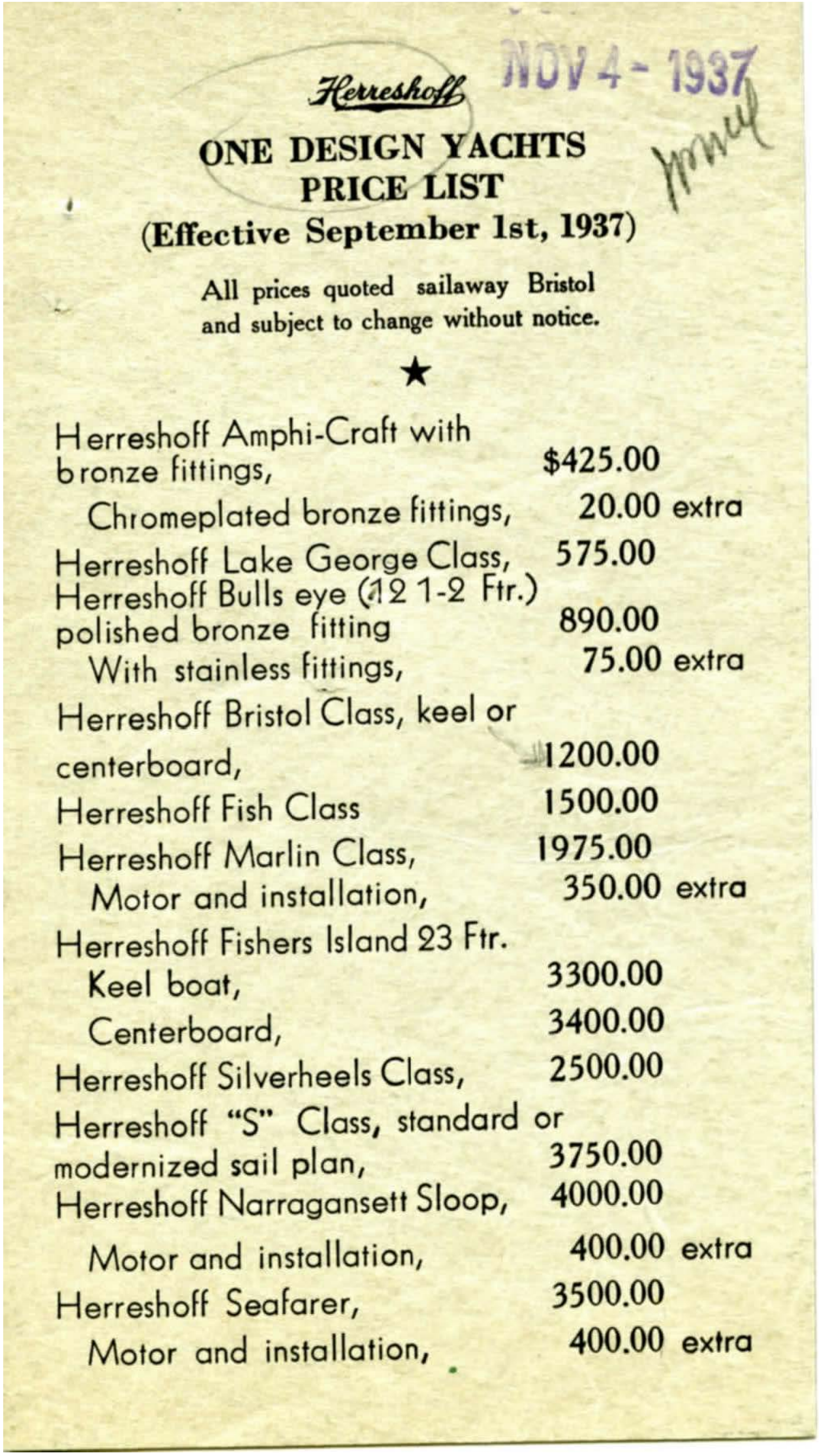



Figure 11 – Modernized Rig (courtesy Herreshoff Marine Museum)



NOV 4 - 1937

Herreshoff

**ONE DESIGN YACHTS**
**PRICE LIST**
**(Effective September 1st, 1937)**

All prices quoted sailaway Bristol
and subject to change without notice.

★

| | |
|---|---|
| Herreshoff Amphi-Craft with bronze fittings, | $425.00 |
| Chromeplated bronze fittings, | 20.00 extra |
| Herreshoff Lake George Class, | 575.00 |
| Herreshoff Bulls eye (12 1-2 Ftr.) polished bronze fitting | 890.00 |
| With stainless fittings, | 75.00 extra |
| Herreshoff Bristol Class, keel or centerboard, | 1200.00 |
| Herreshoff Fish Class | 1500.00 |
| Herreshoff Marlin Class, | 1975.00 |
| Motor and installation, | 350.00 extra |
| Herreshoff Fishers Island 23 Ftr. | |
| Keel boat, | 3300.00 |
| Centerboard, | 3400.00 |
| Herreshoff Silverheels Class, | 2500.00 |
| Herreshoff "S" Class, standard or modernized sail plan, | 3750.00 |
| Herreshoff Narragansett Sloop, | 4000.00 |
| Motor and installation, | 400.00 extra |
| Herreshoff Seafarer, | 3500.00 |
| Motor and installation, | 400.00 extra |

Figure 12 – 1937 Price List (courtesy Herreshoff Marine Museum)


Figure 13 – Two-Piece Hinged Mast Partner

Figure 14 – One-Piece Mast Partner

Figure 15 – Earlier Traveler

Figure 16 – Later Traveler

Figure 17 – Earlier Bow Chock

Figure 18 – Later Bow Chock

Figure 19 – Boom Crotch Socket

Figure 20 – Early Coaming Ogee

Figure 21 – Standard Coaming Ogee


Figure 22 – Metal Tiller Socket


Figure 23 – Early Builder's Plate


Figure 24 – Middle Builder's Plate


Figure 25 – Later Builder's Plate

Figure 26 – Construction Molds At Mystic Seaport

Figure 27 – Artisan Boatworks Reproduction – Courtesy Artisan Boatworks and Allison Langley.

# One Hundred Years of the Herreshoff 12½ at Quissett

**Authors Douglas E. Cooper & Carol R. Suitor**
Centennial Research Committee, Quissett Yacht Club

**Figure 1 –** Quissett H12½s maneuvering for the start

## Abstract
The waters off Quissett and Woods Hole on Buzzards Bay have challenged sailors for generations. Herreshoff-built boats first started racing there in the 1890s. In 1915, the Herreshoff 12½ footer, a boat designed to be small and seaworthy enough for children to sail on Buzzards Bay, made her debut in a race off Naushon Island. Until 1942 the 12½ was sailed primarily, as had been intended, by juniors, but with restrictions imposed by the Navy during WWII adult yacht club members started racing the boats and discovered their good manners. The boat went on to become the dominant class at Quissett YC with the fleet size peaking in the 1950s. In the 1960s the original wooden boats started to show their age and many were sold or mothballed. With the advent of fiberglass reproductions in the 1970s the class at Quissett was revitalized and remains today the largest fleet in New England.

## About the Authors *For complete bios see the paper on the Proceedings DVD*

**Douglas E. Cooper** is a 4th generation boat builder and designer who learned his trade at the side of his father and grandfather His accomplishments include building, with his father, a replica Gold Cup racing powerboat, restoring a Herreshoff S boat, and re-building and repairing numerous 12½s. His design work includes a 23-foot catamaran, a 30-foot power launch, and the frostbite DC-10. Cooper is currently building a power launch of his own design and re-building two Herreshoff 12½. He has lived in Falmouth all his life and, with his wife Katherine, sails and races a Herreshoff S boat out of Quissett.

**Dr. Carol R. Suitor** first came to Woods Hole in 1968 as a doctoral student of the Johns Hopkins School of Hygiene and Public Health to do research at the Marine Biological Laboratory. Her academic career included positions at the Harvard Medical School and Tufts Veterinary School. Her most recent research has been in the eastern Artic. She has owned many wooden one designs including a Star, Herreshoff Fish, and six Herreshoff 12½s. She recently served as Race Committee Chair of the Quissett Yacht Club and currently lives in Falmouth with her husband Robert Suitor.

The Classic Yacht Symposium™ 2014

# One Hundred Years of the Herreshoff 12½ at Quissett

**Douglas E. Cooper & Carol R. Suitor**
Centennial Research Committee, Quissett Yacht Club

Figure 1 Maneuvering for the start, left to right: PUFFIN, CAPRICE, TSURU, HALCYON, CUTLASS, and SCUP. (Photograph by Dorothy I. Crossley)

**ABSTRACT**

The waters off Quissett and Woods Hole on Buzzards Bay have challenged sailors for generations. Herreshoff-built boats first started racing there in the 1890s. In 1915, the Herreshoff 12½ footer, a boat designed to be small and seaworthy enough for children to sail on Buzzards Bay, made her debut in a race off Naushon Island. Until 1942 the 12½ was sailed primarily, as had been intended, by juniors while their elders competed in larger classes. With the restrictions imposed by the Navy during the war years, adult yacht club members started racing the boats and discovered their good manners. The boat would go on to become the dominant class at Quissett Yacht Club with the fleet size peaking in the 1950s. In the 1960s the original

wooden boats started to show their age and many were sold or mothballed. With the advent of fiberglass reproductions in the 1970s the class at Quissett was revitalized and remains today the largest fleet in New England.

**INTRODUCTION**

The history of boatbuilding and sailing often reveals that a design that most suits the conditions of a particular place will endure when others do not. The Herreshoff 12½ footer has been sailing out of Quissett Harbor on the southeast shore of Buzzards Bay for almost one hundred years. The design has survived wars, hurricanes, and four generations of sailors. When the wind rises to fifteen knots on the bay and the famous chop is cresting past the entrance buoy, it is the 12½ footer that braves the onslaught, safely carrying her passengers to the starting line or any random destination. In these conditions there are no Sunfish, modern sailing dinghies, or trailerable powerboats to challenge her mastery of the scene.

In a relationship that continues as the center point of the club itself, the history of the Quissett Yacht Club and the Herreshoff 12½ is virtually synonymous. Retaining even the original gaff rig, the boat remains, in design, essentially unchanged from when she first appeared.

The following narrative traces the 100-year history of the 12½ footer at Quissett and the surrounding waters from its first appearance to the present time.

Figure 2 Aerial view of Quissett Harbor and Woods Hole looking southwest.

**SETTING THE STAGE**

Although sailing vessels had been traversing Buzzards Bay for work and pleasure since the arrival of the British, it wasn't until the late 1800s that formal racing became established. Yachtsmen in Woods Hole, just south of Quissett, were the first in the area to organize and run races for multiple classes. The club sailed mostly locally built small centerboarders known as "Woods Hole Boats". They also raced larger "knockabouts" (note: at the beginning of the 20th century a knockabout was any sloop without a bowsprit) some of which were built by Herreshoff. They varied in size from 15 to 25 foot waterline length. One of the Woods Hole yachtsmen who raced his Herreshoff-built VIREO (HMCo 459) in the larger class was Ralph Emerson Forbes. Forbes, whose family had owned Naushon Island since 1856, and whose mother was the great essayist Emerson's daughter, would become a key player in the story of yacht racing at Quissett. (VIREO (459) is listed in the HMCo Construction Record as VIERO. Both the QYC records and Browne Littell in his "Early Days of Racing in Woods Hole" written in 1996 record the name as VIREO and that was the name of another 17-footer of unknown origin owned by Forbes.)

In 1897 the Beverly Yacht Club, which then had no home but moved from venue to venue, held one of its travelling regattas off of Quissett Harbor. It is the first record of yacht racing at Quissett and was, according to the Boston Globe, a significant event:

*Vast numbers of city people began to assemble at the Quissett Harbor House…to view the race. Hosts of pretty girls in handsome carriages…were in attendance. Yachts assembled in the harbor midday, 75 boats sailing to and fro.*

Steven Carey, Jr., son of the owner of the Harbor House Hotel, was one of the competitors and most likely the instigator for the venue.

Figure 3 The Quissett Harbor House as it appeared in 1912. (Photo by Baldwin Coolidge)

**A YACHT CLUB AT QUISSETT**

At Quissett the catboat in varying sizes was the preferred type, with a sprinkling of Herreshoff 15s and Cotuit Skiffs. In 1901, the largest catboat regatta on record was held off Woods Hole including the 26 foot ADDIE owned by Charles H. Eldred. "Captain Eldred", who had become a regular competitor in the annual event, owned the boatyard in Quissett where yachts of various sizes were maintained. One of his summer duties was to take out sailing parties from the Harbor House Hotel. At that time, he and Steven Carey were Quissett's greatest enthusiasts for sailboat racing.

The year 1911 saw the Woods Hole Yacht Club disbanded due to disagreements over money and the perceived unfair advantage of local sailors over the summer residents. The loss of a local club to host races caused Quissett sailors, mostly frequent guests of the hotel, to become interested in holding their own races. On August 26, 1911, the Falmouth Enterprise reported:

*A regatta was held in Quissett Harbor on Saturday. A light breeze sprung up about noon and a launch gaily decorated with flags bore the judges with their wives and friends out onto the bay. The race was over a triangular course in 17 – 18 foot catboats.*

By all accounts, the regatta was a resounding success. Among the summer residents of the Harbor House Hotel conversations revolved around establishing a yacht club. As a result, the Quissett Yacht Club was formally organized in 1912.

**THE BUZZARDS BAY BOY'S BOAT**

Two years later, Robert Emmons of Monument Beach at the northern end of Buzzards Bay, approached Nathanael Herreshoff to design a small knockabout that children could handle safely in the bay's steep chop, created by the usual summer sou'westers. Drawing on his extensive knowledge of small boat design and his experiences with Bermuda dinghies, Herreshoff carved a model with a gracefully overhanging bow, concave forward waterlines, a conventional lead ballasted keel, and a deep narrow rudder. The new boat was 12½ feet on the waterline, just shy of 16 feet in length overall, and weighed approximately 1400 pounds. As was standard at the time, she was gaff rigged and had a small self-tending jib. In subsequent years, a Marconi rigged version was designed and sailed at other clubs. Known initially as the Buzzards Bay Boy's Boat, the boat would later be called a Herreshoff 12½ and eventually by Quissett residents shortened to "a Herreshoff". The class would become the "Wizard of Bristol's" most famous and beloved design.

The Herreshoff yard built twenty boats during the winter of 1915 and these appeared that summer in locales around the bay. Ralph E. Forbes of Naushon purchased four boats for his children and named them CLETHRA (HMCo748), KINGLET (HMCo751), AGOUTI (HMCo756), and MIDGET (HMCo757). Another boat, SHRIMP (HMCo749), was purchased by Philip Spalding of Marion and brought to Quissett to be raced by his son Oakes. Marka Wise, Oakes Spalding's daughter, reminisced about her family's beloved boat:

*SHRIMP was given to my father in July of 1915 on his 11th birthday. Throughout his teenage years he sailed her in Marion and all over Buzzards Bay, often camping overnight on some beach. She survived three hurricanes without a scratch—truly a charmed boat. In the early forties she was brought to Woods Hole where she was raced by my brother for several years both in Woods Hole and Quissett, then I took over the helm and raced for several years… At 96 years old she is still being put in the water each year and is being sailed in Marion by my grandson… When I told my brother that she was still going, he was almost brought to tears. (Marka Spalding Wise, QYC Archives)*

Two more 12½s would arrive in Quissett that first year, named RHODORA (HMCo753) and BONITA (HMCo761).

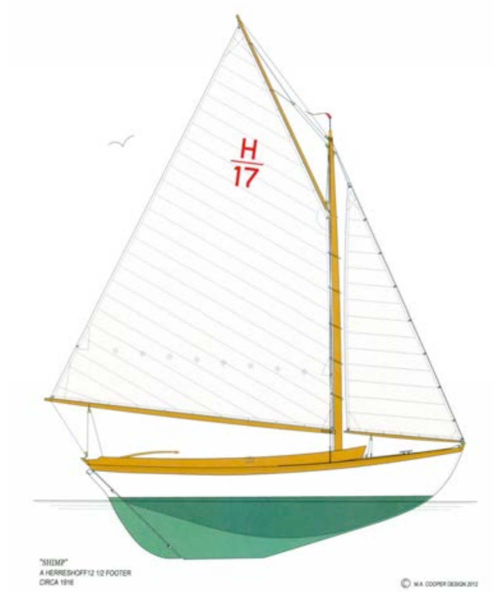



Figure 4 SHRIMP as she appeared in 1915. (Drawing by Matthew A. Cooper)

August 7, 1915 marks the first mention in *The Falmouth Enterprise* newspaper of the Herreshoff 12½s racing as a group when the four Naushon boats and two Quissett boats raced off Hadley Harbor. On August 14 the Quissett Yacht Club held races for all classes with twenty boats turning out to race in a "steady whole sail breeze." In the new 12½ class, or, as the race committee designated them, "2nd class knockabouts", the winner was MIDGET.

The seminal event of the season took place on August 21 when the Forbes family, led by Ralph Forbes in his 17-footer VIREO, brought their Herreshoffs to race at Quissett. "Many thanks are due to the Forbes family of Naushon for their interest in the races both financially and by adding their fleet," commented the Falmouth Enterprise. At a subsequent special meeting of the yacht club Philip Spalding and Ralph Forbes were admitted as new members. Ten years later, Ralph Forbes would become Quissett's third and longest serving Commodore.

When the United States entered the "Great War" in 1917 all yacht racing was suspended up and down the east coast including Quissett. The officers met and resolved that, "on account of the fact that the United States was at war it was not advisable for the club to hold or attempt to hold any yacht races this season." (QYC archives)

**DECADES OF GROWTH**

As the Quissett summer community grew in the 1920s, with residents moving out of the hotel and purchasing their own homes, so did the yacht club. The Herreshoff 12½ was slowly becoming the boat of choice for Quissett's young sailors, but only for those in their teenage years. In 1922 a fleet of Beetle cats, designed and built by the famous whaleboat builder Charles Beetle of New Bedford, was delivered from across the bay. Quissett parents had decided they needed an even smaller boat for their children under age 15 to begin sailing. With more boats and more children in the club a Wednesday series was established where both classes, the Beetle and the 12½, could race every week all summer. Boys and girls from ages 6 or 7 up to 17 competed with the fleets separated by age groups.

The adults, meanwhile, were competing on Saturdays and Sundays in larger gaff rigged sloops of various designs including Manchester 17s and the in-house designed "Q" boats. Even as the Beetle cats (or "Sea" boats as they were called in Quissett) were being sailed by Quissett's youth, the larger catboats that had been the backbone of the fleet at the club's founding were waning in popularity. By the end of the decade the Quissett Yacht Club had raced catboats from various builders, Cotuit skiffs (then called "skeeters"), Herreshoff 15s (or "E" boats), "Q" class knockabouts, Manchester 17s, Eastern 17s, and even Star boats. By 1928 the old knockabouts were showing their age and perceived as obsolete. Convinced by their favorable experience with the 12½ and other Herreshoff designs and determined to shed the pitfalls of handicap racing, club members decided the Herreshoff S boat was a good choice as a one design that could handle the challenging conditions on the bay. A fleet of boats was purchased from Long Island Sound in 1928, ushering in two decades of lively competition at Quissett by the S class.

The sailing season of 1930 saw the Woods Hole Yacht Club reemerge as an active club. New young members, holding no hard feelings from the past, were enthusiastic about racing the new classes and with the help of old stalwarts succeeded in reconstituting the club. Though its clubhouse was long gone, the members were able to run meetings in a private boathouse on Great Harbor. Given their close proximity, there was considerable overlap of membership between Woods Hole and Quissett that quickly resulted in boats competing at both clubs on a weekly basis.

By the mid-1930s, the participation of boats from both clubs, racing at Woods Hole and Quissett, had become a common occurrence. Woods Hole's 12½s, or Buzzards Bay Knockabouts as they were known in that harbor, SEAL (HMCo1007), TUNCH (unknown), VIKING (HMCo1237), and COOT (HMCo893) sailed to Quissett to race on Wednesdays. Conversely the Quissett boats CUTLASS (HMCo1140) and SHRIMP would race in Woods Hole on Mondays. Though the two locations are close as the crow flies, to get from Woods Hole to Quissett Harbor was always a challenge. The boats would set sail in either Great or Little Harbor and then sail through Woods Hole Passage, one of the most treacherous on the east coast, with either fair or foul current. Once through the "hole" it was usually downwind around Penzance Point out into Buzzards Bay before finally arriving at the starting line off Quissett. After racing competitively they would sail back home the same way but usually upwind. Depending on the weather it was very often a long day. If the wind died there was always "the white ash breeze" (rowing). If the current was too strong they could anchor and wait. The Giffords, Clowes, Normans, Drapers and later the O'Sullivans would sail from Great Harbor while the Bradleys and Cranes from Little Harbor. Quissett crews—the Keiths, Kings, Marckwalds and Emerys—made the trip in reverse, arriving in Great Harbor in time to race. Many times, the Eldred Boat Yard work boat ADDIE would stand by to help tow the boats if the tide or wind were unfavorable. If a member sailed in all the races run by both clubs, and some did, they were racing three or four times a week.

One of those who was born into a family of Woods Hole sailors was David Bradley. He grew up summering on Juniper Point at the eastern entrance to Woods Hole. In 1935, when David was 14, his father purchased a Herreshoff 12½ for him that they christened VIKING. Astonishingly his father commanded young David to sail the new boat from Bristol to Woods Hole. What follows is his account of the trip written shortly afterwards entitled "A Voyage in a Twelve Footer" originally printed in the Falmouth Enterprise:

*The morning had brought no wind, and we heaved to off Bristol to eat lunch. How little those calm ham sandwiches suspected the rigorous experiences they were to go through before the day was over. Nor had we any premonition. As the afternoon breeze freshened, we started beating up the long Sakonnet fjord toward the ocean. The ponderous railroad bridge swung sluggishly on its pivot to let our little Herreshoff twelve footer through. The tide was running hard against us but we managed to work through and up to the auto bridge. With much bellowing and horn blowing, we finally convinced the bridge tenders that we wished to pass. Slowly the two sections reared back and we nosed out of the eddy to beat through. The roaring current swirled us back a couple of hundred yards, and amid a convincing display of appropriate vocabulary and hair tearing the bridgemen slacked the bridge down and traffic resumed its usual rush.*

*In an hour the tide turned favorable and running against the now heavy wind had kicked up quite a white-capped sea. Again the bridgemen hoisted the bridge back and we roared out into the swirling, tossing chop. It seemed an endless beat to Sakonnet Point. Five hours of chop, roll, spray, tack after tack, each one wetter than the last. Our little ship ploughed and plunged, crashed and splashed its weary way along, while puffs would lay her down and water would pour in over the gun'l. Our sou'westers kept us partly warm and dry as the bow would toss the top of each wave in our faces. I've never seen a boat throw so much water for its size. It seemed as though most of the ocean was flying through the air; a good part sloshed about in the bottom, soaking our food and bedding; the rest trickled down our shivering spines.*

*Finally the waves got the upper hand of us. Joe left off pumping out the boat and stood a watch at the lee rail to take care of his automatic stomach, and a little later the endless chop took toll of me. Some seamen! Out by Sakonnet Point the enormous ocean swells were sweeping in in their powerful, indifferent manner, dashing high in a silver wreath over the rocks and lighthouse. We would climb and climb to the top of the world of water, and then drop sickeningly over into the trough.*

*Out past the point we fetched a red nun where we eased our sheets and swung off for Cuttyhunk. The land slowly faded into the mist and we were alone, a chip tossed about and discarded by each roller, a plaything for the restless ocean. A tramp steamer wallowed by, the crew waving heartily as it nearly swamped us; the plaintive wail of the Hen and Chickens whistler came in an irregular throb.*

*Just as the sun sank into the horizon mist, looking like a misshapen tomato, we fetched Cuttyhunk, cold, miserable, empty. Running lights were lit and we ghosted along before the wind under the lea of Cuttyhunk and Nashawena in the pale afterglow. Then, blue-black night engulfed us; the wind slackened; the green starboard lamp glared into the murk, while the port cast a ruddy gleam on the lower part of the sail. Only our palely lighted boat seemed to have finite proportions; we were gliding in an infinitude of deep blue, while cottony foam-clouds boiled along under our quarter, and silent lobster-pot buoys slid by unexpectedly. Brilliant Venus was our friendly beacon.*

*In a couple of hours the black bulk of Weepeckets emerged from the gloom and we bore up a couple of points to starboard. At first, Woods Hole was a confusing array of lights, but soon the Hole straightened itself out and we slipped in on a slackening tide, past the green blinking spindle, past the swaying ghostly black can, past the port blinker—home. It was about midnight. With tired eyes and aching backs, happy hearts and uneasy stomachs, we made fast our sleek little ship, furled the sails, and sloshed ashore in our bulky, dripping oilskins, homeward bound on a road that pitched and swayed far too reminiscently. (David Bradley, The Falmouth Enterprise)*

Towards the end of the 1930s, with the number of 12½s in Quissett slowly growing, adults started to move into the junior fleet. Inexplicably, as there is no documentation to explain the change, some mothers began to race with their children. At first, the women were most likely crew but then they swapped off at the helm with series honors being awarded to both mother and child. By 1940 the adult women were in full competition with their children. One explanation is that women who had never raced were able to sail in a class free from the dominance of their husbands. Probably juniors saw it as an amusing opportunity to best their mothers in sport. Whatever the reasons, the Herreshoff 12½ class for juniors evolved over a few years into adult women battling it out every Wednesday.

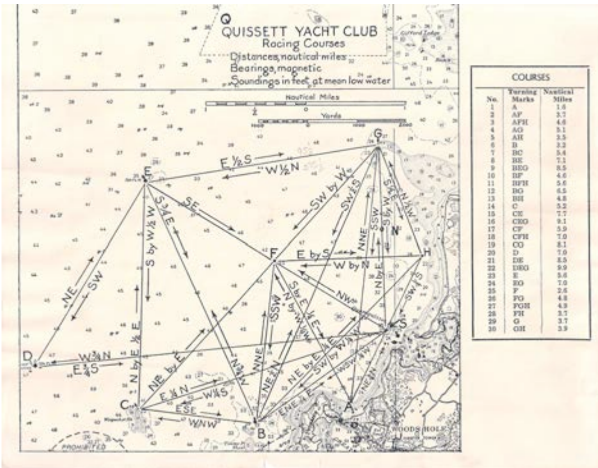



Figure 5 Quissett Yacht Club course sheet from the 1930s. (QYC Archives)

**STORM CLOUDS OVER THE BAY**

Because of the harbor's natural advantages and the post Labor Day timing of the storm's arrival, Quissett survived the Great Hurricane of 1938 relatively unscathed:

*Its harbor, facing west-northwest, was protected from the southeast winds and the relatively high lands at the entrance blunted the worst rise of the sea. (Glorious Good Times, QYC)*

In Woods Hole however, with its harbors facing to the south, many boats were wrecked and, even worse, lives were lost in the 20-foot tidal surge. Some boats were a total loss. Others would be rebuilt by local craftsmen.

On September 1, 1939, Europe was once again plunged into war. Though an ocean and a continent away even Quissett would eventually feel the repercussions. A year later, siblings John and Elizabeth Bevan, eight and thirteen years old respectively, needed to escape German air raids in Britain and were sent by their parents to the United States. With $40.00 between them they arrived in Quissett to stay with a host family and instantly fell into the summer routine. Having recently endured aerial bombing, the children were terrified when an evening thunderstorm came booming across the bay and left them "cowering beneath their bed clothes, thinking only of the air raid alarms and bursting bombs they had left behind…"

By 1941 fourteen-year-old Elizabeth was racing DOVEKIE (unknown) in the 12½ footer class.

*The boys of Quissett made the most of their happy circumstances in the days before the war. Like boys of any era they were prone to mischief and enjoyed the playfulness of nicknames. Franklin King, Jr., the eldest son of Franklin and Margaret, was known to all as "Bunge", a nickname inherited from his father… (Glorious Good Times, QYC)*

As a teenager, while beating to windward in a fierce southwest blow, he swamped his family's 12½, PSYCHE (HMCo953). Her watertight bulkhead didn't hold and she sank off of Penzance Point. Fortunately, before PSYCHE slid beneath the waves, Bunge had the presence of mind to tie a cushion to a halyard. After being rescued by the Race Committee Bunge returned home to face the wrath of his father. Thanks to his quick thinking, though, the boat was found and raised the next day and would resume her racing career.

*Charles Goodwin had to earn his nickname. His reward for bringing his older brother a cold drink… was to be called Shanghai Charlie after the hero of a popular radio show. It stuck for life as Shanghai or Shang. Racing in a strong northwest breeze Shang, while crewing for Kent Swift, Jr. in WINDIGO (HMCo1135), gained notoriety by swamping on a run. As waves broke over the stern, the 12 ½ started to founder. Shang bailed madly but dropped the bucket over the side. He then grabbed the pump but in his excitement it also went overboard. In desperation he grabbed the spinnaker bag but lost that too. Both boys grimly accepted their fate although they had made it within a hundred and fifty yards of the finish when WINDIGO finally swamped, held up only by her watertight bulkhead, with just the tip of the bow above water and the boys hanging onto it. The boys and the boat were rescued by the old reliable ADDIE. (Glorious Good Times, QYC)*

The racing season of 1941 seemed far away that December when the surprise attack at Pearl Harbor lead to the subsequent declarations of war. Having repelled the air onslaught, the Battle of the Atlantic became critical for Britain's survival. Supplies of all kinds had to be shipped to the island and the Germans gave top priority to sinking as many ships as possible. Warships and freighters were assembled into convoys for the North Atlantic crossing. One of those gathering places was Buzzards Bay. Due to the convoys forming near Weepecket Island and to the west of Quissett the yacht club was prohibited from using its outer racing marks and as a result set temporary marks closer to the harbor. These marks would remain in use, roughly in the same location, until the present day. This restriction severely fettered the S class, which needed the longer courses. The officers of the club suspended S boat and Handicap racing for the duration of the war. The Herreshoff 12½ fleet had been gaining momentum before the war and in 1942 became the only alternative. Members racing 12½s out of Quissett on the usual course to the Woods Hole Bell in a southwest breeze had to sail through the ships anchored to await a convoy; this proved to be thrilling and challenging. As the little boats tacked through the anchorage, with interested crews hanging over the ships rails as spectators, the skippers had to decide whether the windward or leeward side of a ship conveyed an advantage over competitors.

**A NEW ERA**

With the surrender of Japan in the summer of 1945 everyone anticipated life in general, and Quissett in particular, would return to normal. As the United States entered a new and unprecedented era of prosperity the isolated summer community of Quissett was experiencing deep social shifts. These began with the yacht club itself, which elected its first female commodore in 1946, Mrs. Margaret "Giddy" King. At the time of her election she had become an accomplished racer, having started as crew for her husband in S boats, but then winning as skipper in the 12½ class. That summer, 28 boats formed the Herreshoff 12½ racing fleet. There was a significant growth in population and housing in the larger Falmouth area, including parts of Quissett. A number of new families came to the Quissett region in the summer and the yacht club membership list grew accordingly. Another reason for the increase in membership was the growing popularity of the Herreshoff 12½ as a one-design boat that all ages could sail.

Figure 6 From left to right: ADAJIO, CUTLASS, CAPRICE, CORMORANT, and JANCY LEE racing upwind. (Photograph by Dorothy I. Crossley)

The most stunning news came not from racing but from a near tragic sailing accident. Lieutenant Hilton, a naval officer, and Virginia Stoddard, governess to the Webster children, decided to sail RHODORA, the Webster's Herreshoff, to Weepecket Island. The couple left Quissett Harbor around noontime in a choppy northeast breeze bound for the small island just to the west of Naushon. Before reaching Weepecket, RHODORA took a large wave over the stern, swamped, and five minutes later sank. Somehow Stoddard and Hinton swam ashore to the island, but then decided to swim across to Naushon before dark. They "struggled against the full force of the northeast blow and the heavy tug of waves and current. They were flung against the rocks as they landed on the Naushon shore." They reached a Forbes house and were given a ride to Woods Hole on the five o'clock launch. RHODORA, one of the original 1915 boats, was never found and remains undisturbed on the bottom of Buzzards Bay.

1947 saw the further increase of the 12½ fleet, compelling the Race Committee to split the racers into two divisions: A and B. The faster boats, A division, started five minutes before the slower B division. However well a skipper did in the previous race determined his division ranking for the next race. If a boat did well she could move up, if badly back down again and so on throughout the season. As before the war the Woods Hole boats were coming to Quissett each Saturday to compete, thus swelling the size of the fleet. The class completely dominated the racing scene at Quissett with as many as thirty boats involved in the Saturday Series, Cup races or Wednesday races. At the Edgartown Regatta that year NORMANDIE (HMCo1462) sailed by Andy Norman from Woods Hole won in the 12½ class with Quissett's ace Bob Walmsley coming in second in ROCKET (HMCo1488).

Paul Lloyd O'Sullivan was a French Canadian who, as a result of playing professional hockey for a Boston team, settled in Boston. He loved sailing his old catboat BUNDEE, named for his two daughters Bunny and Deedee. He decided his family would summer in Woods Hole so the girls would be in a scientific community. After purchasing PELICAN (unknown), a Herreshoff 12½ that had been damaged in the '38 hurricane and rebuilt, from Charlie Eldred the two girls began to sail in the waters of Woods Hole. There they met young Prosser Gifford whose family had sailed out of Woods Hole since 1910. Gifford, all of 15, showed them how to sail a 12½ through Woods Hole passage against the current. Forced to learn in difficult conditions, both girls became formidable racers. Bunny, the elder, usually skippered but after Deedee tired of being second string she convinced her father to buy another Herreshoff, dubbed appropriately LITTLE LADY (HMCo1009). In 1949 Deedee continued the tradition of other Quissett female skippers when she won the Prosser Cup, a woman's regional championship, sailing plywood 110s in Larchmont, New York. She would repeat this victory when she won again in 1953, racing off of Quissett in the familiar 12½. To complete her triumph, the Prosser Cup was named for the grandfather of the man she would eventually wed.

Charles E. Burt grew up in Connecticut where he was introduced to sailing and continued with it as a lifelong love. A successful electrical engineer, he summered with his family in the Moors neighborhood of Falmouth and kept a boat in Falmouth Harbor. One day his eldest son David, who had been frustrated at summer camp by the lack of sailing exposure, was wandering around Wormell's boatyard and spotted an attractive small keel boat. His father, noticing his son's interest, spoke up, "They sail those in Quissett and they're too expensive." Then, upon further consideration, he added, "Quissett is where the real sailors are." Towards the end of the summer, to the delight of David and his siblings, Charles relented and bought a Herreshoff 12½, the last wooden one built by Cape Cod Shipbuilding in Wareham. David and his younger brother Teddy, ages 12 and 9 respectively, sailed her down the Wareham River and on to Quissett, under the watchful eye of their father aboard his cruising sloop LITESKIP. David recalled the ceremony on the following day:

*The next day, our little sister, Janet Lee Burt, donned a dress and white gloves, and with a bottle of "the champagne of ginger ales" wrapped in white cloth with ribbons christened our Herreshoff 12½* JANCY LEE (Cape Cod Shipbuilding). *Janet was no longer called Jancy after that. (C. David Burt memories)*

With JANCY LEE on a mooring in Quissett, Charles Burt decided to move LITESKIP there as well. Though the Burt family was still not officially a member, they would eventually become intimately involved in all the club's activities.


Figure 7 Getting the boats ready for the season at the Eldred Boatyard. (Photograph by Edwin Gray, Courtesy of the DeWitt-Coffin family)

During the 1940s and 50s Charlie Eldred, who had inherited the Eldred Boatyard from his father, owned and chartered several 12½s each summer season. All of his boats had bird names including PUFFIN (unknown), CORMORANT (HMCo1168), PELICAN, COOT, and DOVEKIE. When one of his boats acquired a bad racing reputation, probably because of those sailing her, she was labeled "a dog" by the racing pundits. The result for Eldred was that nobody wanted to charter her. Being a pragmatic Cape Codder and not wanting a boat to go unused, over the winter he painted the 12½ a different color and re-named her. The next summer the boat was viewed as a new arrival, eagerly snapped up, and after a successful season widely viewed as "fast". In somewhat of a conflict of interest Charlie Eldred had the added perspective of operating the committee boat in most of the races.

1954 saw another hurricane hit the area. Though not as severe as 1938s the storm arrived in late August when the harbor was full of boats, even transients. Many boats were washed up on the sea wall at Quissett and badly damaged. As the storm started to abate, two young Quissett sailors, eleven year old Toby Tompkins and his best friend Freddie Houston, decided, unbeknownst to their parents, to go for a sail in the 12½ MOONSHINE (Quincy Adams). In a colorful and possibly exaggerated account entitled "Stupid Kid Tricks", Toby relates the tale, a sample of which follows:

*I set MOONSHINE off on the port tack, and I think the big wind's direction was the only thing that spared us. Running directly before the wind seemed too dicey: the huge waves could easily come in over the stern and swamp us. And sailing close-hauled, I quickly discovered wasn't in the cards either. Almost as soon as we cleared the moored skiff, I had to head up and take in sheets to steer around a big moored Concordia yawl. [Hurricane] Carol slapped MOONSHINE down so hard green water poured in over the lee rail. O'l Nat had planned for a bit of a breeze, to be sure: the 12s were so broad in the beam that when they heeled over dangerously, the windward side of the hull stole some of the wind from the belly of the mainsail and the boat would right itself. Of course he never imagined anyone would be dumb enough to go sailing even in the "tail-end" of a hurricane.*

*Freddy and I slacked off the sheets immediately, and we took up a medium reach, the wind coming in over MOONSHINE'S forward quarter. 12s ran best on a medium-to-broad reach, engaging the waves at an angle, heeled slightly, their 2½ foot keels with 750 pounds of lead on the bottoms keeping them from slipping alee, and their mains and jibs working at maximum efficiency…*

*Even with the handkerchief main, MOONSHINE went like stink. The waves were working with us, and we roller-coasted faster than either of us had gone in a 12, which isn't exactly built for speed. We'd kept the pump set up, and Freddy quickly cleared the water that had come in. He joined me on the windward of the two long benches, and we howled, terrified and ecstatic, as MOONSHINE surged along. We were already in the* *broadest section of the Outer Harbor, making for the channel, and the waves had changed from hard, choppy punches to immense combers, the curls of spume at their crests whipped into the sky as soon as they formed. The sloop climbed the muscular backs of the rollers, punched through the crests, and slid into the troughs, and I think at least one of us actually yelled "Wheee!"*

Suffice it to say, the boys lived to tell the tale.


Figure 8 COOT, reefed and ready to race. JANCY LEE (#7) astern. (Photograph by Dorothy I. Crossley)

Throughout the 1950s the wooden 12½s soldiered on, racing twice if not three times a week. The Quissett fleet was still sizable, not including the boats from Woods Hole. The S boats were gone by the end of the decade, the reason given as lack of crew, but it was mostly because the boats were considered passé, a fate the 12½ s didn't share. The boatyard struggled to keep all the boats in shape with varnishing and painting each winter. The yearly burden finally overcame Charlie Eldred and he sold the yard in 1958 to Bruce Barnard, who had cut his teeth racing and building Cape Cod Knockabouts.

Reporting on the 1959 season Commodore Spalding, who had sailed SHRIMP as a boy, wrote, "A team race was held with the Beverly Yacht Club with over 40 Herreshoff 12s participating. The results of the race unfortunately are still very much in doubt as each side claims that the other side was the victor." Apparently, in an act of Buzzards Bay diplomacy, both fleets were too polite to accept the prize.

In 1961, the Race Committee realized that the watertight compartments that were supposed to keep the boats afloat if they swamped were no longer reliable. As the boats aged the seal between the decks, sheerstrake, and planked bulkheads had become compromised (something that had been known for some time with the sinking of PSYCHE and RHODORA). With the invention of Styrofoam many boat owners stuffed the forepeak with the material for peace of mind. That year it was made mandatory in the club to so modify all boats. Some boats had the foam in the lazarette (aft storage compartment) also and one boat that swamped in a junior race kept sailing with decks awash. To this day most of the remaining wooden boats retain this feature.

Cynthia DeWitt Coffin, whose family had summered in Quissett since the 1890s, was given her own 12½, built by Quincy Adams, in 1946 when she was 22 years old. Sailing throughout the 50s and 60s while raising a family she became, by the early 1960s, the dominant racer. But there was youth behind her rising fast. Janet Burt, then a teenager was beginning to steal the silver in her JANCY LEE. Janet remembered a regatta at Beverly:

*With Ted (Janet's older brother) sailing JANCY LEE, I brought the Bergmann's CORMORANT. I was hot that summer and more brazen than I ought to have been. I remember I port-tacked the entire fleet (probably 30 boats), and found myself leading the fleet to some unknown windward mark. After a while it became apparent that boats behind me were tacking away to go to a different mark. Ted was close enough to me so that we could talk. We decided that he and half of the Quissett fleet would go to the mark most of the boats were peeling off for, and that I would lead the rest of the Quissett fleet past H and E… The race was endless, taking hours to complete. "Hot Rocks" Peirce, the Beverly Yacht Club ace at the time, won the race. (Janet B. Chalmers memories)*

In 1963 the two women teamed up to win the Prosser Cup with Cynthia at the helm and Janet as crew. The next year it was 19-year-old Janet's turn to win as skipper.

Figure 9 CUTLASS sailing out of Gansett at the entrance of Quissett Harbor to compete for the Prosser Cup in 1964. (Photograph by Dorothy I. Crossley)

**FALL AND RISE**

By the early 1970s the old wooden 12½ fleet was dying. Most of the generation that had inherited the boats perhaps lacked an appreciation for how valuable they were. They had grown up with them, always had them, didn't have to buy them, and apparently were reluctant to invest in restoring them. It was just a question of time, and not much more, before the class would be gone from Quissett. The same was true in other clubs around Buzzards Bay with the number of boats competing dropping dramatically.

In 1972 there was a regatta for all 12½ owners in the bay and a meeting to discuss a solution. At this meeting Bill Harding proposed building a fiberglass reproduction, not as Cape Cod Ship had done employing a modern rig, but a gaff rigged version retaining most of the original woodwork. The next year the first Doughdish, as the Harding boat was called, was finished and sailed. In trials that summer against the wooden boats the new glass version seemed competitive yet equal. In 1974 a Quissett member, Bob Hurd, purchased one of the first boats, named her WENDY, and brought her to Quissett. After a summer of racing with his wife and young sons, WENDY was accepted by the fleet to race with full privileges as the other members noticed no superiority.

Meanwhile, realizing their misreading of the market, Cape Cod Shipbuilding came out with their own gaff-rigged fiberglass version. Once again a Quissett member purchased a boat and brought her to Quissett for a season of trials. The same process was adhered to as with the Doughdish and the Herreshoff racers declared the Cape Cod Shipbuilding boat acceptable. The H class, however, voted at an annual regatta to permit only Doughdishes to compete with the wooden boats at all future inter-club events. Confronted with this turn of events, the Quissett Yacht Club flag officers, after much angst, reversed their decision regarding the Cape Cod Shipbuilding boat's eligibility to race. Their official position was that the Cape Cod Ship boat varied too much from the originals and that "we don't want members going to an H Class regatta only to be told they can't race". When shown that in some ways the Cape Cod Ship boat was more authentic than the Doughdish the directors made the additional claim that it was desirable to have only one manufacturer. The "one manufacturer" rule was also the stated position of the H Class.

There were other new competitors entering the racing scene at Quissett in the early 1970s. William Cooper arrived in Quissett in 1944 on a schooner and developed an instant bond to the place. He later married Judith Eldred, daughter of Charlie Eldred, whose father had inherited the boatyard from his father Captain Charles. Working for a time at the boatyard Bill developed a deep affection for the 12½ and all things Herreshoff. In 1972 one of the boats he had admired and taken care of in his youth, CUTLASS, came up for sale. Though not a member of the club nor a racer he bought the boat, a simple act that would change the life of his youngest son Douglas permanently. After crewing for Sheila Burke, a sailing instructor and successful Quissett racer in her youth, one season in CUTLASS Douglas was keen to compete himself. The Club wanted to keep the boat in competition so Douglas, great grandson of a founding member, was allowed to join on his own at 16 years of age. This was an unprecedented bending of the membership rules spearheaded by Cynthia Coffin. Not having grown up in the club he never attended any formal sailing class but acquired his skills from his father, Sheila Burke, and on his own. In 1974 the third regatta of the new H Class was at Quissett and that year a junior championship was also held on Friday. Douglas Cooper in his famously fast CUTLASS was the winner of the juniors.

Having grown up in California sailing, Jalien Hollister was eager to get out on the waters surrounding Woods Hole after moving there in 1965. When her eye caught the pretty Herreshoff 12½s riding to their moorings she was smitten. Jalien purchased ROCKET (HMCo1488), a boat that when sailed by the legendary Bob Walmsley had proven almost unbeatable. ROCKET was past her prime and Jalien struggled in the early years. Through dogged determination Jalien gradually improved and by 1978 was winning on a regular basis.

Rob Hurd had grown up sailing at Quissett and started racing Quissett's first Doughdish, WENDY, in the late 70s. High strung and savagely competitive he progressed into one of Buzzard Bay's finest racers. He would go on to coach the Tabor Academy sailing team and win 6 H Class championships.

By 1980 the Herreshoff 12½ fleet had expanded from its early 70s lows to the biggest turnout for a race being 17, five of which were Doughdishes. It was clear that the fleet was being revitalized by the fiberglass boats and more wooden ones were being rebuilt, though other boats were sold off. Although the 1980s saw a continuing rise in the number of fiberglass boats, once again the wooden boats started to decline with the result being the overall fleet size remaining the same.

Quissett sailors had their share of H Class championship wins in the 1980s: C. David Burt in 1980 sailing his Doughdish, TAG ALONG, and Douglas Cooper winning two years in a row in 1984 and '85 in the wooden CUTLASS. Rob Hurd sailed WENDY to victory in 1987. 1989 marked the 75th anniversary of the 12½ design. At Quissett, 18 wooden and glass boats turned out to honor the class in a parade of sail. The boats were loaded with crews ranging in age from 7 months to 80 years. David Burt brought along 4 students from Spain, and though late for the parade Bunny O'Sullivan brought five people and four dogs. Wooden boats participating were: SPONGE (HMCo1102), CORMORANT, PANI BABA (HMCo1277), MARLIN (HMCo1010), GAMBOL (unknown), and TUMBLEWEED (HMCo1365).

The 1990s brought more Quissett H Class champions: Janet Burt Chalmers in 1992, Rob Hurd again in 1993 and '94, and C. David Burt in 1997.

Figure 10 Approaching the reach mark, H Class Championship Regatta at Quissett, 2002. (Photograph by Carol R. Suitor)

**A BOAT FOR THE GENERATIONS**

As the centennial of the Herreshoff 12½ design approaches, Quissett Yacht Club has a strong and vibrant Doughdish fleet. The number of wooden boats, regrettably if predictably, keeps declining as a percentage. Perhaps as a testament to the care they have been given, though their numbers are few they remain extremely competitive. A review of the current Herreshoff-built 12½s still sailing reveals the owners' depth of devotion and the boats multi-generational appeal.

William Armstrong II bought ADAJIO (HMCo1294) in 1970. He considered changing her name but was dissuaded. After years of father and son racing, Bill Armstrong III now races with his son George, grandson of William.

Figure 11 ADAJIO with three generations of Armstrongs aboard. (Photograph by Janet B. Chalmers)

FREEDOM (HMCo1098), the oldest wooden 12½ still actively sailing in the Quissett fleet, was purchased by Dick Jones "the mayor of Quissett" in the 60s. The boat was completely rebuilt in 1992 and is now sailed by Dick's son Douglas and his grandson Henry. She's won many trophy races with Douglas Jones as skipper.

Weatherly Dorris, named for a twelve meter when her father, Bruce Barnard, was part of the ownership syndicate, is an example of someone being named after a boat instead of the more usual other way around. Weatherly grew up at the Quissett boatyard sailing 12½s. Her father acquired PANI BABA in the 60s for his children. Weatherly and daughters Charlotte and Lilly still competitively race the boat. PANI BABA won best boat in the Quissett Yacht Club in 2013, beating out all the Doughdishes and wooden Herreshoff 12½s for the honor. Weatherly, who currently owns Quissett Harbor Boatyard, also owns another 12½, CORMORANT.

TUMBLEWEED, formerly owned by Bunny O'Sullivan but now in the hands of her daughter Rebecca Hunnewell, was rebuilt in 2012. Bunny's own boat PELICAN, given to her by her father, is currently undergoing extensive repairs after surviving several hurricanes and decades in mothballs.

WILL O' THE WISP (HMCo1193) was purchased by Carol Reinisch Suitor who brought the boat back to Quissett after years of absence. Carol came to Woods Hole in the 1960s as a student. Though having little sailing experience she developed an interest in the old wooden boats of the area. After owning several boats she settled on the 12½ footer. Father and son William and Douglas Cooper, who had worked on her various boats, convinced her that through racing she would become a more accomplished and competent sailor. She has owned, at various times, six Herreshoff 12½s. Carol believes that WILL O' the WISP is the best 12½ she has purchased and swears, at age 68, it will be her last. Her multiple ownerships are explained by her quest for a boat with an original builder's plate and an accurate record of ownership. One of Carol's previous boats, EVENFALL (unknown), is now LORELEI owned by Terry Cronburg and was second in the 2013 H Class Championships.

CUTLASS is still owned by Douglas Cooper who is currently doing a total restoration of the boat. She is known not only for her speed but her Keith green topside paint, a color that can only be described as unique. CUTLASS has been in Quissett since she was new (1930) and hopefully has many years of sailing and racing ahead of her.

NORMANDIE (HMCo1462), a boat that has been in the same family since she was built in 1939, sails out of Woods Hole having undergone a complete restoration by Steve Ballentine. She had a distinguished career when raced by Andy Norman who, as part of his accomplishments, managed to swamp her in the Woods Hole passage following a Labor Day race. NORMANDIE is currently owned by Nancy Lassalle, sister of Andy, and is treasured more now than ever by the family.

There are old Quissett boats that still sail but are no longer in Quissett. SHRIMP, the oldest, still sails in Marion. The Naushon boats, though never moored in Quissett, raced at the Club in the early years and share the local nostalgia of the design with the Quissett boats. Astonishingly, all four boats, CLETHRA, KINGLET, AGOUTI and MIDGET are still moored at the dock in Hadley Harbor and still sailed each summer by Forbes descendants. In 1998 there was an unintentional reenactment of 1915 when Quissett 12½s, both wooden and fiberglass, sailed to Naushon and raced with the Forbes boats in outer Hadley Harbor.

ROCKET, after a restoration in the 1980s, is still owned by Jalien Hollister, former Quissett Yacht Club Commodore. ROCKET compiled a distinguished racing record both with Robert Walmsley and then later with Jalien. The boat currently sails out of Padanaram Harbor to the delight of the grandchildren.

Figure 12 PHOENIX with three generations of Garfields in the Centennial Boat Parade. (Photograph by Richard Michaelson)

The overall influence of the Herreshoff 12½ design in Quissett continues on. The fourth generation of Garfields, a family who started out sailing the wooden PUFFIN, now race two Doughdishes. Weatherly Saunders, whose great grandfather Laurence Saunders bought the wooden Cape Cod

Shipbuilding 12½ ME TOO in 1946, now races the Doughdish FOUND IT when not crewing for her grandfather Mort Saunders. Though the highly successful JANCY LEE was sold out of the Burt family, the assorted children, grandchildren and in-laws now race the Doughdishes TAG ALONG, SEA BREEZE, and SWIZZLE. Nina Hocker, whose family (Mayberry) owned ROCKET in the 1950s, currently competes in her Doughdish DORY TOO. Jack Morse, whose father bought the wooden TERN from Charlie Eldred, now races the fiberglass TERN.


Figure 13 Quissett Yacht Club's Centennial Boat Parade. (Photograph by Richard Michaelson)

**CONCLUSION**

The Herreshoff 12½ footer, more than any other boat design adopted by multiple yacht clubs, has been THE small boat to sail and race on Buzzards Bay for almost one hundred years. Youngsters to Octogenarians venture out into the bay with no fear of the rough and tumble waters knowing that their little vessel will bring them home safely. For other owners the fact that the old boat is no longer put in the water matters little. They love going out to the garage or barn just to look at her and dream of the past.

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We also thank many individuals who provided important information about their Herreshoff 12½s.

**ABOUT THE AUTHORS:**

**Dr. Carol Reinisch Suitor** [pictured in her laboratory in Iqaluit, Nunavut (eastern Arctic)] first came to Woods Hole in 1968 as a doctoral student of the Johns Hopkins School of Hygiene and Public Health to do research at the Marine Biological Laboratory. Her academic career included positions at the Harvard Medical School and Tufts Veterinary School. Her most recent research has been in the eastern Arctic. Over the years, she has owned many wooden one designs including a Star, Herreshoff Fish, and six Herreshoff 12½s. She recently served as Race Committee Chair of the Quissett Yacht Club and currently lives in Falmouth with her husband Robert Suitor.

**Douglas E. Cooper** is a fourth generation boat builder and designer who learned his trade at the side of his father, William B. Cooper, and his grandfather Charles L. Eldred. His accomplishments include building, with his father, a replica Gold Cup racing powerboat in the 1980s, restoring a Herreshoff S boat, and re-building and repairing numerous 12 ½s. His design work includes a 23-foot catamaran, a 30-foot power launch, and the frostbite DC-10 sailing dinghy. Cooper is currently building a power launch of his own design and re-building two Herreshoff 12 ½s at his shop in Falmouth. He has lived in Falmouth all his life and, with his wife Katherine, sails and races a Herreshoff S boat out of Quissett Harbor.

APPENDIX

**Catalog of Herreshoff 12 ½ footers Raced at Quissett 1915 – 2013**

The authors recognize that this list may have inaccuracies since early QYC race results are incomplete or missing. HMCo hull numbers are shown where known. QA refers to Quincy Adams built boats and CCS refers to Cape Cod Shipbuilding. Not all these boat belonged to members of the Quissett Yacht Club but include boats from Woods Hole Yacht Club as well. Many boats had their names changed over the years so it is certain that there are duplications in the list of which we are unaware.

The authors gratefully acknowledge Steve Nagy and his Herreshoff Registry for the invaluable information it provided.

| No. | Name | Owners | Current Owner |
|---|---|---|---|
| 748 | CLETHRA | Ralph E. Forbes | Forbes Family |
| 749 | SHRIMP | Oakes Spalding | Marka Wise |
| 751 | KINGLET | Ralph E. Forbes | Forbes Family |
| 753 | RHODORA | Webster | Sank in Buzzards Bay, lost |
| 755 | GRANNY | Hallowell | |
| 756 | AGOUTI | Ralph E. Forbes | Forbes Family |
| 757 | MIDGET | Ralph E. Forbes | Forbes Family |
| 761 | BONITA | E.W. Atkinson, Gerard LoPorto | Herreshoff Marine Museum |
| 847 | PENGUIN | Evans | |
| 848 | DOODLEBUG | Ralph E. Forbes | |
| 860 | MINK | Mrs. Walton | Elizabeth Bacon McNamara |
| 893 | COOT | Charles Blevins, Barbara Gifford | Selby Turner |
| 897 | ISABEL V. | Dean Emery, Isabel Haigh | |
| 902 | DOUGHBOY | Tompkins | |
| 905 | GARODA (ex CINCH) | Dwight McVitty | James C. Goff |
| 945 | JUNO | | |
| 953 | PSYCHE | Franklin King | |
| 985 | SHARK | Charles Barker | Mary White |
| 1007 | SEAL | George Clowes, Carol R. Suitor | Robert E. Moore |
| 1010 | MARLIN | James Ware Jr. | Mitzi Ware |
| 1047 | TAR BABY | Harold Sears | Alfred Slanetz |
| 1072 | DUCKLING | Janney | |
| 1073 | BARBAKINS III | Charles Barker | Robert Garry |
| 1082 | KELPIE | Stedman | |
| 1098 | FREEDOM (ex RACCOON) | S. W. Carey, Sandy Daignault | DeWitt C. Jones |
| 1102 | SPONGE | Bolster, Constance Martyna | Destroyed in fire |
| 1107 | JUANITA | Joseph Lilly | Ugo Baravalle |
| 1135 | WINDIGO | E. Kent Swift | |
| 1137 | BANDIT | Mary Draper | Richard D. Gentile |
| 1140 | CUTLASS (ex PAPILLON) | H. W. Endicott, Harold Keith | Douglas E. Cooper |
| 1168 | CORMORANT | Alex Winsor, Charles Bergmann | Weatherly B. Dorris |
| 1193 | WILL O' THE WISP | Wickersham, Winslow Carlton | Carol R. Suitor |
| 1194 | TERN | John Morse | |
| 1237 | VIKING | Joseph Bradley | Destroyed in '38 hurricane |
| 1238 | OVERHAUL (ex NOBSKA) | Ann Hall | |
| 1277 | PANI BABA (ex EASTWIND) | J.K. Lilly, Houston | Weatherly B. Dorris |
| 1280 | PICCOLO (ex SPINDRIFT) | Charles Eldred, F. L. Goodwin | Jim Phyfe |
| 1294 | ADAJIO | Richard Haigh | William F. Armstrong II |
| 1365 | TUMBLEWEED | Renee O'Sullivan | Rebecca Hunnewell |
| 1399 | PEEPER | Charles Eldred | Daniel W. Shea, Jr. |
| 1462 | NORMANDIE | Edward Norman | Nancy N. Lassalle |
| 1463 | TSURU | Martha Crane Gruson | |
| 1471 | DAPHIE | Philip Alton | Daniel Robb |
| 1485 | QUADRILLE | Carol Reinisch | Arthur Gaines |

| | | | |
|---|---|---|---|
| 1488 | ROCKET | Mayberry, Robert Walmsley | Jalien Hollister |
| QA | CAPRICE | Cynthia Coffin | |
| QA | MOONSHINE | Tompkins | Mary Edith Frank |
| QA | HUFFIN | Jake Peirson | |
| CCS | JANCY LEE | Charles Burt, David Burt | |
| | PUPCHEN | Egloff | |
| | ME TOO | Laurence Saunders | |
| | TRITON | F.M. Rivinus | |
| | PEQUOD | Robert Ackland | |
| | PUFFIN | Eleanor Garfield | |
| | OVERHAUL | Ann Hall | |
| | PELICAN | Charles Eldred | Renee B. O'Sullivan |
| | LORELEI (ex EVENFALL) | Carol Reinisch | Terry Cronburg |
| | EVENFALL II | Carol Reinisch, John Lakian | |
| | SCUP | Ryan Fort | Destroyed in fire |
| | DUODECIMO | DuBois | |
| | TUNCH | Brown | |
| | ALIBI | Munson | |
| | KIRSTEN | Ely | |
| | SEA HORSE | Finnerty | |
| | HALCYON | Margaret King | |
| | TOM TOM | Burke, Huffman | |
| | GAMBOL | Pomeroy Day | Thomas C. Bolton |
| | LITTLE LADY | Harrington, Deedee Gifford | |
| | BEBE | Metcalfe | |
| | SNAPPER | Meigs | |
| | CROCKERDILE | Crocker | |
| | BENO | Sears | |
| | CAPILANO | Hiam | |
| | SANDAB | L. Dabney | |
| | SEA GULL | Walker | |
| | SEAWARD | Francis T. Ward | |
| | SENGA | E. Warbasse | |
| | SNARK | Bigelow | |
| | SPOKIE | G. Pichot | |
| | SWASHBUCKLER | T. Rudd | |
| | CLIPSIE | | |
| | BERZ | | |
| | JIMITZI | | |
| | OUT OF BOUNDS | | |
| | DOVEKIE | | |
| | ATALANTA | | |
| | LeSTRIS | | |
| | DIXIE II | | |
| | GOLDEN EYE (ex CHICKADEE) | | |
| | TEAL | | |

# Traditional Boat Building & Restoration in a Modern Era

**Author Erick R. Singleman**
Amateur Boat Builder / H12½ owner

**Figure 1 –** A view of the sheer after the author made corrections. The beam hovering over the boat maintains the centerline of the boat down the actual center. The beam is attached to the cross members at the remaining molds.

## Abstract

The invention of modern materials has had a huge impact on boat design, construction and maintenance. These technical innovations lure the classic boat owner as if to say, "Use me and your boat will last years longer and be less of a hassle", This paper identifies some of the decisions the boat owner or amateur restorer may face when attempting to build or restore a classic wooden boat in an era where new techniques and materials are available to potentially enhance the longevity or reduce maintenance. However, from a design, value, or collectability perspective, we must carefully consider that straying too far from the original construction methods may result in a vessel that is no longer representative of the original design, or construction methods of that era. Whether you are restoring an original classic boat or building a reproduction may factor into the decisions as well. When applied properly, modern materials and techniques can also be a great help in keeping classic boats in service, keeping these treasures afloat for all of us to enjoy.

## About the Author

**Erick Singleman** is a native of Albany, NY, and holds a master's degree in Mechanical Engineering from Rensselaer Polytechnic Institute. He enjoys boat building and Shaker style furniture making. He learned his woodworking skills by watching his father Alfred Sr. "Sing" make all manner of things in the woodworking shop at the Albany Boys' Cub where he was a director. Erick and his wife, Ann, are captivated by the lines and charm of classic yachts, and can be seen sailing or paddling traditional wooden boats in the lakes and protected waters of New York and New England.

-The Classic Yacht Symposium™ 2014

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**ABSTRACT**

The invention of modern materials has had a huge impact on boat design, construction and maintenance. These technical innovations lure the classic boat owner as if to say, "Use me and your boat will last years longer and be less of a hassle." This paper identifies some of the decisions the boat owner or amateur restorer may face when attempting to build or restore a classic wooden boat in an era where new techniques and materials are available to potentially enhance the longevity or reduce maintenance. However, from a design, value, or collectability perspective, we must carefully consider that straying too far from the original construction methods may result in a vessel that is no longer representative of the original design, or construction methods of that era. Whether you are restoring an original classic boat or building a reproduction may factor into the decisions as well. When applied properly, modern materials and techniques can also be a great help in keeping classic boats in service, keeping these treasures afloat for all of us to enjoy.

**INTRODUCTION**

Almost every time I take one of my little wooden boats to the shore or a lake, people come over and want to take a look at them with the same enthusiasm that women have when you bring a puppy to the park. They ooh and aah and say things like, “they don’t make them like that anymore.” Well, actually they do still make them like that; you just have to be willing to pay a premium for the craftsmanship involved or be able to build or restore one yourself. Beyond the premium price, another deterrent to owning a wooden boat is a stigma surrounding the cost and time associated with their maintenance.

Over the past sixty years, let’s call it the era of the chemical revolution, boat building has evolved, technologies have developed, and materials and practices have changed, mostly due to the advancement in adhesives, sealants and coatings. What has developed from these advancements are boats made from non-traditional composite materials such as fiberglass, Kevlar and carbon fiber held together in a polyester or epoxy resin matrix. These newer systems have given designers the ability to create lighter, faster and, in most cases, less expensive and leak-free boats compared to their wooden counterparts. Yet somehow there remains a strong fascination with the classic wooden boat. Is it the classic lines, the noble distinctive quality of varnished brightwork and interiors, or just the feelings of nostalgia of a time gone by that draw us to them? Regardless of the reason, there are people out there purchasing these relics of the past with the intent of bringing them back to their glory days, and others having replicas of 100-year-old designs built from scratch.

When I purchased my 1941 Herreshoff 12½ sailboat, ALEMANA, I had several decisions to make regarding the application of newer technologies and materials in the restoration of this classic wooden boat.

**THE PURCHASE**

During our honeymoon in 2004, my wife Ann, and I stopped at the Herreshoff Museum and became members. We went sailing on one of their 12½s and the love affair began. I had already lusted after the Haven 12½ (Joel White’s centerboard version) and had purchased the plans thinking I would someday build one. But the prospect of owning one of the original boats, especially one that was in need of restoration, was most appealing; the more derelict the boat, the less costly it would be up front. It would also make the process more of a challenge and a greater learning experience.

A year later, while searching on the internet, I found her: hull number 1498 with the original builder’s plate. The purchase was a rough negotiation. The boat was listed for $2,000 and I was, miraculously, the first person to call. I live about two and a half hours away from Haddam Connecticut where the boat was located, and made plans to go see it on the weekend. The owner of the boat owned a saw mill and had received the 12½ in a trade, not knowing the pedigree of the boat. I suspected that if he found out, the price would increase. I had to be prepared. I calculated that regardless of the shape of the wooden structure (that looked pretty bad in the internet photo, see Fig. 1), the trailer, bronze hardware, ballast, sails, etc. would be worth about $4,000. After I offered a very logically thought out and elegantly executed explanation of the inherent value, Ann said, “I’ll let you spend $3,000 and no more.”

When we arrived to look at the boat, the owner said, “I’ve received many calls on this boat and if you want to take it today it will cost you $3,000.” “SOLD”, I said. Ann wrote out the check, and as she handed it to the man he said, “I don’t understand how you could let him spend $3,000 on this pile of junk”. Her response confirmed to me that I’d made the correct decision in marrying her a year earlier when she said, “Sometimes it’s more costly to deny a man his dream”. Shortly after, on the ride home, she said, “I can’t believe we just bought a shipwreck.” But in reality, what we had done was purchase a kit for one of the most popular classic wooden sailboats ever produced.

Figure 1 The shipwreck.

**CONTEMPLATING THE RESTORATION**

I had plenty of time to think about the restoration process, as we had decided to renovate our kitchen before starting on the boat. During this time, I started spending a lot of time on the WoodenBoat Forum and reading books on wooden boat design and construction in order to understand carvel planking and its repair. I had run across several threads about the annual taking-up of these boats and the difficulties people had stopping or controlling leaks. I began to wonder if having a carvel boat was going to be a problem. Would I have to sit with the boat for a week with a bilge pump at the ready until she takes up? When I looked at the 12½ I had purchased, it was obvious that one of the previous owners was having these take-up difficulties because there was plenty of caulk of various types and colors sticking out of many places, as well as broken and sistered frames all over the cockpit. In my mind, I started to question the logic behind carvel planking when there were alternative methods available that would eliminate the problems associated with spring take-up, and/or in-season leaking. The following is a list of the methods I researched and the positives and negatives of each.

**Strip Planking** – Strip planking orients the grain of the wood in the same direction as carvel and would afford a similar stiffness to the hull. Making the strips would be fairly easy, but there is a lot of gluing, and usually a glass and epoxy skin. There is minimal wood movement, but repairs could be difficult.

**Cold Molding** – This process produces a monocoque hull that adds stiffness in additional directions beyond just the fore-aft direction and requires fewer frames than a carvel boat. Cold molded boats are skinned in fiberglass cloth and epoxy, or just painted with epoxy. If done properly, the result is a leak proof hull, with negligible hygro-dynamic wood movement because the moisture is held out, and any movement would be curtailed by the constraint provided by the alternating laminations. On the downside, there is a lot of gluing, possibly vacuum bagging, and you are relying on the epoxy to not delaminate, crack, or otherwise let water in and allow rot to begin. Repairs could also be difficult with this system.

**Plywood Lapstrake** – Epoxy clinker-built boats afford a woodworking experience similar to carvel, with minimal gluing. Fewer frames are required. Plywood is possibly susceptible to rot with more end-grain exposed to water if not sealed properly. This method may require glass and/or epoxy sheathing for a moored boat (or one that sees extended periods in the water). Products like clear penetrating epoxy sealer (CPES), and two part epoxy paints may be effective in protecting the end-grain. One must also concede the smooth hull when building in this method, but lapstrake affords its own aesthetic beauty, when done correctly and the strakes are even and parallel.

**Double-Planked Carvel with Epoxy** – This method allows for carvel planking, only you would be doing it twice. The grain of the wood is in the same direction as carvel. Spiling and getting out planks is similar to carvel. There is a lot of epoxy gluing between the two carvel layers, and it is recommended that multiple coats of epoxy be applied to the outer surface to restrict water absorption and subsequent wood movement. The planks being glued to the frames make planking and frame repair potentially difficult. However frame damage itself may be a non-issue because the planking is not expected to expand and contract with the epoxy outer coating protecting it, therefore the stresses on the frames would be minimal.

**Epoxy Edge Glued Carvel** – Basically the same process as carvel except the edges are epoxied together, the planks are glued to the frames, and a least three coats of epoxy are required on the outer hull to prevent water absorption and subsequent wood movement. This process can also be performed on an existing boat by scraping the caulking out of the seams and epoxy gluing wedges into the seams prior to epoxy painting the hull. Repairs will be difficult, and this method requires that the boat not be allowed to excessively dry out during winter storage.

All of the above methods would result in a leak-free hull, free from seasonal take-up issues. But all require the use of and the reliance on glues and their ability to stay bonded, and all would require some type of scarfing-in of new sections for repair. I initially had a keen interest in the last two methods, especially the edged glued carvel method, after seeing a beautiful example of this type of construction from Alec Brainerd of Artisan Boatworks in Rockport Maine. What made it appealing to me was that it would be like doing a carvel build with a little gluing in between, then epoxy painting at the end.

One clear advantage to a carvel boat is that it is very maintainable. Everything is not all glued together; planks and frames and other structural members can easily be replaced - by a person with the correct knowledge and some skill, I must add.

Over time I began talking to more people who own carvel boats and was gaining evidence that the take-up of small boats is not necessarily the nightmare that many perceive. Many of the problems stem from people seasonally stuffing more goop into the planking seams in an attempt to hasten the taking-up process. This practice merely causes the planks to "compression-set" even further, and/or puts more stress on the frames, particularly in boats built with a harder wood such as mahogany for the planking as in the later Quincy Adams 12½s.

Let me explain the term "compression set" as I understand it. When one builds a carvel hull it should be built with wood that has stabilized to the moisture content (MC) of the local environment. Usually that is around 10% MC in the Northeast. When you plank the boat you edge set (force together) the planks to some degree to get a good fit-up so the planks are touching most of their length, and where they are not touching they are very close (these small gaps will eventually close up when the planks swell). When the new boat hits the water, the planks expand due to water absorption until they are in full contact with their neighbor and then they start to compress against each other. As they continue to swell from moisture, the compression forces increase and the joint is forced closed and becomes watertight.

The compression is elastic at first, meaning that the planks would spring back without damage if the constraint was removed or they immediately started to dry out again. But after a point, the compression takes the wood past its elastic limit and the fibers near the seams start to crush and deform slightly. The crushed wood fibers exist at the areas of highest stress. Areas where the stress is below the elastic limit are still behaving elastically, so when the boat dries out in the winter these elastic non-crushed areas will retain their ability to shrink and swell. Any gaps that are showing in the spring are due to the reduction in swelling as the planks dry out from not being submerged for several months.

If the small gaps seen in the spring are left alone, the parts of the plank that shrank during the winter storage will swell again as the boat sits in the water for a few days, resulting in nice tight seam again. If you introduce more material into the gaps, or allow debris to collect in them, before you put the boat into the water, you run the risk of crushing the plank fibers even more, putting more stress on the frames.

Overstressing the frames can result in frame cracking; once a frame begins to crack, the cyclic loading from the dynamics of sailing will cause it to break relatively quickly thereafter. Using soft materials that will squeeze out of the plank seams minimizes the risk of over-stressing the frames. There are also techniques that can be used to minimize the drying out, such as storing the boat outside, protected from the drying effects of the wind and sun, and over gravel so it does not dry out past its equilibrium moisture content. Springtime measures like putting burlap in the bilges and spraying them with water or having a sprinkler hose under your trailer can help get the taking-up process started.[1]

This new education on carvel boats was starting to temper my fears, but it wasn't until I got a few enlightened responses to a thread I had posted on the WoodenBoat Forum that I was fully on board.

One individual advised me that re-building her carvel would be much more like woodworking as opposed to applying all of that glue required for the other methods. That statement struck a chord with me. The second and more compelling response was, "You own a boat that others dream about owning; she's a piece of history that deserves a proper restoration". That's when the light bulb went off. What was I thinking? It had to be restored as it was designed.

**TOOLING**

In the meantime the kitchen remodeling was going along swimmingly. Amazingly enough, many of the tools purchased for the kitchen job, such as the table saw, bandsaw, thickness planer, router, and dust collection system, would carry over for use in the boat building. Imagine that. It took a little more doing to make a compelling case for the chain fall hoists and the addition of three heavy beams in the garage ceiling, but the boat yard was coming together as the kitchen project was winding down.

Boat building requires some specific tools and one of the tools I needed for carvel planking was a backing-out plane. These planes have a radius blade and a similar convex sole and are used to contour the inside of planks to match the curvature of the frames to allow a flush fit of the planks against the frames. I couldn't find a manufacturer that makes new radius planes, and I couldn't find any used ones on eBay. I did however manage to stumble across a company called Hock Tools that makes plane kits and sells plans for homemade planes. I purchased their plan and blade kit for the radius plane, and after about a week's worth of work in the evenings, I had a functional backing out plane. Upon using this plane, I believe I allowed far too large of a gap in front of the blade that caused the chips to jam up in the plane quite often. I will correct this error at a later date.

Figure 2 Backing out plane.

Another essential tool was a profile gauge. A profile gauge is essentially a collection of pins allowed to pass through a holder. This tool was necessary to make the sheer strake with the signature Herreshoff profile.

Figure 3 Profile gauge used to verify the shape of the sheer strake.

Everyone can attest to the versatility of duct tape. Kids in school are making backpacks and wallets out of it. Myth Busters even made a boat out of it. Well, the makers of Gorilla Glue have come out with Gorilla Tape, which is essentially duct tape on steroids. In case you haven't experienced this miracle tape yet, it is much heavier and stronger than your average duct tape, and the adhesive is much stronger as well. I made use of this product when I needed to clamp something and couldn't get a clamp in the particular area. I also used it to seal the seams on some of the steam bags I made, as it didn't come loose with the exposure to the heat.

Wire ties are another item that can replace clamps. These came in particularly handy when steam bending the frames. Instead of clamps for most of the length of the frames I used wire ties through holes in the molds. The slight reverse curve of the frames near the keel required clamps although they had a tendency to slip off due to the planking angle on frames farther away from the beam. In retrospect, I should have tried to find larger wire ties and used the clamps only to bring the frame into place until I tightened the wire ties. The iron clamps had a tendency to crush the frame that had been softened by the steam, leaving little clamp marks in a few places. There just wasn't time to try to fit in a sacrificial wood piece between the clamp and frame when you are in full panic mode trying to get the frame secured before it cools down too much. The first few frames we bent must have looked like a scene from a Three Stooges skit, but they ended up fine.

One very helpful bit of tooling was the scarfing jig to scarf the planking. The one I made was a creation of Ed McClave; the only modification done was to make it a little wider. Because planks curve, it is rare that you scarf two pieces straight on, so in order to account for the angle that they come together, a wider jig is helpful.

**THE RESEARCH**

The original 12½s were built from 1914 to 1943 at the Herreshoff Manufacturing Company (HMCo) in Bristol, Rhode Island, then later at the Quincy Adams Yard, and Cape Cod Shipbuilding. My hull #1498 was one of the last dozen or so built at HMCo. The design had been modified somewhat over the years, so it was important to me to find out what would have been original to my boat and what might have been something changed or added by one of the past owners. For example, my boat had a peculiar toothed bronze piece on the lazarette deck that was used to hold the tiller in a particular position (crude auto-pilot). There were wooden supports for the coaming at the transom instead of the usual bronze angle pieces. My oar lock sockets were blocks of wood outboard of the coamings, and there was a sliding gooseneck that I'd never seen on a 12½ before. As it was built in 1941, I wondered if some of these changes were made due to a scarcity of materials redirected to the war effort. I was able to verify that the wooden oarlock sockets where most probably original from a photo on page 234 of "Herreshoff of Bristol".

The Hart Nautical Collection MIT Museum holds the plans for the 12½, and they allowed me to sit down with the 1938 version of the HMCo plans. Reviewing these plans helped me understand the configuration of the late model 12½s. For example, I found out that the bronze hand-hole that was behind the mast on my foredeck may have been moved there when an owner decided to make hatches in the forward bulkhead, although many of the later boats seem to have the hand-hole in this location.

The plans have no hatch shown because the forward bulkhead was designed to be sealed off for buoyancy in case of capsize. Many owners however decided to make use of this space after experiencing how stable the 12½ is with its 735 lb. lead ballast. The plans showed the hand-hole on the bulkhead near the starboard seat. The purpose of this hand-hole in my estimation was for ventilation or inspection of the forward reaches of the hull with a flashlight. HMCo may have decided to move the hand-hole to the new location behind the mast because directly under it is a keel bolt for the lead ballast that would be inaccessible if the hand-hole were in the location denoted by the 1938 plans. Removing or tightening the ballast would have required disassembly of the bulkhead, which on earlier boats may have been more difficult. However, in the later boats the bulkhead was plywood and would only require removing some screws to take half of it out. So with all of that being said, the hand-hole re-positioning remains a mystery to me.

Figure 4 Hand-hole cutout shown just forward of the mast as in my boat (internet photo).

Figure 5 Hand-hole positioned as indicated on the HMCo 1938 revised plans for the H12½ (internet photo).

I don't think the hand-hole makes a good vent behind the mast, as it would allow rainwater to just fall inside, so I am going to place it on the bulkhead as in the plans. That way I can make a watertight locking hatch in the bulkhead and leave the hand-hole in the original bulkhead position so that it can act as a vent.

Another invaluable aid to establishing the configuration of an original 12½ is a website hosted by Steve Nagy. Steve is a fellow who follows Herreshoff boats very closely and has developed a website called the "Herreshoff Registry".[2] On this website Steve has a database of the 12½s and other Herreshoff boats, as well as historical information including design or configuration changes that have taken place over the years.

**THE RESTORATION**

Let me begin this restoration section by explaining my philosophy. I realized that this was an original Herreshoff-built boat that has some historical significance, and like any antique, the more it is left in original condition, the more it is worth. However, if this boat is going to be sailed, it has to be structurally adequate. If it were the last of its kind going into a museum it would be acceptable to leave deteriorated, original parts on board. But, if I left marginally adequate parts on the boat, they would eventually have to be replaced at some point, so why not replace them now instead of letting them be a weak link in the system? Besides, any boat that remains in the water long enough will eventually have to have almost the entire hull replaced. Just think about the USS CONSTITUTION or the CHARLES W. MORGAN; very little of their original hulls remain, but they are still considered the same boat.

My plan was to use as much of the existing boat as possible as long as the parts were solid enough or could be made solid enough to last as long as a new one. Unfortunately, this meant not too many of the original parts would be retained.

Then how is this still the same boat? On the Herreshoff Registry website's "On Restoration" page, Steve quotes WoodenBoat Magazine's Maynard Bray with regard to what is considered a restoration in the wooden boat community. Maynard cites a philosophy that he believes comes from the Europeans where… "Recently, the informal standard has been that to qualify as a restoration, the hull has to remain recognizable as a boat throughout the project." This seemed reasonable to me, as this surely would have been the case for the USS CONSTITUTION. Having said this, let me add that re-building this boat in a manner that kept it looking like a boat throughout the process made things much more complicated. Building a new hull next to the old one would have been much easier.

"The Shipwreck" needed a lot of work. The frames were all rotted at the base and the hull had so many fastener holes from sister frames that the planking was also useless. The floors were badly checked. The keelson was so badly checked you could see right through to the floor (which was surprising in a piece 1 3/8″thick). The stem was twisted and checked and the transom was rotted away at the base, not to mention the outboard stringers cobbled up to it to keep it from falling apart.

Figure 6 Photo showing the amount of caulk used to prevent leaking around the coamings. Also note the block used for the oarlock socket, typical of later boats. Metal support pieces were added by a previous owner to support the coamings as well.

**The Frames**

With respect to modern methods, the frames could be laminated as opposed to the time-honored technique of steam bending. The trouble with laminating is all of the cutting and gluing and aligning of the laminations. It was my feeling that a laminated frame would result in a stronger frame that would be less susceptible to rot. The strength would come from the fact that there would be less internal stress in a laminated frame when compared to a steam bent frame, and a fatigue crack in a laminated frame would have a built-in crack arrester by virtue of the laminations. The extra work involved in laminating the frames would have deterred me from doing it if there were a real choice in the matter, but I had already decided I wanted to go the traditional route and learn to steam bend the frames.

I began with the molds. I decided to build new station molds for each frame in order to steam bend new ones. I suspected my hull was slightly out of shape, but I relied on the existing shapes at frames 1, 2, 3, 4, and 5, as they looked pretty good. Frames 8 and 20 have to be the correct shape because they have plywood bulkheads supporting them. For the rest, I had to take measurements from several places, including other boats and the Mystic Seaport plans for the Herreshoff 12½ NETTLE.

Figure 7 Frames on the molds after steam bending; notice the use of wire ties.

My experience in steam bending was limited to bending the frames for my ukulele, so I read up on steaming boat frames. I read a lot of things, some of which were contradictory, so let me fill you in on what I experienced. Wetting of white oak at this 13/16″ thickness, whether it is green white oak or it is dry white oak that has been soaking, doesn't necessarily help (maybe it matters on thick pieces), except to open up surface checks when steaming. Putting primer on the surface of the high moisture content oak minimizes the checking that occurs due to the rapid drying effect caused by the steam. I have steam bent wet oak (18% - 20% MC) and dry oak (10% MC) frames with similar success. The heat softens the wood regardless of moisture content. I have had good results bending both wet and dry frames of this size. The event that proved this was frame #23, the last pair in the boat. This frame has the most severe bend and I decided to steam this one in after the hull was completely planked. All the others were hit up with primer and soaked for a month before I bent them. Having only a few pieces of dry frame stock at hand I decided to steam bend frames 23 dry, and there was no problem. Having straight parallel grain stock with no grain run-out really helps. And as stated by Bud MacIntosh, direction of the growth rings did not affect the bending in any way.[3] An hour of steaming per inch of thickness is a good rule of thumb, but I found an extra 25% worked well with the dry white oak.

White oak is an excellent wood for frames. Many people cite the steam bend-ability, rot resistance and the strength, but my favorite quality of white oak is the ability to hold screws. It has to be one of the best woods for this purpose.

**Floor timbers**

Some of the floor timbers were badly checked; others were crushed at the top from constant re-tightening of the keel bolts. Since I was replacing all of the frames, I decided to replace all of the floors as well. I used kiln-dried white oak for the floor timbers and I applied red lead primer and painted the end grain to slow down water absorption. As an additional measure, I applied CPES to the inside of the boltholes in the floor timbers lowest in the boat (the ones that may be submerged due to water collection, at frames 12, 13, 14, and 15).

**The Stem**

To make the new stem I had to decide whether to bend a solid piece or laminate, and what wood species and/or glue to use. In making these decisions I had to first evaluate what problems existed with the old stem that would benefit from a change in approach. The problems were moderate checking and a little bit of twist. White oak appears to be prone to checking when it experiences rapid and numerous wetting and drying cycles. The greatest areas of checking on my boat were associated with areas that had lost the protective paint coating, which makes sense since paint slows down the moisture movement. The twisting could have been related to moisture movement, as in many cases a new solid wood stem is cut green and steamed into the final shape. During the process of drying from green to 10% moisture content, the piece could twist due to a varying internal stress distribution caused by any of several factors related to how the grain runs and what part of the tree the stock came from. The checking problem can be minimized by not letting the boat dry out too much (no heated garages, minimize exposure to sun and wind, etc.), staying up to date with the painting, or by picking a wood less prone to this type of checking.

There are always trade-offs with different wood species, though. For example, white oak is very strong, steam bends well, holds fasteners really well and is somewhat rot resistant (durable). Mahogany has mostly the same qualities and doesn't check as much, but is not as strong and is much more expensive. Experience in picking the right stock can probably go a long way in making a solid stem with little or no in-service twist.

So why laminate? First of all, I was not confident in my ability to find or pick out a suitable piece of green white oak, and I already had some air-dried white oak with a nice straight grain. I had great success steam bending the frames but they were much thinner. I had no experience trying to steam bend a dry piece of oak that thick, and would still be afraid it might twist in service due to some unforeseen reason. Therefore, with the stem I strayed from tradition and made a lamination.

Figure 8 Unglued stem laminations clamped to the form after steaming in an effort to pre-curve them to facilitate glue up.

I had read several posts on the WoodenBoat Forum with back and forth arguments about failure of white oak joints that were glued with epoxy. Some individuals claimed they never had success and others said that the failures must have been prepared improperly. I have seen a trend for some new boats using purpleheart for structural members such as stems and keelsons. As it turns out, purpleheart is a very strong wood, and, like oak, is durable, but less prone to checking. I wasn't really comfortable substituting a different wood species. I'd rather laminate a species that was called out in the plans then use a completely different species such as purpleheart.

A few factors pushed me into laminating. West System came out with a new epoxy called G-Flex that was designed for hard to bond woods including white oak. The elasticity of this new epoxy allows the glue to expand and contract with the wood movement, putting less stress on the joint. Epoxy also slows down water absorption, so having bands of epoxy in the lamination would minimize the effects of checking and twisting. Laminating allows you to alternate the grain orientation so that the internal stresses in the wood are evened out. To me, these benefits of laminating would make a better stem than one I could possibly steam bend from solid stock, considering my inexperience.

Figure 9 The laminated stem after the clamps were removed; notice the lack of spring- back from the form.

Figure 10 The completed stem next to the old one.

If I laminated with recorcinol I would be required to use many thin laminations because recorcinol has no gap filling qualities and so requires a good fit-up and high pressure glue-up (good clamping). I wanted to go with fewer laminations to minimize the cutting and spreading of glue, but the thicker laminations would be harder to ensure a good clamping pressure and I thought there could be some small gaps. The G-Flex epoxy with its gap filling quality would be the glue of choice for thicker laminations.

In most traditional lamination glue-ups the stock is cut thin so that each piece can individually bend to the desired final curvature; glue is applied and the stack of laminations are clamped to the form. With my 2½ inch thick stem, this would have called for over twenty strips. Instead, I used six. Obviously the six thick laminations would not be flexible enough to clamp to the form, so I steamed the strips and clamped them to the form unglued for a couple of days and then unclamped and separated them to dry out for a few more days. This process pre-curved the laminations so that they almost matched the form (there was a little spring back), making them very easy to clamp in place with the epoxy applied. It worked so well I could have possibly used resorcinol. Another advantage of this method was, since there were fewer glue lines, I ended up chiseling through mostly wood when making the stem rabbet. I hate pushing my sharp chisels through cured epoxy.

**The Keelson**

I found a local mill that had a piece of semi-air-dried white oak big enough for the keelson. When I brought it home a year earlier than I needed it, I immediately painted the end grain to slow down the drying and minimize checking. After time, huge, long checks began to open up. After I posted pictures on the WoodenBoat Forum, an informed fellow enlightened me that the piece was cut too close to the pith, and that was why it was checking so badly. I found a mill in Connecticut that specialized in boat timbers that had air-dried white oak stacked all over the place. This time, I picked a board sawn well away from the pith that had been sitting outside for over three years with no checking. This became the actual keelson, and has been very stable through steam bending and installation. The only checking was very small surface checks due to, in my haste, not applying primer to the piece before steam bending.

The keelson required a rabbet for the garboard plank to sit in. The challenge in making this rabbet is that the angle of the rabbet changes as the angle of the frames changes. In order to have a nice flush fit of the garboard, the rabbet must twist along the length of the keelson. It would have been real nice to say I did all of this with hand tools, like they somehow managed to back in the day. But even if I could learn how they did it, it would have taken me ten times longer because I would have been afraid to mess up this piece, potentially causing me to buy a third large piece of white oak for this part. No. I decided to put modern technology to work in the form of a palm router. I measured all of the angles that the frames made as they approach the keel. I then made triangle shaped pieces that would clamp to the keelson with the top surface of this triangle piece 90 degrees from the frame angle, which happens to be the required angle of the rabbet at that frame. I cut notches in the top surface of the angled pieces for two tracks to sit in. The tracks would therefore twist as the frame angle changed. The palm router would then ride on the track and adjust to the required angle as it went along.

This technique worked out perfectly and produced a smooth and continually changing rabbet that the garboard plank sat very nicely into. Too bad my router track creation will be used on only one keel plank.

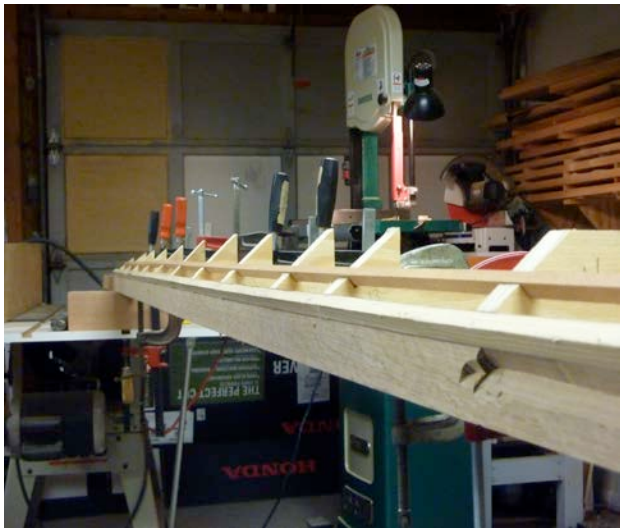

Figure 11 Palm router track set-up.

Figure 12 Alternate view of router track.

Another challenge to making a new keelson is that you must make sure that the keel bolts will align with the holes in the new keelson. When I removed my ballast and dead wood, I inspected the keel bolts and they were fine. There was no way I was going to get them out of the lead without an ordeal, so that was a good thing. However, as the ballast dropped out of the boat I said to myself "This is not going to be an easy proposition to get all five of these keel bolts lined up such that they slide right back into a brand new set of the associated floor timbers that are, on average, five inches tall."

Figure 13 A view of the completed rabbet.

I spoke with Dan Shea of Bristol Boat Company about my keel bolt dilemma and he advised me that I could temporarily install floor timbers 10, 12, 14, 16, and 18 with bolts to the frames instead of rivets, and remove the floors when I install the ballast. This way, the keel bolts would only have to simultaneously pass through the 1 3/8″ keelson rather than the six inches of keelson and floor timber, making alignment a little less problematic.

As it turns out, Dan's suggestion paid off and the five keel bolts came up easily through the keel plank as I lowered the boat back down on the ballast. I'll take credit for nervously drilling the holes in the right places at the correct angle, and making sure all five bolts were parallel.

When the ballast and dead wood was fit-up I noticed I had a few very small gaps less than 1/16″ and one section above the lead that had about a 3/16″ gap. I applied some epoxy to fill up the larger gap and then installed a piece of Irish felt (essentially thick tar paper) between the hull and the ballast and dead wood. This cleared up all the gaps. Then, as a final measure to ensure no leaks through the keel bolts, I painted the bottom one inch or so of the keel bolts with tar and left a nice blob at the base that would squeeze around the hole. I feel pretty good about how the ballast and dead wood went back on. It had been a source of anxiety leading up to this point as I was concerned that I could really screw up all of the nice work I had done up to that point by fouling up the keel with multiple holes trying to mate the ballast up. But it all worked out fine, leaving the only daunting task the making of new coamings. All of the rest, the decks, bulkheads, cockpit floors, etc. are just child's play, except I do have a schedule to keep, so maybe not.

## The Transom

A varnished mahogany transom is the part of the boat you want to show off and make as nice as possible. In addition to the transom on this boat being painted (sacrilege, I say), it was outfitted with external vertical stringers to keep the boards from separating. It was bad enough that the removal of this aesthetic nightmare would leave holes to be plugged, but in addition, the bottom of the transom was so rotted that the steel drifts were visible. Rather than retain only a small section of the transom, I decided to replace the whole thing using matching wood from the same tree. I used epoxy to install 5/16″ bronze rod instead of using ¼″ steel drifts. Drifts were pointed spikes with barbs along the length and were originally used to hold the boards together because there were no functional waterproof glues at the time. Waterproof glue for plywood was not invented until late 1934 by Dr. James Nevin.[4] The recorcinol glue that we hold as the standard for boil-proof, waterproof glue today may not have been invented until a few years later by Dr. Yarstey of Yarstey Laboratories England, and used in the construction of the DeHaviland Mosquito bomber.[5] With the epoxy holding the boards together, I probably didn't need the bronze drifts, but I put them in anyway, in an effort to stay as close as possible to the original design.

Figure 14 The lower portion of the old transom showing the extent of the rot. Notice the exposed pointed steel drift.

Figure 15 Aligning the bronze drifts so they don't interfere with the traveler. This view is from the aft end of the transom. Notice the traveler is offset to the port side of the boat because the mainsheet block is to the starboard side of the tiller. This compensates so that no adjustment of the sheet is necessary when changing tacks.

I used wood dowels to help align the six pieces used for the transom. Although I took care in the position of the bronze rods so they would not interfere with the coaming brackets or the traveler, I did have a wood dowel located right in the center of the transom that showed up when I cut out the hole for the tiller. Fortunately I was able to put a mahogany plug into this hole; it's not a big deal, but it reminds me that I have to be careful as I go forward because not thinking ahead could be a source of a more troublesome problem down the line.

Figure 16 Cleaning up the overall shape of the transom prior to making the edge bevel.

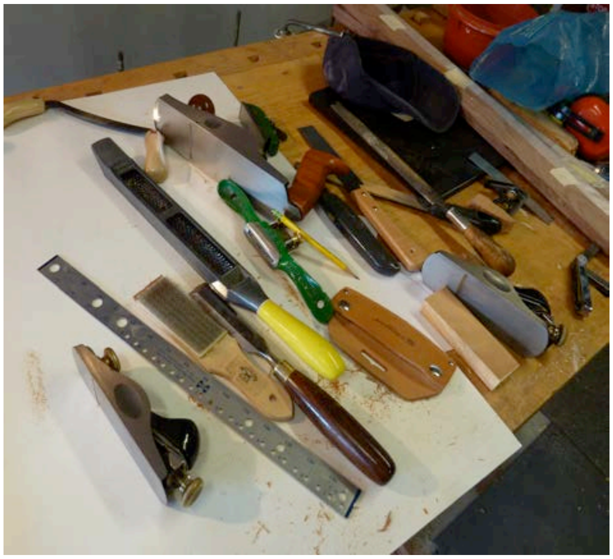

Figure 17 Tools used to make the transom edge bevel.

**The Spars**

When I first set eyes on my boat, I noticed right away that the mast and boom were painted white. I thought to myself, "Who would do this to a wooden mast?" Okay, I understand varnish breaks down due to ultraviolet light exposure much faster than paint does, so the maintenance is less. But why not paint it a color closer to a wood tone, like a tan? As it turns out, the paint may have been a blessing in disguise; it may have protected it better during the fifteen years the boat sat around waiting for someone to save her. I was determined to save the mast, although it needed a new lower section scarfed in because a crack, at least a third of the way through, had developed right at the level of the mast partner. I also scarfed in a new top section about a foot long, as the tip had checked and cracked from water intrusion. It will probably take a couple of decades for the new sections to catch up with the patina of the old wood, but the mast really looks nice again with fresh varnish applied.

I wasn't aware that my boat came with dogs, but the wooden pieces that form a ledge on the mast for the stays are called "hounds". The hounds that came on this boat were in really bad shape; I had to put them down. Making the new hounds was an interesting project.

The boom had so many screw holes in it from having cleats moved around, it was a tough call to try and refurbish it. The boom was originally made from two pieces glued together, but due to the poor maintenance, it had delaminated a third of the way from both ends. I managed to split it the rest of the way and epoxy it back together again. I ended up treating all of the holes with CPES, which is designed to rejuvenate the fibers damaged by rot, and then installed Dutchman repairs in several spots, again using epoxy as the glue. The jib club that came with the boat looked like a beaver made a meal out of half of it, but the hardware was salvageable.

Figure 18 Shellac was applied to the end grain of the transom bevel so that the oil would not be sucked out of the oil soaked cotton wicking used to seal the seam between the ends of the planks and the transom.

Figure 19 Cutting the hounds on the bandsaw.

Figure 20 I cut out three nice single piece hounds. I ended up cutting them in half in order to fit them properly around the mast.

Figure 21 Hose clamps are useful in securing the hounds while the epoxy dries.


Figure 22 A view of the completed hounds.

**Some Other Parts**

I began making a new breast hook and I didn't like the way it turned out. It just didn't fit like the original one. So I took a hard look at that original and decided that the old screw holes and the relatively large check in it could be filled with epoxy (G-Flex) and it could be re-used. So it became the first of the original pieces to be retained in the hull. In addition to the breast hook, the other original parts included: frame #1, the lead ballast, the deadwood, most of the bronze hardware, the seats, the mast and boom (with new scarfed-in sections). I am also planning to re-use the curved coaming supports that go from the sheer clamps to the bulkhead, and possibly the cockpit floor boards and ceiling pieces.

**The Sheer Planks**

The 12½ has a very elegant look, and a big part of that look is the varnished sheer strake in either white oak or mahogany. Mine was mahogany and was in very bad shape. What gives this sheer much of its elegance is the shape, which is a type of elongated ogee where it bulges out at the top and gracefully tapers down to the thickness of the planking. Duplicating this shape on new stock seems daunting at first, but Eric Dow lays out a nice method that uses a table saw to rough out a profile by changing the blade height.[6] This process results in a stair-step pattern close to the actual profile, after which planes are used to smooth the shape.

I did something very similar, only I used the router table and changed the height of the router bit to obtain a similar stair-step pattern. I then used a block plane on the outside curves and a round scraper blade (actually it looked like a French curve) on the inside curve, followed by a sanding block shaped to the desired profile and several grades of sandpaper attached by double sided tape.

After getting the sheer plank shaped, I had to install it, but I wasn't 100% sure that the original shape of the sheer on the boat was correct. I could be confident that the sheer at frame 8 and 20 were correct because the plywood bulkheads would force the frames to maintain their shape there. I was more concerned with the shape of the sheer from frames 7 to the stem and from 9 to 19. This is where measurements from other boats and the Mystic Seaport plans helped me to align the sheer. I used a long batten to check that the line of the sheer was fair, and I installed it. The only problem was that I could not get far enough away in the garage to really determine if it looked right. I ended up putting the boat on casters and rolling it outside so I could gain the proper perspective. Much to my chagrin it didn't look right to me. The section from frame eight to the stem looked okay, but the middle section looked too flat.

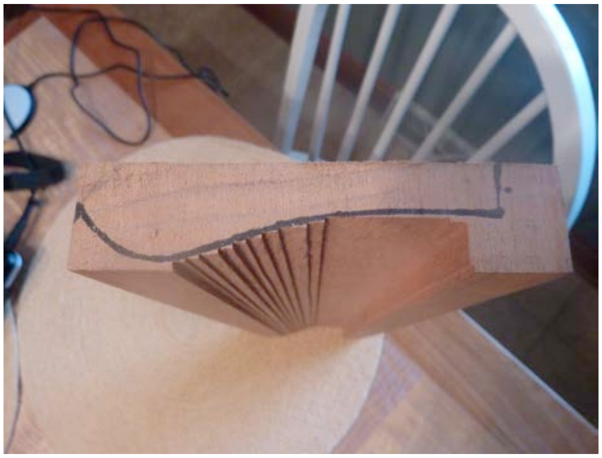

Figure 23 The router creates a stair-step pattern close to the desired profile. Reminds me of Simpson's rule for calculating the area under a curve.

It took an extra two days to correct both sides, but I felt that the sheer was one of those essential features to the boat's final look and must be set to a pleasing shape (see Figs 25 & 26).

**The Cedar Planking**

I read as much as possible about how to, as they say, "get out a plank". But I felt I wasn't going to really get a feel for it until I either did it a hundred times, or was taught how to by an expert. I couldn't make it to one of the regularly scheduled classes at Mystic Seaport, so I decided to pay for a private lesson. Fortunately for me, the instructor was excellent and really stressed accuracy in spiling and accuracy in wood removal. We worked all day and my plank fit really well on the practice jig. When I left I was much more confident that I understood the process and would be capable of making the planks fit without too much rework or waste of material.

Because it was necessary to set the sheer first, instead of starting the cedar planking at the garboard with the boat upside down and working to the sheer (as HMCo would have done), I decided to plank the boat halfway down, then flip it and work from the garboard to the middle. This would require making what is called a "shutter plank" that fits between two set planks. This necessitates making two edges that have to be perfect instead of just one as with the previous planks.

While doing the rest of the planking I was using the traditional spiling method of scribing arcs on a spiling batten.[7] This method is fairly accurate and I was becoming better at it as I went along, meaning it took me fewer iterations of trial fitting and tweaking for each successive plank. The process usually involves planing the planks down to the spiled line and then putting it on the boat to trial fit it. You clamp it in place and inventory where it is tight and where it has minor gaps. The plank is then planed some more in the high spots until the plank is touching for most of its length and has only small gaps in some areas. I used a feeler gauge to check my gaps between planks, and I was not happy until the planks were touching or had a gap less than .012 inches. But I knew there had to be a better way for the shutter plank. I decided to put modern technology to use again in the form of a digital caliper.

Figure 24 80% of the planking is complete.

For the shutter plank, I spiled one edge as I'd done previously, and transferred the marks to the cedar stock. This time I tried to be extra diligent in my accuracy. Then I drew a line through the marks with a long batten. For the next step, I used a digital caliper (a once expensive tool that you can now get for $20 or less) to take measurements of the plank space at each frame down to the thousandth of an inch. I added .006 to each of these values and marked the stock at each frame location. I drew the line for the second edge and then cut both edges and planed them down close to their respective lines. I measured the plank at each frame location with the digital calipers, then planed it carefully until the edge was within +/- .005″ from the original adjusted measurements (gap plus .006). The plank fit almost like a glove. It only had to be planed a slight bit more in a few places, then I tapped it into place with a slightly snug fit. I was ecstatic. There wasn't much cedar stock left for do-overs. The other shutter plank (port side) went in just as easily.

A note on steaming the planks: The planks on the lower half of the boat did not require steaming; however the upper planks did as the planks twist near the bow and toward the transom. Instead of bagging the planks and steaming them in their entirety, I used the technique of wrapping the ends in ribbons of cut towels and pouring boiling water on them, then sliding a plastic sleeve over

Figure 25 Profile view showing the flat of the sheer in the midsection. The old planking is attached to the boat with wire ties around the frames because I didn't want to screw into the new frames until I was actually screwing in the new planking.

Figure 26 A view of the sheer after the correction. The beam hovering over the boat was my way of keeping the centerline of the boat down the actual center. The beam is attached to the cross members at the remaining molds. It stops at frame eight because the deck beams are already installed up forward.

them to keep the heat in.[8] I reapplied the boiling water every five minutes for a half hour total. This allowed the planks to twist into place where I clamped them for a day before final fastening.

My boat has a rabbeted keelson for the garboard to sit in. Earlier 12½ boats did not have this feature and were prone to leaks. I thought about this and wondered why the rabbet would help. It does not add another sealing surface unless you put some goop on that additional surface. Maybe they used oil based bedding compound back at HMCo? Having something on this rabbet surface would be a belt and suspender approach rather than relying solely on the cotton caulking and seam compound on the other surface (see diagram below).

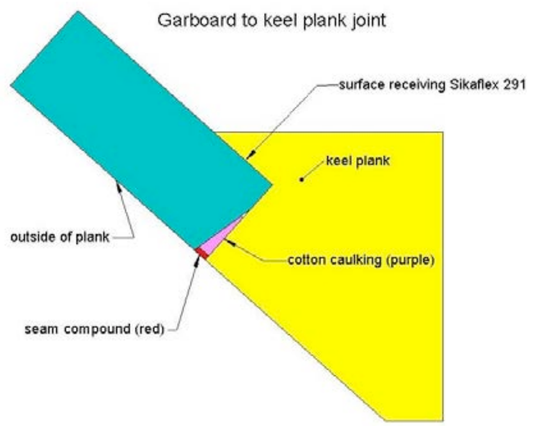


Figure 27 Diagram showing the additional surface created by the keel rabbet. This surface helps to stabilize the garboard and allows the addition of a sealant. Older 12½ boats relied entirely on the surface with the cotton caulking as there was no rabbet.

I decided that I would research what sealants were available to seal the joint but not aggressively glue it together like 3M 5200 would. That's where I found Sikaflex 291 which has a 205 psi bond strength compared to 3M 5200's 700 psi. I applied the Sikaflex to the garboard to keelson rabbet with the hope that it wouldn't be too difficult to separate if I (or someone else) ever had to.

**Plugging the Screw Holes**

You might ask why even bring up an aspect of boat building as mundane and unexciting as plugging the screw holes? I have read several recent books where the authors prefer using epoxy mixed with fairing filler for this purpose. But I had also watched a YouTube video where shipwrights were cursing holes filled in such a manner because it is difficult and time consuming to get at the screws for plank removal or re-fastening, and the hole gets butchered up in the process.[9]

Figure 28 Sikaflex 291 on the garboard rabbet. Also notice the frames and floor timber end grain have been primed and painted where they will mate with the planks.

The preferred method for getting at the screws later is to install wood bungs of the same species as the planking and glue them in with…. you might be surprised… paint. Yes, paint. Old leftover paint or varnish holds the plugs in just fine, and when it ever comes time to remove them, you just drill a small hole in the center of the plug and pick it out with an awl, chipping away small pieces at a time. This method leaves the hole intact, allowing the same size plug to be used later.

This process does take more time, and I was fortunate that my wonderful wife, Ann, allowed me to coerce her into cutting out, installing, and flush cutting all of the approximately 1200 plugs for ALEMANA.

**Caulking the seams**

YouTube played yet another roll in my carvel boat building education.[10,11] There were several videos detailing how to caulk the seams with cotton, but most were on larger boats with larger seams. On those larger boats, they used cotton wadding. I'd read cotton wicking was more appropriate for small boat seams. One explanation that made a lot of sense to me was that the cotton was placed in the seams in loops for a reason. This looping action would cause the cotton to go into the seam in an alternating pattern of thick-thin-thick-thin. The theory was that the cotton would act as teeth that would keep the planks from sawing against each other as the hull adjusts to the dynamics of sailing. So I installed the wicking in a similar manner.

Figure 29 Ann applies paint to the bungs and pushes them into place before lightly tapping them in with a mallet.

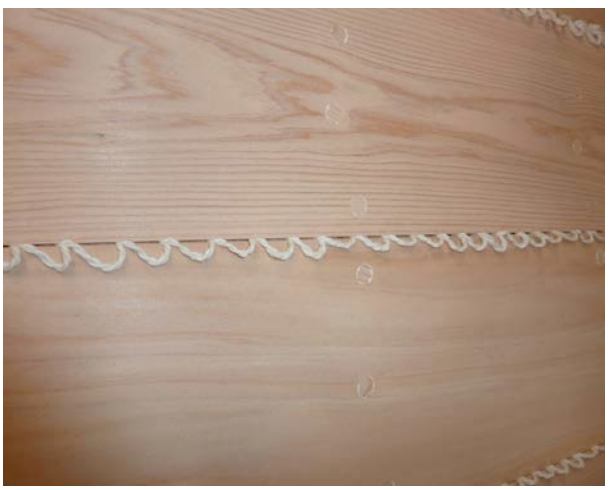

Figure 30 Looping in the cotton wicking. This is called "stitching" the seam.

After caulking, it was time to pay the seams. Here I stayed traditional and used an oil based seam compound (above and below waterline versions). Shipwrights in videos explained that if done correctly, the seams would not be detectable. What the heck? This is a wooden boat, man! I want my seams to be detectable. Otherwise it will look like one of those fiberglass imposters. So when I noticed that the seam compound shrunk slightly after a week, I was very relieved. With a coat of primer in place, the seams were just nicely detectable. Of course, how much the seams show is likely to change once the planks expand, but I am hoping the seams will not change too much above the waterline.

Figure 31 Looping in a second time. After stitching the first loops in half, we "make" the seam by pushing the caulking even with the seam, like in the center of this photo. The caulking is then "set" in with roller similar to a pizza cutter or pushed in with a putty knife or fine blade caulking iron.

Polysulfide caulk is the modern alternative to the oil based seam compounds. Many owners with experience with these compounds relate that they stay adhered to the seams for several years with little or no maintenance required. But these materials adhere so well that removal, when necessary, can be problematic because you must get back to bare wood in the seams for re-application.

**The Ballast and Dead Wood**

When I removed the ballast and dead wood I was very lucky that the bronze keel bolts were still in good condition, and the threads were good. I say this because I tried to pound them out, and they just would not budge. I guess if I had to I would have found a way, but I'm so glad I didn't have to. I just ran a die through the threads to get the crud out. The bolts holding the rudderpost on were a different story though. It was much easier to cut them in order to get the rudderpost off. I did manage to save one of them, which I cut shorter and re-threaded to use in place of a shorter one. The rest required making new bronze bolts. For this I purchased some Si-bronze rod, heated the end with a propane torch and peened it over to form a head. Then I cut threads in the opposite end. I saved some money making them myself, and had some fun doing it.

The dead wood was made of Douglas fir (Oregon pine), and had some moderate checking in it from drying out over about twenty years. I filled the checks with the underwater oil based seam compound so when it swells back it will squeeze out. I also had to scarf a small section back in the rear point of the deadwood because the bolthole there had blown out.

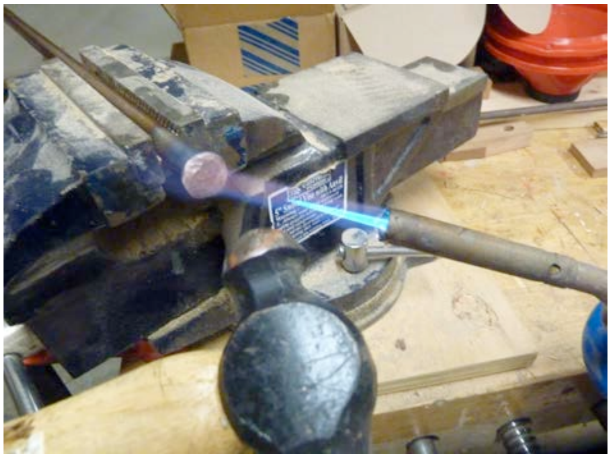

Figure 32 Peening over the bolt head.

The original rudderpost was made of white oak and had bowed significantly and was severely checked. A new rudderpost had to be made. The same was true for the rudder that was also bowed in the same direction.

**Deck Canvas**

There are modern alternatives for the traditional painted canvas deck laid in white lead. Three of the methods I ran across include: canvas laid in epoxy and epoxy painted; dynel laid in epoxy and epoxy painted; and canvas laid in Titebond II waterproof PVA glue and painted.[12] If I were not on a tight schedule and could wait until spring to open the garage doors and windows to vent the place, I would use the good old canvas in white lead method. But in order to keep to schedule I decided on the Titebond II instead of the white lead so I could keep from having to use the respirator and heating the garage for too long a period for the white lead to set up. I was also fearful that the epoxy would bond too well and cause problems if the canvas needed to be replaced twenty-five years from now (by the next owner, that is). I may also experiment with waterbased paint on one or both of the decks after I find out from the manufacturers how water permeable it is compared to old-fashioned oil based enamel paint.

**SOME PRACTICES NOT USED IN THE ORIGINAL BUILD**

"I have just one word to say to you…plastics!" How many of you remember this quote from the movie "The Graduate"? And although I hold out as much as I can from putting this modern material in my classic wooden boat, there is a place for it in the construction process when it comes to steam bending. Eric Dow uses this method to steam the keels of the Haven into place, and other folks have used this method to steam the sheer clamps and other large or difficult to handle parts. The old-time practice of building a steam box works great for items like frames that are all roughly the same size; you can put a bunch in the box at the same time, and bend them in sequence as you take them out. The problem with a steam box is that you have to work very quickly once you remove the hot part from the box because it cools quickly out in the open. Plastic of the 4 or 6 mil variety can be wrapped around parts allowing them to be steamed into place by sticking a steam hose into the wrapping. Using this method allows you to get a better feel for when the steaming is complete. You can gradually tighten clamps as the wood begins to become compliant until it finally pulls into place. You can also shut off the steam and clamp the part in place in a less frantic manner, with the plastic still on, since the plastic insulates the part from cooling too quickly.

Bagging also allows you to steam a section of a long piece in lieu of having to build a box long enough for the whole piece, or cutting holes in your steam box doors to steam a long piece that bends only in the middle. I used plastic to steam the new keelson, and the sheer clamps. All three pieces were over twelve feet long.

Figure 33 Steam set up for the keel plank.

One thing I learned from an article written by Ed McClave in WoodenBoat magazine was that paint is your friend; paint everything and everywhere before assembly as much as possible.[13] End grain lets water into the wood so you want to seal off end grain at the bottom of the frames and ends of the floor timbers, where there may be standing water. Many progress photos of wooden boat construction often show that all the woodworking is done first and then the paint is applied when you have no access to this end grain. I mixed my own red lead primer and applied it to the floors and frames, then painted them before installation. Figure 35 shows the rotted lower ends of the frame #8 and #7. Figure 36 shows red lead primer applied to the frames and floors, and white enamel applied to the contact surfaces of both pieces; this was done before the parts were assembled.

Figure 34 A similar steam set up was used for the sheer strakes. This photo demonstrates how parts can be clamped in place with the bag still in place slowing down the cooling.

Figure 35 Rotted frames bottoms at #8 & #7.

I also painted the bottom of the floor timbers, as they would be inaccessible after installation. On the lowest frame ends in the boat (#12-15), I have even experimented with clear penetrating epoxy sealer (CPES).

Carvel boats typically employ butt blocks to join planks when long enough stock is not available. My boat had about four or five butt blocks in the original planking; a few were even in the cockpit. After I made the first one, I decided that was a sufficient homage to tradition, and I epoxy scarfed the rest of the planks that needed length. I allowed myself to do this because butt blocks were not always used; if they had stock long enough, there would be no butt blocks at all. Using epoxy to scarf the boards is cheating a bit, but with the planks painted, no one will ever tell it's not a full plank (let's keep that our little secret). With the stock I had, I was able to make single piece planks for all of the below the waterline planks.

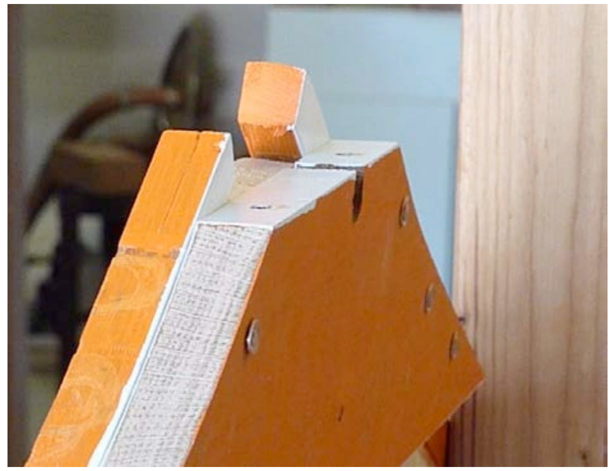

Figure 36 Painting before assembly. The mating surfaces are primed and painted before riveting the parts together. After sawing the frames flush, the end grain on the frames and the floors receive the same treatment.

They didn't have 3M 5200 or any of the modern adhesive sealants during the 12½ construction era. For the stem-to-keel joint and the keel-to-stern knee, they would have used an oil based compound similar to Dolphinite. I decided to use 3M 5200 in these locations.

HMCo used slotted bronze screws on the 12½s. However, slotted screws easily slip out of the bit when used with a drill/driver. I have had a terrible history with Frearson head silicone bronze screws camming out on me with the associated Frearson tip, so when I tried the square drive screws for the first time, I fell in love with them. The square drive allows the bit to stay engaged in the screw and allows you to apply more torque to the screw. But in a hard wood like oak, if you don't drill a proper pilot hole, you can break the threaded portion of the screw right off in the wood. I have not cammed out a single one yet, but I have broken two off in the joint, requiring screw extraction. I find extracting a couple of broken screws on occasion less aggravating than the multitude of Frearsons I used to cam-out. Another factor that may contribute to the Frearson camming out problems is the use of tapered drill bits. Tapered drills are a compromise. It is desirable for a screw to bite into a hole for the length of the threads, so for that portion of the screw the hole should be smaller than the threads. In the shank portion of the screw, the hole should be the same diameter as the shank. If you drill a tapered hole too deep, only the threads closer to the shank engage, making a weak joint. If you drill too shallow, you cause undo torque to be applied and will probably snap a square drive screw or cam-out a Frearson. The answer would be to use a drill bit like the one in Figure 37, which no one seems to make any more. My father used one of these bits to drill and provide a flush countersink when building his 18-foot Luger cabin cruiser in 1964 that was a plywood boat covered with fiberglass cloth and polyester resin. A deeper countersink would be necessary for a wooden bung. Or you could grind your own like Harry Bryan suggests.[15]

Figure 37 Stanley Screw Mate from the 1960s. It countersinks the head flush to the wood, however it could be designed to countersink deep enough for a bung.

**A Note on Epoxy**

Epoxy is a very useful tool in the restoration and building of wooden boats. It's not a traditional material for seventy-plus year old boats, but it can allow one to add back material in a way similar to what welding can do to metal parts. The only difference is that, unlike welding, you must have enough surface area for the bond because the adhesive bonds of glues are nowhere near the strength of metallic bonds. This means that sometimes the joint must be carefully thought out. If the pieces to be joined are very small, glue of any type may not be the answer.

One of the main advantages of epoxy versus other types of glues is its gap filling qualities. This means that the strength of the glue's bonds to itself are as strong or stronger than the bonds of the glue to the substrate.[15] If two surfaces aren't perfectly smooth, the epoxy will fill the gaps and make a well bonded joint. It also means that you do not have to have a high clamping force. Most other types of wood glue require high clamping forces to minimize gaps.I used epoxy to scarf some of my planking, in lieu of having butt blocks visible in the cockpit. I also used epoxy to scarf in a new lower section of the mast. Because I wasn't confident that I could make a good 12:1 or 10:1 scarf in a 3.5-inch diameter mast, I made a 6:1 scarf and used mechanical fasteners (screws) to add to the security of the joint.

There are also many types of materials that can be added to the epoxy mixture that enhance the performance of the epoxy in various applications. Fairing powders give thickness to epoxy for spreading on and leveling out surfaces, and also make it easier to sand. Micro-fibers thicken and add strength and could be used to glue two uneven surfaces together. Using microfibers in this way enhances the gap filling by making it a composite material in the gap similar to cement with rebar as opposed to just cement alone.

In the epoxy family there is a material called clear penetrating epoxy sealer (CPES). CPES is a two-component system that is essentially a very thin epoxy. The low viscosity allows CPES to penetrate into wood fibers, especially end grain. It can be used to seal out or at least slow down water entry into wood, and block rot spores from getting into the wood. Many people claim that it is an excellent primer for subsequent painting. I used CPES sparingly on ALEMANA. I used it in the end grain of the tops of all the frames and in the bottom end grain of the frames lowest in the boat that I thought would potentially see standing water for periods of time. I also coated the underwater section of the rudder with CPES before I epoxy coated and painted it with bottom paint. I took this extra precaution with the rudder because the old mahogany rudder had bowed significantly and I wanted to slow down the water absorption in the new one as much as possible to keep it from doing the same.

Be careful when using CPES. If you open the cans without a respirator, your nose will instantly send you a message that if you continue along this path of insanity you are probably going to pay a price (in the form of a huge headache). Make sure to wear a good-fitting organic vapor respirator with an up-to-date set of cartridges when using this product (even if you are outside!!!). I would even suggest one with a full-face mask so the vapors don't irritate or enter through your eyes.

**PAINTS AND VARNISHES**

Paint technology has improved significantly over the past sixty or so years due to chemical engineering. Traditional topside enamels have been replaced in many cases by polyurethane or epoxy paints. The latest evolution is an industry movement toward water-based paints and varnishes which is being driven by environmental regulations aimed to reduce exposure to volatile organic chemicals (VOCs), aka solvents.

On my first boat, IMP, (Joel White's Pooduck skiff), a plywood lapstrake boat, I used one of the polyurethane topside paints and it was very durable. Four years later, when I repainted the boat, I used an off brand, and found that the paint cracked over winter. Looking to get away from the long drying times of these polyurethanes, I became aware of a new type of exterior house paints. These new water-based exterior latex paint-and-primer-in-one paints claim to have interstitial molecules that caused the paint to bond better and also tightened the gaps that would allow water through. This sounded interesting and made me curious as to how these paints might perform on a boat hull that was a trailer-sailed boat like my IMP. The experiment was a success; the semi-gloss white went on very easily, dried very quickly and held up very well. The best part was that touch-ups were very easy and would dry so quickly; you could touch up in the morning and be sailing in the afternoon. I used the same paint with similar success on my Iain Oughtred Wee Rob canoe. I am not so sure this latex paint would be adequate for a boat that resides in the water.

**Paint Update on ALEMANA:**

As I write this paper, it is closing in on Thanksgiving here in the Northeast, and I am doing some painting while the air is nice and dry. I am using traditional semi-gloss white enamel on the inside of the hull. It is taking five coats to cover the dark grey primer. Note to self: Use white primer next time.

Here's my take on painting. I will avoid VOCs and long drying times and the use of paint thinners for cleaning as much as possible. Since there are no good glossy water-borne varnishes, I will varnish with the good ole stuff. I have spent a good two weeks putting five coats of traditional enamel on the inside of the hull, with all of the respirator wearing and solvent brush cleanings, and long drying times. But I'm okay with that because if I have a cockpit cover over the boat, I should not expect to have to re-paint the inside for quite a few years.

I have decided to experiment with a water-borne acrylic exterior deck and porch paint for use on the outer hull above the waterline. This would be impossible if I wanted a high gloss hull, but I prefer a low luster white. I expect that this paint will be easy to apply by brush, will be very tough, withstand scrubbing, and will inhibit mildew formation, have good resistance to UV, and it will let me put the solvents and respirator away. The only downside that may be problematic is that some individuals have reported that some of the acrylic paints are difficult to sand and that the paint tends to ball up and quickly clog the sand paper. I will do some sanding tests to make sure this will not be a showstopper before I commit to using it on the hull. I am also going to submerge a piece of painted wood for a few months to make sure it stays adhered to the wood under that type of moisture exposure since the area just above the waterline will see constant water due to wave action at the mooring. If the paint passes these tests, no more respirator and long drying times for me! Well, except for the varnishing. And annual touch ups or re-paints will be a cinch.

Traditional copper-based bottom paints are now known as "solid" bottom paints, meaning the film is meant to stay on the hull. This may seem like a strange definition, but today's boat owners know that we have a new type of bottom paint to choose that is designed to slowly wear off as time goes by, revealing a fresh layer of biocide to repel sea creatures. These "ablative" bottom paints can also reduce the buildup of paint associated with re-coating solid paints. Most recently, these ablatives have come out in a water-based version. My plan is to use two coats of traditional oil-based solid bottom paint as a base, followed by two coats of water-based ablative, and then repaint with the ablative at the beginning of the new seasons thereafter.

Varnishes have historically been made from oils such as linseed oil or tung oils with pine resins. Modern chemistry has advanced these products by substituting synthetic resins and adding ultraviolet blockers and drying agents. Spar varnish is a term that came about from the need to have a flexible coating that would not crack with the bending of masts and spars due to wind loads. Today's oil-based spar varnishes are a product of decades of research and testing and provide a very glossy and protective finish, but the sun's effects are very strong and annual re-coating is still required to properly maintain varnished brightwork. In the lower latitudes a second coat per annum may even be required.

I have experimented to a small degree with the new water-based exterior architectural finishes. I use the term architectural finish because that is the category these water-based coatings seem to fall under in the coatings industry. I think this is because the industry has not yet come out with a product they are willing to label a true water-based spar varnish. Meeting the flexibility requirement may be part of the issue with the water-based products because the resins are different. Today's water-based paints still carry the "latex" term, which may imply flexibility. But these paints are not latex at all, but are instead acrylic or polyvinyl based. Before using these products, my research will include discussions with paint company chemists to determine the relative flexibility of these newer waterborne paints and varnishes compared to oil-based counterparts.

The initial products in the water-borne architectural category were not as clear or as glossy as we are accustomed to seeing in a spar varnish, but they are improving, albeit at a slow pace. I have experimented with a water-based hybrid product from Target Coatings on the transom of IMP where flexibility was not required since it was dimensionally stable plywood. It has held up well for two years with no re-coat. However, the transom has a severe tilt and the sun's rays can only hit it at a shallow angle, therefore this may be why it has not shown signs of degradation thus far.

Eventually water-based varnishes will catch up, and there will be a day when we can apply topside paint, bottom paint and varnish with products that dry so quickly that you can spiff up your entire wooden boat in a single day or weekend. I predict that when this day comes we may see resurgence in wooden boat ownership, or a significant increase in the wood trim displayed on fiberglass yachts.

I recently sailed on the yacht HERON out of Rockport Maine on the occasion of her 10th birthday. The boat is a beautiful remake of a John Alden Schooner. You would have thought the boat was christened on that day; the brightwork was just immaculate. I asked the skipper (who was also the builder) what his trick was, and he said, "I just hit the scratches and dings up as soon as I notice them, so they don't have a chance to damage the wood underneath". I took that to mean that you don't have to do a touch-up that results in a perfect finish, just protect the wood and make it all pretty and nice again when you put the next full coat of varnish on. I think the same rule applies to the painted areas of the boat, just keep it sealed the best that you can, because although boat builders select woods that are durable, we don't necessarily have to put that wood to the extreme test of its durability if we don't have to.

**CONCLUSION**

Many professional wooden boat builders and restorers are graduates of specialty schools such as The Landing Schoolor The International Yacht Restoration School, or have accumulated their knowledge from years of experience and apprenticeship under a master shipwright. These seasoned professionals honed the time-honored skills of traditional boat building, and they have seen new materials and techniques develop as technology creeps into the field. Some professionals prefer to use the old techniques not only because they are tried and true, but because they carry on the tradition. Other professionals are employing the newer methods and producing fine replicas of older designs as well as brand new designs. The boat builder, owner, or restorer, whether he is an amateur or professional, usually has a philosophy regarding how he will address the application of newer technologies in the construction process. I lean toward being the traditionalist when restoring an original boat like ALEMANA. The older, and by today's standards "low tech" methods, I sometimes find a more elegant solution. But there are some new methods that just make sense to use. For example, I think Captain Nat Herreshoff would have embraced resorcinol and epoxy as waterproof glues and would be in favor of water-based paints that dry in a couple of hours and are ready for recoat, not to mention the safety considerations of avoiding exposure to volatile solvents. He may even have been in favor of laminating some structural members if this resulted in a stronger and lighter part.

The use of newer methods and materials is a personal decision, but if this is the direction you want to take, make sure to research the proper application and the reasons why professionals may be using these new techniques. After all, there are centuries of experience with the older techniques whereas there are only decades at the most with some of the newer technologies. That being said, if one chooses to apply a material or technique with insufficient history of performance or longevity, one must be prepared to accept what this may mean with respect to future maintenance or repairs.

I chose to restore ALEMANA in a very traditional manner, and as a result it has thus far been a very satisfying woodworking project. She is still under construction as of the submittal date of this paper, but she should be completed by early summer 2014 so that I can have a chance to get familiar with her before the annual Herreshoff Regatta in August. I still have no personal experience with owning a carvel boat, but information in the Herreshoff Registry indicates that these boats have lasted for decades and have been passed down through generations. Hopefully the restoration I am giving to ALEMANA can keep her actively sailing for several more decades.

**ACKNOWLEDGMENTS**

I'd like to express my appreciation to the following people for providing either advice or inspiration to what has turned out to be a very rewarding project: John Palmieri and the staff at the Herreshoff Marine Museum, Steve Nagy, and Richard Gentile for their insights on the 12½. Dave Corcoran, Alec Brainerd, Steve Ballentine, and Dan Shea for providing fine examples of what excellent build quality should look like, and Dan for his advice. The Wizard of Bristol for designing such a beautiful small daysailer that would be relevant for a century and beyond. And finally, to my wife, Ann, for giving me the support to fulfill this dream project.

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## ABOUT THE AUTHOR

Erick Singleman is a native of Albany, New York, and holds a master's degree in Mechanical Engineering from Rensselaer Polytechnic Institute. He enjoys boat building and Shaker style furniture making. He learned his woodworking skills by watching his father Alfred Sr. "Sing" make all manner of things in the woodworking shop at the Albany Boys' Cub where he was a director. Erick and his wife, Ann, are captivated by the lines and charm of classic yachts, and can be seen sailing or paddling traditional wooden boats in the lakes and protected waters of New York and New England.

# HMCo Centennial Class Panel
# 1914 - 2014

**Moderator- Halsey C. Herreshoff**
**Panel- D. Cooper, F. Fossati, A. Giblin, S. Nagy, E. Singleman, C. Suitor, C. Wick**

**Figure 1 –** Capt. Nat aboard RESOLUTE May 3, 1914

**Figure 2 –** Centennial Class half models top to bottom- [ALERION III, SADIE, Newport 29], BB25, H12½

CYS is fortunate to assemble a panel of individuals of experience and passion for Newport 29s, Buzzards Bay 25s and Herreshoff 12½ Footers. Their scope ranges from technical applications of talent for restorations as well as sailing experiences. The purpose of the brief panel discussion is to flesh out additional salient details following from CYS 2014 papers focused upon the subject classes. This will be done mainly by panel member responses to audience enquiries and comments.

Given time restraints, panel member initial remarks will be limited to no more than one minute per person so that there will be sufficient time for dialogue with audience participants, proctored by the moderator.

Subject may include:

1. Construction detailing that has stood the test of 100 years.
2. Items of failure or degradation facing restorers of the boats.
3. What it will take to achieve another 100 years?
4. Any advice for changes to original scantlings, evidence, and reason.
5. What is the most efficient process in restoration?
6. Sailing these craft in classic or modern competitions.
7. How should owners of these boats best preserve them?
8. Pride in continuing these signal Herreshoff traditions.

# RELIANCE Project
## Discovering HMCo Capabilities


**Author Sandy Lee & the Reliance Project Team**


**Figure 1** – The volunteer crew from left to right: Mike Mirman, Steve Siok, Tim Horton, Sandy Lee, Keith Bradley, Joe Uzzo, Herb Luther and Bill Lawton. *(Missing from photo: Denise Bolduc, Tim Greves, Craig Grantham, George Herchenroether, Garry Holmstrom, Michelle Crist, Virginia Sanders)*


## Abstract

A year ago September, a volunteer crew undertook a project to build a 38-foot tall and fully rigged one-sixth scale museum quality model of 1903 America's Cup winner RELIANCE. RELIANCE is unique not only as the biggest, most extreme and technically advanced of the 90 footers, but most importantly because she inspires the SPIRIT OF INNOVATION.

Our journey to completion by July 4th, 2015 is yielding insights into Nathanael Greene Herreshoff's expertise in:

a. Structural, weight, and materials engineering
b. Manufacturing engineering

We are also observing a number of important advanced business practices at Herreshoff Manufacturing Co. that should secure its place in the American Industrial Revolution with continued relevance to 21st century high-technology firms. Highlighted in the paper are some of the observations that will be explored over the next eighteen months and developed into exhibits to accompany the display of the RELIANCE model.

The Classic Yacht Symposium™ 2014

# RELIANCE Project
# Discovering HMCo Capabilities

## Sandy Lee & the Reliance Project Team

**ABSTRACT**

A year ago September, a volunteer crew undertook a project to build a 38-foot tall and fully rigged one-sixth scale museum quality model of 1903 America's Cup winner RELIANCE.

RELIANCE is important not only as a symbol of the biggest, most extreme and technically advanced of the 90 footers, but most importantly because she inspires the SPIRIT OF INNOVATION.

Our journey to completion by July 4th, 2015 is yielding insights into Nathanael Herreshoff's expertise in:

a. Structural, weight, and materials engineering
b. Manufacturing engineering

We are also observing a number of important advanced business practices at Herreshoff Manufacturing Co. (HMCo) that should secure its place in the American Industrial Revolution with continued relevance to 21st century high-technology firms.

**INTRODUCTION**

This paper presents some of the observations that will be explored over the next eighteen months and developed into exhibits to accompany the display of the RELIANCE model.

Our team is acutely aware that we will not be successful if we only build a world-class model. Our greatest fear is to invest our time creating one of the largest and most impressive models but without a home in Bristol to attract worldwide audiences. We must therefore create the imperative for investors and patrons to support the Herreshoff Marine Museum and RELIANCE.

At the same time we are aware that building RELIANCE is also an important journey into the story of RELIANCE as:

a. Representative of HMCo's large racing yachts
b. A story of management of rapid innovation and engineering/ manufacturing excellence

We believe that exhibits that tell these stories are an important complement to our model and will create that imperative for investors and patronage.

HMCo appears in 1903 to be a wonderful blend of the traditional, evolutionary and revolutionary. Those of us who are model shipbuilders of 19th century craft see a lot in common, whether rigging, fids, diagonal bracing, and metal spars, for example. Some of RELIANCE is very traditional; some is a unique application of the traditional; and some is purely innovative.

Those of us who are familiar with 19th century boat and ship building also see much that is familiar. We wonder if we were discussing building RELIANCE with a shipwright from the 19th century whether that which we see today as wondrous would be so ho-hum to him. It is just that we have more than a century distance between us and forget how accomplished they were at the beginning of the 20th century.

It will be important to research RELIANCE in the following context:

a. The evolution of HMCo's boat and ship building
b. Technology developments going outside of boat building business.
c. Developments of business management practices that we may find are actually quite advanced in that pre-computer age.

To illustrate point a., some of RELIANCE's pedigree starts with the evolution of metal-hulled "Big **B**oats" and associated technologies.

Transitioning from composite boats like STILETTO, "Big" Boat" metal-hulled building began in 1888 (BALLYMENA HMCo 151), steel-hulled private steam yachts and US Navy torpedo boats exceeding 100 feet in length. Through these vessels HMCo developed lightweight metal-hull designs and the experienced "steel crews" to build them.

So, how much technology and manufacturing capability were developed and evolved from these early metal-hulled boats (including torpedo boats) that found its way into RELIANCE?

Exhibit (1) shows the timeline of lightweight, advanced "metal-hulled" shipbuilding and modern yacht design at HMCo.

(To add to the picture of RELIANCE's pedigree, we have also included in Exhibit (1) the development of the modern sailing yacht. Capt. Nat's deep-hulled sailing yacht designs evolved over the ten years, 1883-1892. Beginning with the 29-foot WL plumb-bowed English style cat yawl CONSUELO, advancing through the 1887 CLARA, and the 1890 GANNET and PELICAN ("*the first I had designed with an overhanging bow and I was so impressed with the advantages, I used the principle in the extreme in designing GLORIANA")*[1]. The 1891 NY46-footer Class GLORIANA, winner of every race in its first year against the best of US yacht designers solidified his reputation as the leader in modern sailing yacht design.)

In thinking about point b. we know that there were important, exciting engineering developments occurring at that time in many industries and the fields of fluid flow, mechanical engineering, and materials science, and that N.G. Herreshoff studied mechanical engineering at MIT, worked as an engineer for Corliss Steam Engine Co., was inquisitive and methodical and had an impressive technical library. He was therefore certainly aware of technology advances and scientific methods of analysis going on in the world around him.

To illustrate, Exhibit (2), (3), and (4) show web frames, rings and stringers with bulbs. Exhibit (5) shows wooden C-Channels formed into box girders with bulkheads for torsional stiffness. How much of these are commonplace technologies used elsewhere but brought into a staid boat building industry?

He also broadened and deepened his interest within the naval architecture arena. We know he surveyed torpedo boat developments in England in 1879, at which time he became a member of the Royal Institute of Naval Architects (INA) (the leading technical organization of the day) and was a founding member in 1893 of the American Society of Naval Architects and Marine Engineers (SNAME). We've seen in *Their Last Letters 1930-1938*[2] that he would also cast a critical eye on boat designs (perhaps even INDEPENDENCE.)

And he was diligent. He prepared himself well in the 1890s for the work ahead through extensive and detailed testing of hull materials (Ni- steel, Tobin bronze, aluminum), wire rope, and sail cloth; and there may be others. Through that process he had the engineering knowledge from which to develop standard designs, work the materials to their full potential - thereby saving weight - and to qualify his key material suppliers and their products[3].

One cannot help but do copious amounts of research and delve deeply into plans and drawings when building a boat of the stature of RELIANCE. And then there is the experience of building scale parts to exact fidelity; all of which gives great insight into "Big Boat":

a. Construction techniques
b. Structural Engineering
c. Weight Management
d. Materials Engineering

This construction experience gives rise to the observation RELIANCE goes together quite easily and simply - by design and business practices- and leads to point c.

We also observe that RELIANCE was built, launched, mast stepped, rigged, test-sailed and delivered to the Iselin Syndicate 194 days after receipt of order (ARO). Her keel was poured 41 days ARO and steel frames erected two months ARO. (RELIANCE was only in the water for 147 days before being hauled out and ultimately scrapped! See Exhibit (7) timeline of life of RELIANCE)

HMCo contracted, designed and manufactured a number of boats during the RELIANCE timeframe. The large racing Schooner INGOMAR was designed and built, the Bar Harbor 31 class was designed and built as well as a number of launches and small craft. See Exhibit (8). And we shouldn't forget the intense activity to update COLUMBIA and CONSTITUTION) for the Cup defender trials) and provide aftermarket support of all the America's Cup boats 24/7.

How did HMCo do this? Those of us familiar with aerospace and high technology manufacturing have seen large manufacturing engineering staffs on the shop floor operationalizing design-engineering plans. All there was at HMCo was Capt Nat with several draftsmen!

Before we bestow all laurels on Capt. Nat, we must acknowledge that it was the "business" of HMCo to make all this happen. Therefore, our search for answers must lie in understanding the HMCo business practices that made the half-century miracle possible. In fact, the story of the blind John Brown Herreshoff (partner, president, treasurer, negotiator of contracts and much involved in daily operations) may be just as important!

Indeed, it is interesting to note that the Herreshoff firm was the Herreshoff Manufacturing Co. not Herreshoff Engineering Co., Herreshoff Technology Co., or Herreshoff Designs Inc. The HMCo organization shown in Exhibit (9) illustrates this.

Those of us around the museum have heard the story that Henry Ford visited HMCo to understand advanced manufacturing. (We have found no evidence to confirm the story or the relationship in the Herreshoff records at the museum. We plan to search Ford archives.) Whether the story is true or not it is a good yarn, and it leads us to seek answers to the questions "Why was HMCo well-known as an efficient high-tech manufacturing company?" and "What is its relevance to 21st century business?" We are working with Roger Williams University Business School and the Community Partnership Center (CPC) to explore these areas.

In closing the introduction, the RELIANCE Team notes that we are not naval architects, or structural and materials engineers, ship building historians or even generic historians. We are volunteers with varied boat building, model-making, technology and business backgrounds.

Much of what we are doing, and what is being discussed in this paper is very similar to an archeology dig, except we are doing business and engineering practices archeology.

We offer our observations that need to be explored with deeper research and understanding in the coming months. If you can help, we ask you to please join our team or at least "consult" with us.

Finally, we note it is important to remember that RELIANCE is truly a unique, purpose-built boat:

- To sail calm, placid summer waters of Long Island Sound and off New York Harbor.
- Pushing extreme design to win at all costs, compromising comfort and safety, and with longevity not an issue.
- Accepting the real probability of breakage and accident (all the 1903 contenders suffered major accidents and dismastings. Two lives were lost in 1903 trials)
- Without constraints of insurance and construction rules (Lloyds), government regulations, or adverse legal environment.

## STRUCTURAL, WEIGHT & MATERIAL ENGINEERING

RELIANCE as built is really from the second carved hull. The first one was shown to a syndicate member and Nat was challenged to make it more extreme - in the words of C. Oliver Iselin "Pikes Peak of Bust"[4.] Her comparative size is shown in the table below[5].

| | Height | Length | L.O.A. | Sail Area | Displ. |
|---|---|---|---|---|---|
| **Reliance** | 220' | 202' | 144' | 16,159 | 169 T |
| **Shamrock III** | 204' | 187' | 134' | 14,154 | 167 T |
| **Constitution** | 206' | 192' | 133' | 14,230 | 156 T |
| **Columbia** | 192' | 184' | 132' | 13,135 | 149 T |
| **Rainbow** | 179' | | 128' | 7,535 | 141 T |

Height- from bottom of Keel to top of masts or #1yards
Length- from tip of bowsprit to tip of boom

To achieve winning power and speed within the limitations of the Seawanhaka Rating Rule under which RELIANCE raced (and the America's Cup rules that set a 90′ waterline limitation), Capt. Nat had to create a lighter-weight, stronger, and higher powered boat than his competitor. Lighter hull weight allowed for a heavier keel and bigger sail area. Conversely, excess weight aloft would necessitate a heavier keel and smaller engine (sail area) in order to keep within the 90′ waterline length.

He created a boat 10 feet longer on deck than Lipton's boat with longer waterline when heeled over and with 2,000 square feet more sail area at almost the same displacement. It was as if SHAMROCK III was designed to beat CONSTITUTION but Herreshoff had moved on!

We have seen the "envelope" pushed in four areas, and we'll note a couple of key examples in each.

### Hull Design

Tongue-in-cheek, RELIANCE is a 93 ton keel[6] tied to a huge mast-step which is in turn kept afloat by a long, flat overhanging egg shell.

There are only 21 steel ribs, or web-frames, the whole length of her hull; these are connected by a series of angled stringers[7] – the longitudinal framing concept introduced on CONSTITUTION. The stringers have structural "bulbs" and the web-frames are "H" shaped in cross-section with a flange and angle-bar connection to the hull plating. The forward half has diagonal bracing. See Exhibits (2), (10) and (11).

Diagonal bracing was certainly used in ships – See USS CONSTITUTION and Clipper Ship design, for example. And girder design was in common use. The 1903 Wright

Flyer was also a very light-weight diagonally braced contemporary extreme design. Like the Wright brothers, it appears that Nat Herreshoff applied existing engineering techniques to extreme designs.

The photo below from the Museum's collection shows a piece of one of DEFENDERS aluminum deck beams with the bulb and angle construction.

## Steel Spar Design

A re-rigged DEFENDER and COLUMBIA introduced fabricated steel masts on America's Cup boats in 1899. COLUMBIA's metal mast was a significant weight saving of one ton[8] over her original wooden mast (and promptly broke on her first sail, see below[9].) She also had a telescoping (wooden) topmast.

RELIANCE's main mast, boom and gaff were fabricated metal structures. Like the hull, there were "H" cross-sectioned rings and angle-iron stringers with bulbs and of course the riveted plates. In the case of the spars these plates were overlapped, not butt-jointed as on the hull plating. Rivets for the hull, mast, boom and gaff were ground flush. (Drawings of the boom illustrate these facts. See Exhibits (3) and (4).)

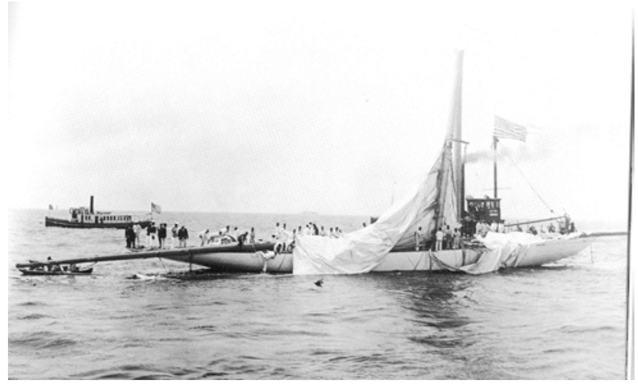


Exhibit (12) shows that two gaffs were made for RELIANCE. The first has heavier plating with the overlapping at the top. The second has lighter plating and overlapping on the bottom, perhaps indicating that Herreshoff was testing light-weight designs in real-time. In fact, Iselin in his logbook notes on August 23rd in the middle of the America's Cup races that they decide to change the gaff and NGH is sent to Erie Basin with the gaff to oversee its strengthening and stiffening. [10]

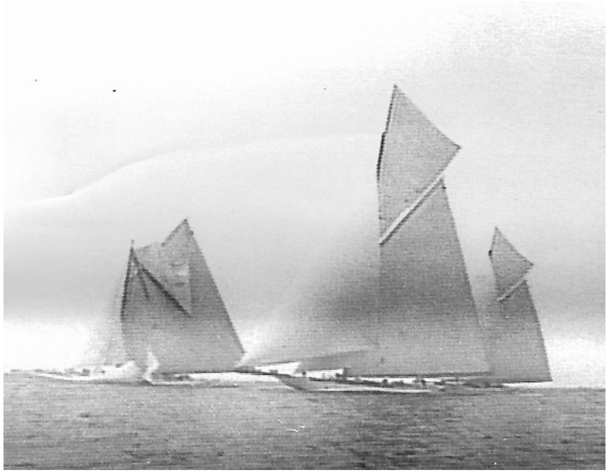
We should also note here that the mast was 26 inches in diameter, and only tapered at the very top[11]. Similarly, the boom and gaff had long central cores, the boom being 21inches in diameter[12]. Both the boom and gaff had the same taper at inboard and outboard ends[13]. This is an important consideration for the discussion of simplified manufacturing processes in the following section. The long, same diameter cores would have the same rings, stringers and plates throughout. Rings, stringers and plates on the tapers could be doubled for inboard and outboard ends. And of course jigs and plate rolling rollers would be simplified, and costs reduced.

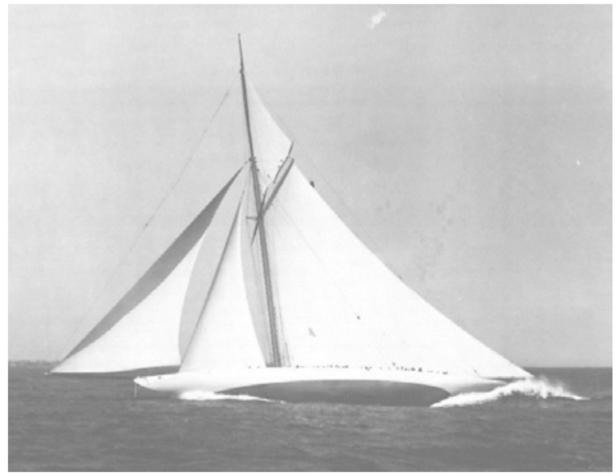
Steel masts were probably a contemporary phenomenon. Windjammers had them. U.S. Navy ships had steel masts (U.S.S. Olympia (1888) where there appears to be telescoping sections (fixed?), for example.)

## Wood Spar Design

RELIANCE's wooden spars included 58-foot topmast[14], club topsail yard, club topsail club, 83-foot spinnaker boom[15], and 41-foot bowsprit[16]. There were three sizes of topsail yards and clubs, corresponding to the #1, #2, and #3 club topsails. The #1 yard and club were 68 and 58 feet long, respectively[17, 18], and supported a topsail with a 105 foot long luff[19].

These spars were Douglas fir, which was prized for its bending strength and lightweight. (After RELIANCE was dismasted in June 1903-see below[20] - the topmast was replaced with a Sitka spruce mast. Iselin writes in his Journal the new mast was 23% lighter[21].) The bowsprit was solid[22]. The rest were hollow[23, 24, 25, 26].





The spinnaker boom was constructed with the traditional “barrel stave” approach, round in cross section[27]. The yard and club were box girders[28],[29]. All three, like the boom and gaff, had the same tapers at inboard and outboard ends. These wooden spars had bulkheads spaced throughout for torsional stiffness, the grain of which runs parallel with the spar. Again, the same construction simplification statement can be made here as previously in the mast, boom and gaff discussion.

At least two yards and clubs of were made for each size of spar. As shown in Exhibit (6) the spare yards were proportionally thicker in cross-section, perhaps suggesting more conservative backup plans.

Exhibit (5) shows the strength side of the yard box girder, the 3″ thick fore and aft sides, to be “C-Channels” with the inside routed out to a depth of 1″ (“guttering” in Herreshoff parlance[30]). These 3″ thick walls are attached to relatively thin side walls to make the box girder. The guttering is a constant 1″ in depth throughout the length of the spar even though exhibit (5) also shows the 3″ thick walls are themselves reduced in thickness towards the ends.

Exhibit (5) also shows the centerline cross section of the #1 club topsail yard to be 13 5/8″ x 10 1/16″, tapering to 4 ½″ round at each end. This spar is 132 to 200 feet in the air and all effort was taken to have a strong yet lightest possible spar up there.

The lighter, smaller club has similar characteristics, though no “guttering.” Its strength sides however are the left and right sides, reflecting the different direction of forces[31].

In this photo[32] we can see the bending loads on the club topsail club in light wind. It is somewhat “S” shaped. RELIANCE carries no jib topsail and a small club topsail yet she is heeled over in light wind and seas with a large rooster tail and elongated waterline length.

The spinnaker boom tapers from 12¾″ at mid-section to 5 ½″ at each end[33].

This weight reduction effort was no small matter! In the case of the yard, two 68-foot long boards 1″ thick were removed by guttering. In addition, the 3″ thick sides were reduced in thickness at each end and the whole spar was tapered to 4½″ cross-section at each end. Serious weight-reduction aloft!

The topmast is constructed differently! We thought we’d see similar construction to the COLUMBIA topmast in storage in Building 28 of the Museum[34]. That mast is standard “barrel-stave” construction and tapered. (Apparently, this is COLUMBIA’s first topmast that was paired with her initial wooden main mast. There are interesting scarf joints and no special joint techniques or special glues. It does have some internal doubling of walls at certain points –breakage points? This needs some research!)

As can be seen in Exhibit (13), the topmast is made by gluing eight 58′ long 5″ x 5″s to create a hollow “straight-stick” 13″ diameter mast. It seemed to us that the 5″ x 5″ were glued together in pairs, then routed out with a 7″diameter arc, and finally mitered with 45$^{o}$ angles to form the four sides.

Exhibit (13) shows the center section of the topmast has a 7″ diameter hole and 3″ thick walls. This tapers out to a 9″ hole at each end and 2″ walls, in essence internal tapering rather than external tapering. Again, strength and light weight construction considerations.

This construction methodology simplifies the construction of the wasp-shaped hollow innards, and we found the square shape in gluing up the sides to be an easy layup in our jig[35].

The Iselin logbook notes changing the topmast several times. Apparently they were looking for lighter, stiffer topmasts throughout the summer. He even notes on July 24th a topmast made of 16 pieces, which was 300 lbs. lighter, but this was soon replaced with a heavier one. [36]

We have made 4′ long sections of the real-sized wooden spars[37]. These can be seen with the model. In our scale it is hard to remember the heavy weight and immense size of the originals. The table below shows the weights of the mid-sections of our wooden spars.

| **Weights of 4′ Sections on Display with RELIANCE** | | |
|---|---|---|
| **Spar** | **Total Length** | **4′ Weight** |
| Topmast | 58′ | 95 lbs. |
| Yard | 68′ | 62 lbs. |
| Club | 58′ | 40 lbs. |
| Spinnaker Pole | 83′ | 58 lbs. |

At the current time we do not have a calculation for the weight of the topsail assembly including spars and sail. (We do know for comparison the #1 jib weighed 700 lbs.[38]). The photo below[39] of COLUMBIA's sail being taken to dry, also offers some indication of size and weight!) Imagine the effort to raise and lower the topsail, topsail yard and club, or the spinnaker and spinnaker boom. No wonder a crew of 64 was required[40]!

We've constructed our wooden spars to exact scale dimensions with Douglas fir and our scale wooden spars are feather light - much, much lighter than comparable small boat spars. We know there is supposed to be some scaling effect – that is what the "experts" tell us – but really!

**Sails**

In passing, we note that RELIANCE had a huge inventory of sails of all sizes as the following table of sails used during the America's Cup races indicates. HMCo sail makers during the winter, spring and summer of 1902-1903 were a busy lot, often making overnight changes on huge sails[41].

| Sail | Race 1 | Race 2 | Race 3 |
|---|---|---|---|
| Mainsail | F | F | F |
| Topsail | B#2 | B#1 | N.M. |
| Fore Staysail | E#1 | C#1 | B#2 |
| Jib | E#1 | F#2 | F#1 |
| Jib Topsail | #5 | D#4, B#2 | D#4 |
| Balloon Jib | Yes | A#1 | B#1 |
| Spinnaker | Ratsey small | Ratsey | Ratsey Silk |

N.M. no mention of topsail used in 3rd race

The Iselin logbook also notes the continual testing and re-cutting of sails.[42] Here we find that Ratsey made headsails and a mainsail and even spent a day onboard RELIANCE to observe the setting of sails. Several of the best sails were put away until the races. Others were re-cut right up to the time of the races. He even notes shipping COLUMBIA's baby jib topsail. Apparently jib topsails were not set until after the start of races. He provides a more complete picture of sails used, tactics and relative positions of each yacht.

| Sail | Race 1 | Race 2 | Race 3 |
|---|---|---|---|
| Mainsail | F 3/0 | F 3/0 | F 3/0 |
| Topsail | B-2 | B-2, B-1 | B-2, B-1 |
| Fore Staysail | C-1 | B-2, C-1 | B-2 |
| Jib | E-1 | F-1 | F-1 |
| Jib Topsail | -5 | Baby, A-1, B-2 | B-3, A-4 |
| Balloon Jib | Yes | Yes | B#1 |
| Spinnaker | Ratsey small | Ratsey | Ratsey |

**Tobin Bronze, Aluminum & Nickel Steel Plating**

The Tobin bronze plating list[43] shows the hull plated with Tobin bronze and the deck with aluminum. It also seems from the line-outs that nickel steel plates were substituted for Tobin bronze on the sheer and margin strakes sometime after the original schedule was created.

Tobin bronze and aluminum were not new. They had been incorporated on VIGILANT (1893) and DEFENDER (1895) respectively. Sample plates from the Museum's collection are shown below. Despite boats getting bigger the plates apparently were not. The HMM Curator's notes say that RELIANCE's Tobin bronze plates were thinner than CONSTITUTION's! These bronze and aluminum plates are shown below (bronze top to bottom, COLUMBIA, CONSTITUTION, RELIANCE and RESOLUTE: Aluminum Plates are from DEFENDER and RELIANCE)


The deck and hull plating plans show in exhibit (14) that Herreshoff was again simplifying manufacture. Here again, many of the plates were arranged to get common sizes and thicknesses. It would be interesting to compare plate thicknesses of earlier boats, adjusted for size of boat, to understand where Capt. Nat was stretching material strength limits. (We note the plating on original RELIANCE is thinner than the fiberglass of our one-sixth scale model which was made to commercial boat standards!)

In conclusion, it seems to us that N.G. Herreshoff's creative hull and steel and wooden spar construction and plating materials enabled him to spread 2,000 square feet more sail on the same 90′ waterline length than his competitor.

We also note in passing the Spartan interior of RELIANCE, Exhibit (15), showing owner's cabin with head and sink basin, areas for the sail maker, berths for sailing master and mate, steward's bench and portable stove, crew berths which also seem to double as sail stowage areas, and two more heads. Interestingly, there are no through-hull overboard discharge outlets for waste water or the bilge pump. Perhaps the Sand catalog Figure 79 Closet had a porta-potty?

**HERRESHOFF MANUFACTURING COMPANY**

This section describes our RELIANCE-based observations on why HMCo was a well-known high-tech manufacturing establishment, and we also suggest the reasons for this;

- HMCo deserves recognition as an important waypoint in the American Industrial Revolution.
- HMCo is still relevant to 21st century high-tech manufacturing business.

Our research with Roger Williams University is focusing on six key business process areas that we summarize below.

***Simplified, focused marketing and contracting process to assure business capture:***
Exhibits in Museum Building 28 highlighted for us that HMCo had a core group of loyal customers. These customers appear as owners of fin-keel boats, Newport 30s and other class boats, America's Cup boats, and the large steel racing schooners. Indeed, their skippers also appear with regularity and may be another important ingredient for success!

HMCo knew its customer base. The loyal customer base was seeking new winning racing/ cruising solutions, and the HMCo continuous product improvement process described below assured upgrade, repeat business. It wasn't that every succeeding HMCo design was perfect, but this customer set "knew" that the very next boat would be. They appreciated genius and respected HMCo capabilities.

The core customer group was a relatively small population of members of the NYYC, other important, competitive clubs and owners (mostly) on the Eastern seaboard, and including several likewise minded groups and owners on the Continent. Thus, the core group of repeat and appreciative customers was critical, just as it is today. "Launch customer" E.D. Morgan and a few others played a significant role[44].

Advertising was not important. Word of mouth sufficed. Racing successes were covered in newspapers and magazines generated the buzz.

At the end of the marketing process was a simple, direct contracting process with "pre-qualified" customers. America's Cup contracts were short and simple (with some legal boilerplate). Perhaps the best example of the process is the advice Charlie Barr gave A.S. Cochrane when contracting in 1909 for the steel schooner WESTWARD "All you have to do is run up to Bristol and tell N.G. Herreshoff you want a yacht for that purpose and be sure not to tell him how to design her for if you do he will probably not take the order. You may have to show him some credentials for he doesn't like to design a large yacht unless he thinks the owner can afford it"[45].

Preliminary design/ sales support activity would be critical in this phase. And at the heart of the closure process was the half-hull – used by ship builders for generations to gain acceptance of the proposal.

Ironically, it may have been the change in this core customer group's buying behavior after World War I as much as a lack of succession planning that caused the demise of HMCo

***Continuous, evolutionary development keeps HMCo at leading edge:***

From 1893 through 1903, HMCo was on a two-year development cycle (except the four years 1895-1899) for the introduction of new, faster America's Cup boats. This was interspersed with similar introduction cycles for the big steel schooners and smaller class boats.

We may find that incredible until we get to the computer age, but in reality wasn't that what Donald McKay and William H. Webb were doing with their clipper ship designs?

The America's Cup boat exhibit in Building 28 gives us some insight. First, when the hull plans for the America's Cup boats of this era are put next to each other, we see each succeeding boat getter longer, thinner, and with more pronounced keel structure - the evolution of the extreme hull shape. Next, there is a timeline for introduction of new technologies. There are continual exploiting materials, construction, and weight-saving technologies. See Exhibit (16).

So, we see a focus on improving critical design elements. This is supported by Capt. Nat's science-based analysis as well as observation of actual performance.

But what seems equally important is what doesn't change.

Capt. Nat relied on standard fittings and structures for non-critical elements. There is design re-use and adaptation and he limits choices and options.

There are a number of comments on fitting drawings to strength test certain items, and occasionally there are red-line changes. But from the numbering system of drawings, dates, and hand-written notations it is evident that much is re-used from earlier big boats.

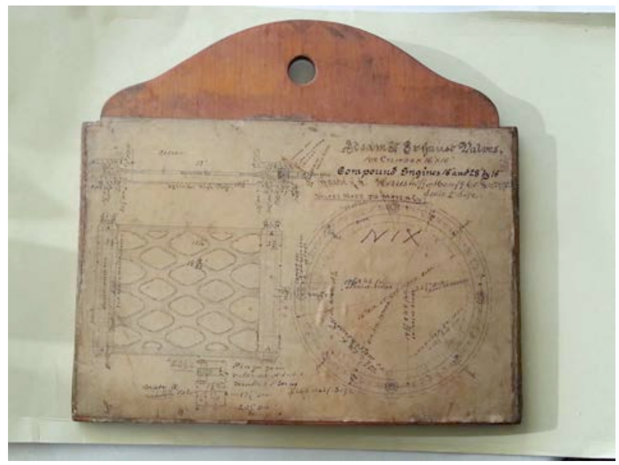
One has only to compare the photo of the foredeck of CONSTITUTION (Exhibit 17) under construction and the layout of the deck of RELIANCE (Exhibit 10) to understand that when Herreshoff thought he'd gotten something right, or good enough, it didn't change.

In conclusion, it will be very informative to create a timeline that showed the truly "AH-HA" revolutionary moments and the important evolutionary changes. We bet it will show a sustained pattern of continuous, evolutionary development in a very systematic and controlled fashion, and that Capt. Nat would be very comfortable with modern theory on rapid, continuous, controlled product improvement.

***Rapid, integrated design process improves accuracy and speeds time to manufacturing:***

The rapid and accurate translation of development concepts to designs and then to instructions for the manufacturing floor has always been problematic.

Herreshoff used half-hulls and a Brown & Sharpe three dimensional coordinate measuring device to create measurements that could be sent at the speed of paper to the drafting department and lofting floor. It was in effect CADCAM without the computer to link engineering to manufacturing.




HMCo employed flat panel displays of drawings at the manufacturing work stations. See photo above from the Museum's collection. These non-computerized laminated blueprints often had red-line changes and manufacturing notes. They hung in the shops and were given to workmen when the call went out to the shop. No need to travel to the drafting department to get a drawing (and we understand water boys brought water to workstations) and no need to ensure that the worker has the latest drawing.

As described before, there was a library of reusable designs. For example there were standard shackle, hook, padeye, turnbuckle, and hatch drawings; and standardized formats for rigging, blocks, and plating schedules. Our listing of RELIANCE drawings shows the extent of reuse and standard designs from folders/ drawers in the 28, 49, 70, 74, 78, 79, 84, 109, and 112 series of drawings for various fittings and assemblies; from the 87 series for NAVAHOE, COLONIA and VIGILANT; from the 89 series for DEFENDER and other earlier America's Cup boats; and from the 90 series for COLUMBIA. These supplement the 86 series of drawings for CONSTITUTION and RELIANCE. Many of the RELIANCE Drawings are updates of CONSTITUTION drawings[46].

HMCo seems to have employed exception-based drawing changes through red-lines, production notes, and drawing change controls. In the NGH Collection housed in the Museum's Model room there are also design change books with tear out carbon copy sheets that Nat used to provide on the spot design change directions to the shop foremen.

There also were standardized production control schedules for:

a. Drawing (releases) Lists[47]
b. Patterns[47] and forgings[48]
c. List of Tobin Bronze Plates[49]
d. List of Steel Plating[50]
e. Plating Plan[51]
f. List of Shapes[52]
g. Riveting Plan[53]
h. Wooden Floor Plan[54]
i. Wire Rigging[55]
j. Manila Rigging[56]
k. Block List[57]

We wonder how these evolved from earlier construction projects and to what extent they were standardized? HMM Curator's notes state that HMCo was determined to finish RELIANCE on time; CONSTITUTION being delivered later in the spring may have contributed to her poor showing. We've seen supporting glimpses of the evolution and standardization efforts and will explore this further.

***Efficient vertical integration except with key suppliers to leverage skills or technology keeps an efficient speedy shop:***

It is true that HMCo was vertically integrated. There seems to be two reasons for this:

a. Security
b. To improve control over the business and to facilitate integration of engineering and manufacturing.

Despite this there appear to be some significant collaboration with other firms, for example:

a. The use of the Boston rigging firm Billing Brothers for RELIANCE and other big boats[58]
b. Boston Spar Co. for America's Cup boats[59]
c. Lawrence Manufacturing Company for development of cross-cut sail materials[60].

(Interestingly, though HMCo made RELIANCE's sails, RELIANCE did try a Ratsey mainsail and did race with Ratsey spinnakers[61]. Other notes mention J. Wood & Bros. Co., Conshohocken PA for nickel steel plates; Lukens Iron & Steel Co. Coatesville PA for nickel steel plates, Ansonia Brass & Copper NYC NY for Tobin bronze plates, and DW Coleman & Sons, Providence RI for Block Strap Material and Nickel Steel. The wire rigging schedule specifies Roebling Wire {Brooklyn Bridge 1883[62]}.)

Of great interest would be deeper exploration into HMCo's relationship with steel and bronze foundries and its wire rope supplier. These appear to be special orders and there are indications of order changes and quick turn-around delivery times.

***Engineering for manufacturability assures on-time, on-cost delivery & quality:***

We have read of the Herreshoff brothers' focus on profitability and cash flow. We also read that despite being a design bureau of one, Nat did spend significant time in the shops. (Nat was both chief designer and superintendent of the shops.) We note that this closeness between engineering and manufacturing is also one of the key success factors attributed for success of Lockheed Martin's Skunk Works under Kelly Johnson which rapidly developed and produced a number of record-breaking aircraft in the decades of the 1940s - 1960s.

We also know HMCo was very committed to delivery schedules; sometimes for race seasons or schedules, but also for the extreme high tides to float deep keeled vessels into Bristol Harbor. So, there are very practical reasons for HMCo to focus on this area.

In many respects this result is the back-end benefit of the rapid, integrated design and controlled innovation processes described earlier, but there is more to it. We have found many good examples of these practices in building our model. Among them are:

a. Standard manufacturing approaches. We can imagine the Herreshoffs telling their foremen "RELIANCE will be like CONSTITUTION but bigger!" and the foremen immediately understanding what was before them. They'd understand the lead keel pouring approach, the steel framing and plating approach, etc. From the standard production control schedules (discussed earlier) they'd understand the timing and amount of work. This is the back-end benefit of continuous, controlled evolutionary engineering.

b. Approaches to Engineering facilitate manufacturing. Earlier in this article we discussed:

i. Emphasis on standard catalog of parts, fittings, structures and options
ii. Deck arrangements evolve from or replicate preceding boats
iii. Simplification of designs such as for spars, hull and deck plating
iv. Drawing libraries and flat panel displays

c. We also note that placement of fittings on deck simplifies manufacturing, for example:

i. Chainplates, winches and bollards are placed on the web frames, not on some specially made platform between frames. See Exhibit (10).

ii. Fittings are placed at measured distances perpendicular to deck edges and/ or forward or aft of web frames. Almost always these are simple feet and inch marks. Refer again to Exhibit (10).

d. We've seen the innovative use of jigs, fixtures and construction solutions; for example the topmast discussed above or the spar jigs mentioned in prior CYS 2008 papers on building spars for the NY 50 SPARTAN[63].We've also noted simple, elegant solutions to complex problems, such as the spinnaker pole launching mechanism inserted in the anchor davit socket (Exhibit 18)

e. Interestingly, HMCo is all Yankee. They'd use existing wood or boiler tube stock when practical. See Exhibit (19) where boiler tubes are specified for diagonal bracing.

f. We've seen that HMCo would judiciously pre-order "strategic" materials to protect schedule. One might quickly think seasoned wood or sail cloth, but it also appears that lead, plating and special metal shapes were committed before contract signing to protect schedules.

g. Our research has even led us to inventory control cards that often have handwritten sketches of the parts in a corner. These indicate that depending on usage, parts are either ordered for stock of special order.

Anecdotally, we have read that the Herreshoff brothers were devotees of "Management by Walking Around" (email and text messaging being some years in the future!) Recently an elderly Bristolian visited our shop, her father having worked on RELIANCE. She remembered that her father commented that John Brown Herreshoff could tell if rivets were improperly placed, fastened, and smoothed flush just by touch. Interestingly, her memories were more about John Brown than Nat.

It also must be emphasized that HMCo workers were highly skilled artisans and seem to be completely in-tune with Herreshoff requirements. All the best engineering principles fail if the receiving side is not equally competent. And we cannot forget that it was on their shoulders that all 24/7 aftermarket support activities ultimately fell (overnight sail alterations or spar replacements, for example).

We can be amused by the HMCo work rules (Exhibit 20) and might bristle at the thought of working under these rules ourselves but we should also remember that these workers were some of the highest paid in the region. They also had a restaurant across the street from Building 28 and a number of cottages in Bristol are known as "Herreshoff Worker Cottages".

HMM is working with Roger Williams University to capture oral histories of those related to HMCo, their families, and the boat building industries that started on the HMCo campus. This effort will also include research by Roger Williams University History Dept. students into the life and times of the Herreshoff workforce.

***Aftermarket Support ensures loyalty and profitable follow-on business***

Aftermarket support must have been an important part of the business.

Technical support is segmented. On the one hand there is 24/7 support for Americas Cup and key racing machines. That includes technical support and overnight delivery of spares and alterations. It also appears that the Herreshoffs made personal visits to key racing yachts and important customers. Nat sailed on all the Cup boats through trials and the Cup races. He was on hand to direct changes, repairs and the ordering of spares from the plant. The remaining customers were supported from HMCo inventories of spare parts.

We cannot overlook the fact that unique Herreshoff design fittings ensure replacements from HMCo. Herreshoff boats owners did not go to the local vendor!

## CONCLUDING REMARKS

Others have focused on Captain Nat's design genius. We also find it interesting, but in context of controlled innovation. We have the unique opportunity through building one of his big, extreme yachts to see other aspects of his engineering skill. Importantly we also have the opportunity to feel the high-tech manufacturing environment that was HMCo.

All six of the business process areas described above worked well together in a very integrated harmonious and "value added" fashion. In that sense, HMCo was a very modern, advanced high-tech manufacturing firm.

As a humorous aside, we have not yet mentioned configuration management. Most of us from the high-tech world would groan at the mention of configuration management. It seems that HMCo had a good grasp of this.

But we've had our issues. There is as-drawn, as-built, as-sailed, and as-raced in the Cup configurations. Often our first inkling of a problem is from photos, but after that we've found good documentation for changes (If you understand the HMCo document numbering system, you'll appreciate this fact! And our black and white copies-of-copies don't show red-lines and hand-written notes very well, which has sent us to MIT to see the original color ones. Refer to our blog postings on building the boom and gaff, for example.)

However, construction of RELIANCE is exceptionally well documented in the HMCo drawings. Even post-delivery changes are documented via "red-line" comments. So when we read 1903 accounts or books mentioning things such as a ratcheting mechanism for RELIANCE's telescoping topmast or the pump mechanism and ballasting rudder we are left to wonder and hope that we'll have more time to research RELIANCE as well as earlier and later Herreshoff America's Cup boats for the answer in a drawing or red-line. (So far, these ambiguities do not impact our model.)

We hope that this paper will interest you in our project, and that you too now understand that the RELIANCE Project is much more than the model. The model itself will be a unique and important world-class model. But the project is also an important vehicle for understanding HMCo's place in the Industrial Revolution and Capt. Nat's prowess in structural and materials engineering.

Please follow our project at **thereliance project.com**. As demonstrated below we have a global following, just as the real RELIANCE did 110 years ago!

**RELIANCE does indeed inspire the Spirit of Innovation!**

On Sept. 3, 2013 Ms. Govinda Mens forwarded us a note and this poem.

Congratulations with her stunning victory 110 years ago! With warm regards, Ms. Govinda Mens, from Amsterdam

110 Years Ago – RELIANCE and the 1903 America's Cup – and admired by the Dutch! Dear fellow lovers of the magnificent Reliance. I found this article in a daily newspaper of the Dutch East Indies from September 3rd 1903. "The Soerabaiasch-Handelsblad." The song was composed by the comedian Mr. Lew Dockstader. http://newspapers.nl.sg/Digitised/Article/straitstimes19030826.2.38.aspx)
The Straits Times, 26 August 1903, Page 5: " IT WAS THE DUTCH."

**"IT WAS THE DUTCH."**

Who are the greatest race of men in this or any age?
And who in this world's history, are first on every page?
To whom did Father Adam go to buy his groceries?
And what brave nation was the first to eat Limburger cheese?
Chorus.
It was the Dutch! It was the Dutch!
Could a Chinaman discover sauerkraut!
N o t M u c h!!!
It was the Dutch! It was the Dutch!
Who always led the world!
IT WAS THE DUTCH.

Who showed the English soldiers, when the Boers and British met,
The English didn't know enough to come it from De Wet?
Who nearly beat the British. though outnumbered ten to one?
And who collected damages when old John Bull was done?
Chorus.
It was the Dutch! It was the Dutch!
Could an Englishman grow whiskers likes, Oom Paul?
N o t M u c h!!!
It was the Dutch! It was the Dutch!
Who first invented hair?
IT WAS THE DUTCH.

When Lipton comes to "lift"our cup and take it over the sea,
Who bids us place Reliance in a Yankee victory?
Americans each year, of course, produce the winning yacht,
But tell me who designs our boats, or have you all forgot?
Chorus.
It was the Dutch! It was the Dutch!
Do you think that all the Herreshoff's are French?
N o t M u c h!!!
It was the Dutch! It was the Dutch!
Who built the largest schooners?
It was the Dutch.
Who filled our best society with Knickerbocker names?
Who was it that first started our exclusive "Holland Dames?"
Who makes the famous Holland gin, that tonic f'or the throat ?
And when we wanted submarines, who built "The Holland Boat?"
Chorus
It was the Dutch! It was the Dutch!
Did Teddy Roosevelt's people come from Spain ?
N o t M u c h!!!
It was the Dutch! It was the Dutch!
Who built up Dutchess County ?IT WAS THE DUTCH.

**ABOUT THE RELIANCE TEAM**

The volunteer crew from left to right: Mike Mirman, Steve Siok, Tim Horton, Sandy Lee, Keith Bradley, Joe Uzzo, Herb Luther and Bill Lawton. (Missing Denise Bolduc, Tim Greves, Craig Grantham, George Herchenroether, Garry Holmstrom, Michelle Crist, Virginia Sanders)

**Mike Mirman**: Retired engineer. Hobbies include clock making, ship model making, miniature guns. He makes all our wax molds for bronze castings

**Steve Siok**: Retired GD Electric Boat mechanical engineer. Hobbies include model ship making and astronomy-trustee at Seagrave Memorial Observatory. He's been doing woodworking, electroplating and metal work for us.

**Tim Horton**: Our team psychologist. Owns a H12 ½. A jack-of-all-trades, he has made our spars and will soon be laying cork.Comment: laying cork? Are we sure?

**Sandy Lee**: Retired aerospace executive and management consultant for a major global firm. Hobbies include ship model making, woodworking and sailing. He is the RELIANCE project leader.

**Keith Bradley**: Retired WHOI Research Associate; still part-time helping with small boat fleet and research instruments. Adjunct professor at Babson College, Special Olympics swimming coach, he does metal work, hull work, heavy stuff and whatever! Capt. Trivia had a Bullseye for 12 years in Woods Hole.

**Joe Uzzo**: Managing Director at Fidelity Investments. Hobbies include sailing and maritime history, and he has been making our hatches, companionways and monitor.

**Herb Luther**: A Rhode Islander living on Cape Cod. Recently retired from the Marine Biological Lab in Woods Hole, he is a kayaker, birder, hiker, and gardener now. Herb works on RELIANCEe displays.

**Bill Lawton**: Apprenticed as a furniture maker, had a long career in boatbuilding including owning his own yard. After ten years in USMC, he began with Pearson on Burnside St. In retirement is a general contractor. Does everything and does everything well!

**Denise Bolduc**: Business owner and expert seamstress. Making uniforms for our crew

**Tim Greves**: Sailmaker. Making RELIANCE's sails

**Craig Grantham**: LT. in East Providence FD and knows his way around a shop so he is invaluable for woodworking and metal smithing

**"Herk:"** Retired IT consultant and business owner. Hobbies include woodworking and boat building. He has been busy making spar displays and developing our branding/ marketing approaches

**Garry Holmstrom:** Retired US Navy Captain and Raytheon executive. Commanded a destroyer and cruiser, working on our branding, marketing and exhibit activities

**Michelle Crist**: Fund raiser at RWU. Jill of all trades

**Virginia Sanders**: Grandmother and our researcher

**END NOTES**

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[1] The restored CLARA is on display in the Museum's Hall of Boats. The quote is from Pinheiro, Carlton. *Recollections and Other Writings by Nathanael G. Herreshoff*. (Bristol, RI: Herreshoff Marine Museum 1998).

[2] Streeter, John, annot. *Their Last Letters 1930-1938. Nathanael Greene Herreshoff, William Picard Stevens*. (Bristol, RI: Herreshoff Marine Museum, 1998).

[3] Tests are recorded in NGH's notebooks housed with the Nathanael G. Herreshoff papers in the Model Room. Courtesy of Halsey C. Herreshoff

[4] Nathanael G. Herreshoff letter to C. Oliver Iselin Sept. 25, 1902. Courtesy of Halsey C. Herreshoff

[5] *America's Cup Yacht Design 1851-1986*, Chevalier and Taglang. Height and Length calculated from drawings therein. RELIANCE's displacement from NGH Naval Architecture and Engineering Notes December 1899 – January 1908. Courtesy of Halsey C. Herreshoff

[6] NGH's notebooks housed with the Nathanael G. Herreshoff papers in the Model Room. Courtesy of Halsey C. Herreshoff
[7] Deck Plan 1-29, MIT Hart Collection
[8] Bray, Maynard and Carlton Pinheiro. *Herreshoff of Bristol*. (Bristol, RI: Herreshoff Marine Museum, 2005, page 93
[9] ibid, page 93
[10] Iselin papers, Mystic Seaport
[11] Mast drawing 86-111, MIT Hart Collection
[12] Boom drawing 86-128, MIT Hart Collection
[13] Gaff drawing 86- 147, MIT Hart Collection
[14] Topmast 2nd Design, 86-173, MIT Hart Collection
[15] Spinaker Boom (sic) 86-119, MIT Hart Collection
[16] Bowsprit 86-119, MIT Hart Collection
[17] Club Topsail Yard, 86-121 MIT Hart Collection
[18] Club Topsail Club, 86-143 MIT Hart Collection
[19] Club Topsails, #1 Topsail, Drawing 86-142, MIT Hart Collection
[20] ) Rosenfeld Collection, #29147, Mystic Seaport
[21] Curators Log, HMM website
[22] Bowsprit 86-119, MIT Hart Collection
[23] Topmast 2nd Design, 86-173, MIT Hart Collection
[24] Spinaker Boom (sic) 86-119, MIT Hart Collection
[25] Club Topsail Yard, 86-121 MIT Hart Collection
[26] Club Topsail Club, 86-143 MIT Hart Collection
[27] Spinaker Boom (sic) 86-119, MIT Hart Collection
[28] Club Topsail Yard, 86-121 MIT Hart Collection
[29] Club Topsail Club, 86-143 MIT Hart Collection
[30] Term Guttering noted in diagram for #2 yard, drawing #86- 121, MIT Hart Collection
[31] See therelianceproject.com blog postings for photos
[32] Rosenfeld Collection, Mystic Seaport
[33] See therelianceproject.com blog postings for photos
[34] See therelianceproject.com blog postings for photos
[35] See therelianceproject.com blog postings for photos
[36] Iselin papers, Mystic Seaport
[37] See therelianceproject.com blog postings for photos
[38] Sailmaker's notebook
[39] Source Herreshoff Marine Museum Archives. Photographer Katherine K. Herreshoff.
[40] Various numbers of crew have been mentioned, from 64 to 72. Herreshoff, L. Francis. *Capt. Nat Herreshoff*. (New York: Sheridan House, 1953) page 239 mentions 64
[41] Sailmaker's notebook
[42] Iselin papers, Mystic Seaport
[43] List of Tobin Bronze Plates, Drawing 86-85, MIT Hart Collection
[44] The future NYYC Commodore owned PELICAN, GANNET (1890), GLORIANA (1891), DRUSILLA (1892) and was a syndicate member of a number of America's Cup boats. A. Rogers, R.P. Carroll and syndicate manager Iselin may be considered part of a "launch customer group," so important in any business endeavor
[45] L. Francis Herreshoff, *Capt. Nat Herreshoff*, , page 276
[46] MIT index of RELIANCE drawings gives good insight into this, but it is incomplete. The RELIANCE Project index of drawings is more comprehensive. Also refer to Series V: Drawings pages 50-59, Guide to Haffenreffer-Herreshoff Collection for Folder labels.
[47] Drawing List 86-92, MIT Hart Collection
[47]Pattern List 86-94, MIT Hart Collection
[48] Forging List 86-93, MIT Hart Collection
[49] List of tobin bronze plates 86-85, MIT Hart Collection. Includes Aluminum Deck plates, and changes to Ni. Steel Sheer and margin plates
[50] List of Steel Plates 86-88, MIT Hart Collection
[51] Plating Plan 86-91, MIT Hart Collection
[52] List of Shapes 86-82, MIT Hart Collection
[53] Riveting Plan 86-95, MIT Hart Collection
[54] Wooden Floor List 86-150, MIT Hart Collection
[55] Wire Rigging Plan 86-101, MIT Hart Collection
[56] Manila Rigging 86-117, MIT Hart Collection
[57] Block List 86-122 & 123, MIT Hart Collection
[58]Bray and Pinheiro, *Herreshoff of Bristol*, , page 89
[59] NGH's Naval Architecture and Engineering Notes December 1899 – January 1908. (Courtesy of Halsey C. Herreshoff) Boston Spar Co. made Columbia's mast, 2 bowsprits, 2 topmasts, 2 spinnaker poles, 2 sets of club topsail spars for each size. Mast was backup if metal mast did not work. Forest and Stream Magazine April 1, 1899
[60] Lawrence Mfg Co, Herreshoff, L. Francis, *Capt. Nat Herreshoff*, , page 178
[61] Sailmaker's Notebook
[62] Wire Rigging Plan 86-101, MIT Hart Collection
[63] See CYS 2008 "Hollow Spars for Spartan" article by Bill Mills, Stonington Boat Works LLC (CT) and "Building Spartan's Mast" article by Jim Elks, Elks Spar and Boat Shop, Bar Harbor ME

## About the RELIANCE Project Team

**Mike Mirman:** Retired engineer. Hobbies include clock making, ship model making, and miniature guns. He makes all our wax molds for bronze castings.

**Steve Siok:** Retired GD Electric Boat mechanical engineer. Hobbies include model ship making and astronomy-trustee at Seagrave Memorial Observatory. He's been doing woodworking, electroplating and metal work for us.

**Tim Horton:** Our team psychologist. Owns a H12½. A jack-of-all-trades, he has made our spars and will soon be laying cork.

**Sandy Lee:** Retired aerospace executive and management consultant for a major global firm. Hobbies include ship model making, woodworking and sailing. He is the RELIANCE project leader.

**Keith Bradley:** Retired WHOI Research Associate; still part-time helping with small boat fleet and research instruments. Adjunct professor at Babson College, Special Olympics swimming coach. He does metal work, hull work, heavy stuff and whatever! Capt. Trivia had a Bullseye for 12 years in Woods Hole.

**Joe Uzzo:** Managing Director at Fidelity Investments. Hobbies include sailing and maritime history, and he has been making our hatches, companionways and monitor.

**Herb Luther:** A Rhode Islander living on Cape Cod. Recently retired from the Marine Biological Lab in Woods Hole, he is a kayaker, birder, hiker, and gardener now. Herb works on RELIANCE displays.

**Bill Lawton:** Apprenticed as a furniture maker, had a long career in boatbuilding including owning his own yard. After ten years in USMC, he began with Pearson on Burnside St. In retirement he is a general contractor. Does everything and does everything well!

**Denise Bolduc:** Business owner and expert seamstress. Making uniforms for our crew

**Tim Greves:** Sailmaker. Making RELIANCE's sails

**Craig Grantham:** LT. in East Providence FD and knows his way around a shop so he is invaluable for woodworking and metalsmithing.

**"Herk":** Retired IT consultant and business owner. Hobbies include woodworking and boat building. He has been busy making spar displays and developing our branding/ marketing approaches.

**Garry Holmstrom:** Retired US Navy Captain and Raytheon executive. Commanded a destroyer and cruiser. Working on our branding, marketing and exhibit activities.

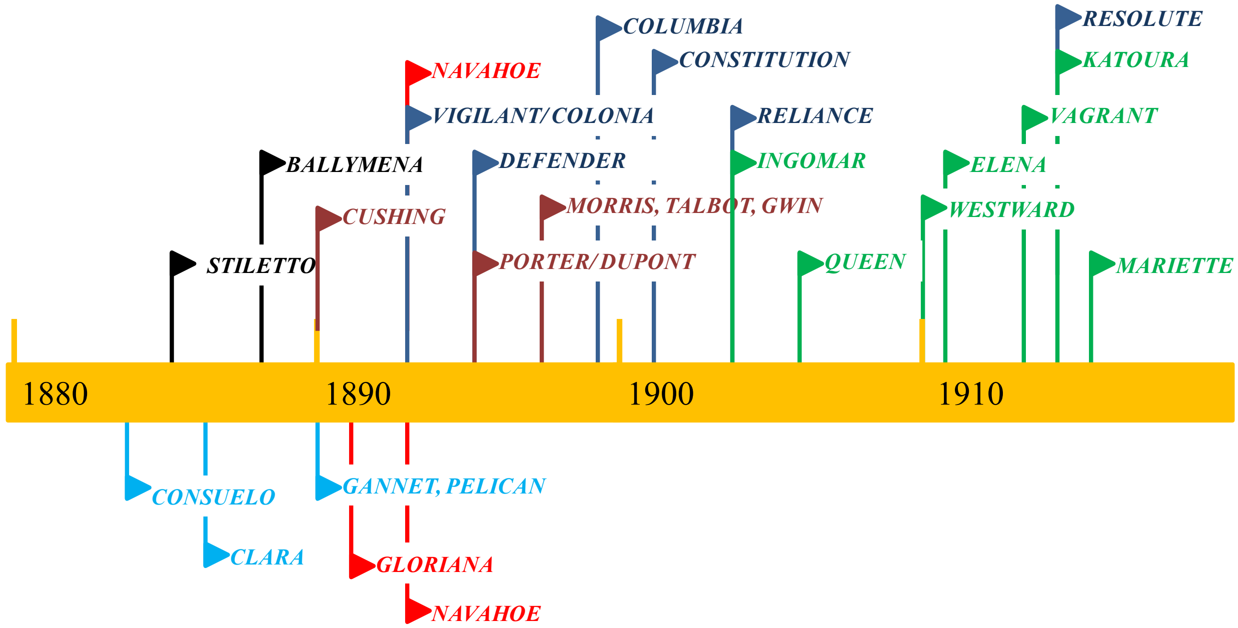
**Michelle Crist:** Fundraiser at RWU. Jill of all trades.

**Virginia Sanders:** Grandmother and our researcher.

Photo courtesy The Mariners' Museum

# EXHIBITS

## EVOLUTION OF LARGE METAL-HULLED BOATS




**EVOLUTION OF THE MODERN SAILING YACHT HMCo 1883- 1892**

**Key:**
Powered Yachts
Torpedo Boats
Cat Yawl
Sloop
America's Cup Boats
Steel Schooners

**Exhibit 1: Timeline:** STILETTO was a composite metal/ wood boat. Steam yacht BALLYMENA at 145-feet LOA was the first large steel-hulled steam vessel built by HMCo. CONSUELO began the development from English style cutter to more modern form in similar size, but cut-away forefoot of GANNET and PELICAN and thence to radical GLORIANA the "first modern yacht". GLORIANA featured a longer overall length, cut away forefoot, deep keel, lightweight composite hull (steel frames; wood planking), cross cut sails and an engineered rig. The 85-foot WL NAVAHOE, HMCo's first really big sailing boat and first steel-hulled sail boat, carried the GLORIANA technology to a larger size. VIGILANT and DEFENDER were the first America's Cup applications of bronze and aluminum hull plating respectively. CONSTITUTION was the first vessel anywhere to use the longitudinal framing system with widely-spaced deep web frames. (From various sources including- *The Herreshoff Torpedo Boats; Innovation at the beginning of the New US Navy* by John Palmieri, Curator, Herreshoff Marine Museum Nov. 2012, Curator Log series *NGH and the America's Cup* available through the museum website, *Herreshoff of Bristol* by Maynard Bray and Carlton Pinheiro and *Capt. Nat Herreshoff* by L. Francis Herreshoff)

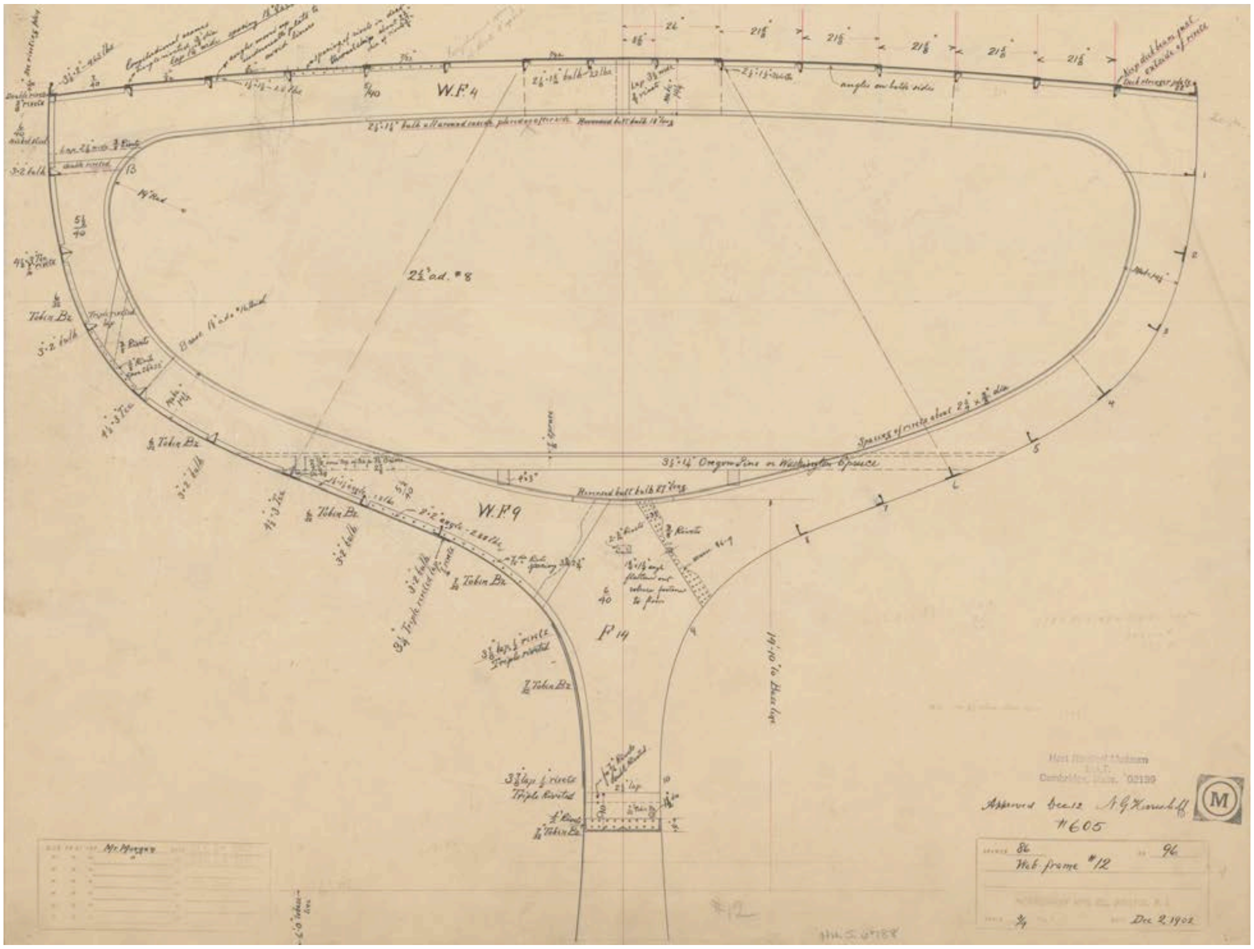



**Exhibit 2: RELIANCE Web Frame #12**, showing "bulb" web frames, bulb stringers, and placement of tubular bracing. HMCo Dwg. 86-96. Courtesy Curator, Hart Nautical Collections, MIT Museum (Exhibit 10 shows placement of diagonal bracing)

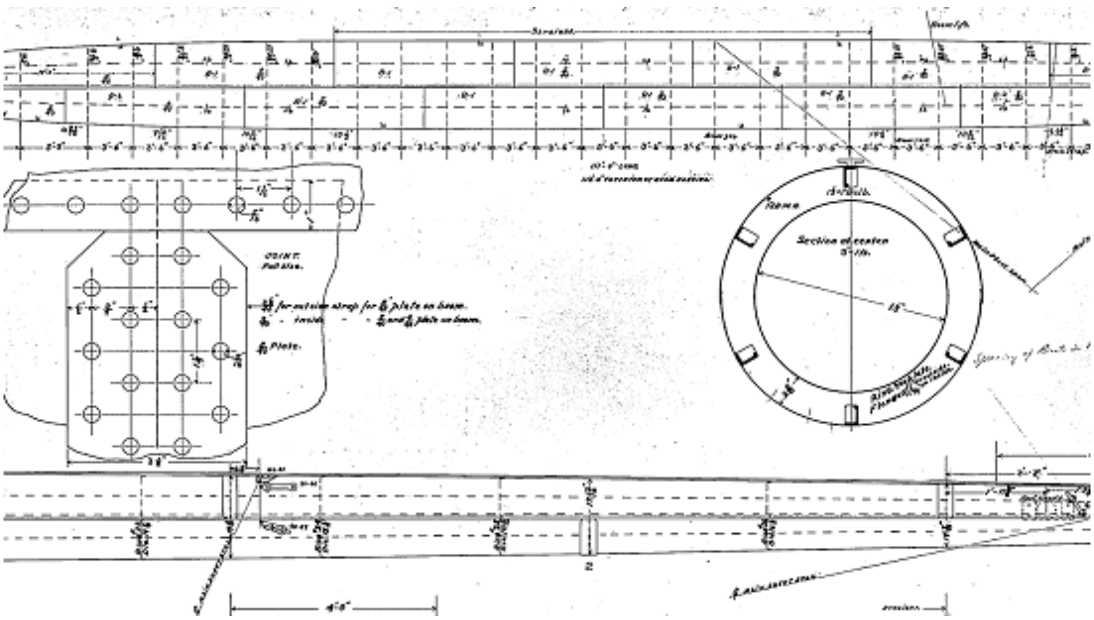


**Exhibit 3: RELIANCE Boom,** showing flanged rings, Stringers with bulbs and plating/ riveting plans. HMCo Dwg. 86-128. Courtesy Curator, Hart Nautical Collections, MIT Museum

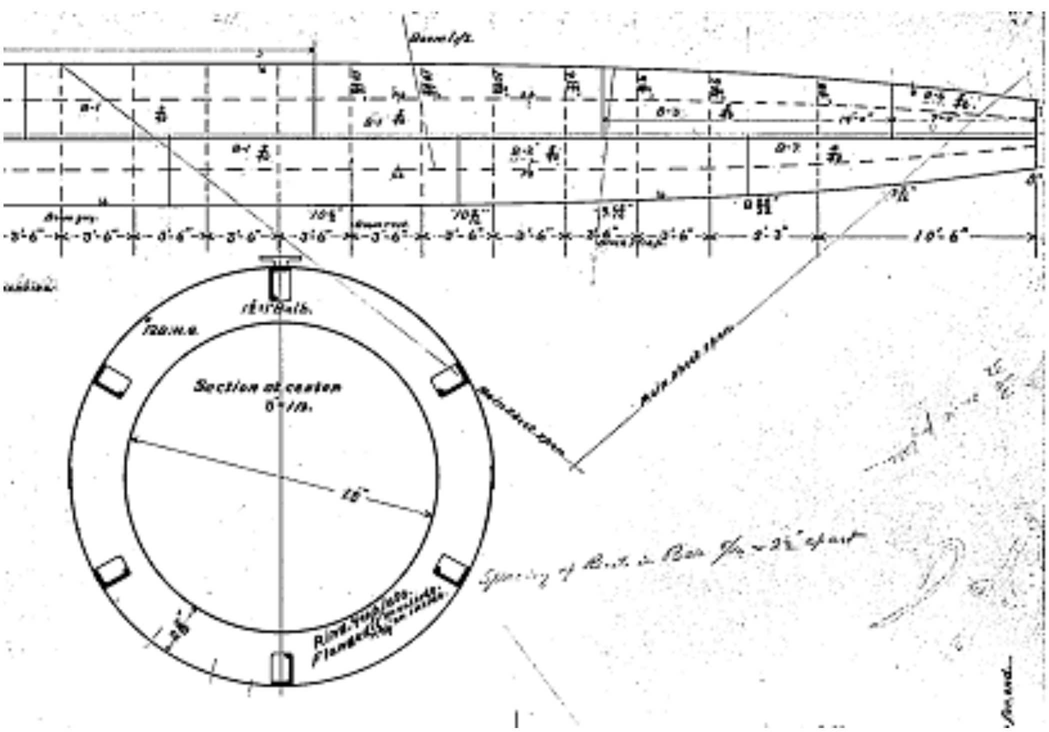



**Exhibit 4: Continuation of Boom** Dwg 86-128 showing taper which is same at both ends. Note plate identification B-1, B-3 and B-6 etc. Courtesy Curator, Hart Nautical Collections, MIT Museum

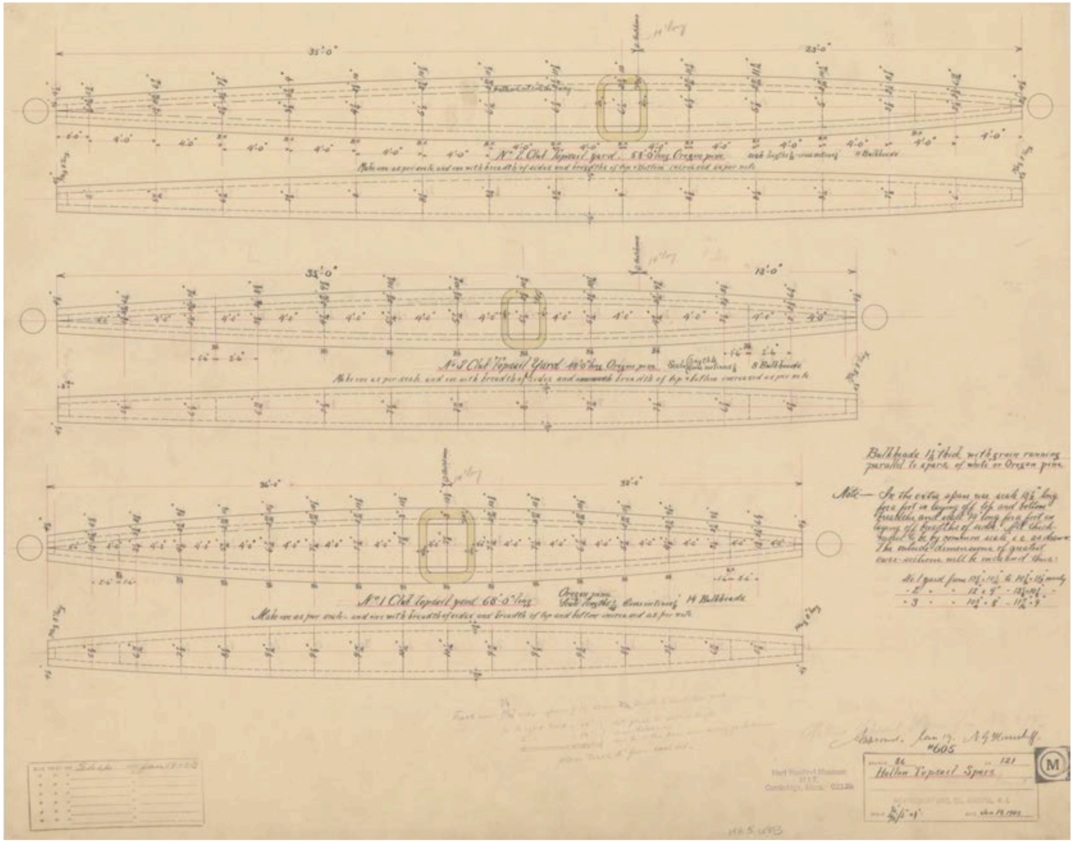


**Exhibit 5: RELIANCE Box girder and C-channel construction for Club Topsail Yard.** Guttering noted on No. 2 yard. Handwritten note adding sail track. Similar tapers at both ends. HMCo Dwg. 86-121. Courtesy Curator, Hart Nautical Collections, MIT Museum

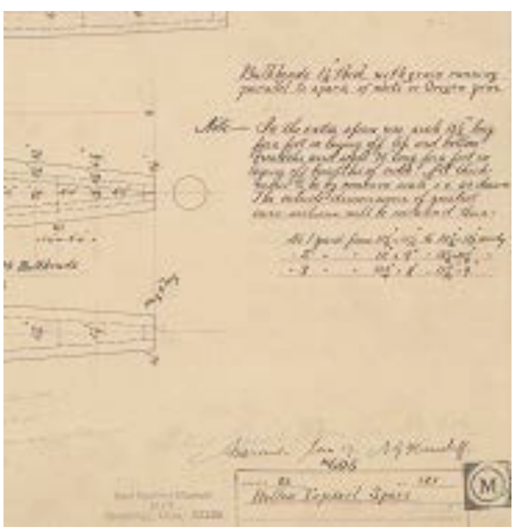


**Exhibit 6: Continuation HMCo Dwg 86-121 Topsail Yard**. Note shows increase in dimensions for spare topsail yards. Courtesy Curator, Hart Nautical Collections, MIT Museum

| TIMELINE OF LIFE OF RELIANCE | | |
|---|---|---|
| **DATE** | **ELAPSED DAYS** | **EVENT** |
| Sept 2, 1902 | -44 | NYYC Secretary Cormack write C. Oliver Iselin to mount a cup defense |
| Sep 5, 1902 | 041 | NGH finishing half hull model |
| Sep 15, 1902 | -31 | Iselin wants more radical design |
| Oct 15, 1902 | -1 | Sir Thomas Lipton's cup challenge received by NYYC |
| Oct 16, 1902 | 0 | HMCo under contract for #605 RELIANCE |
| Oct 19, 1902 | 3 | NGH completes 2nd and final design |
| Nov 26, 1902 | 41 | Construction begins with 7 hour pour of 204,569 lb. lead keel |
| Jan 4, 1903 | 80 | Began making plating for RELIANCE |
| Jan 6, 1903 | 82 | Received last of Ni Steel for RELIANCE |
| Jan 13, 1903 | 89 | Frames all up from mast to head of keel |
| Jan 17, 1903 | 93 | Spars arrived from Boston |
| Jan 23, 1903 | 99 | Began plating RELIANCE |
| Jan 26, 1903 | 102 | Began working on mast |
| Mar 18, 1903 | 153 | Mast completed |
| Mar 21, 1903 | 156 | All hull plating completed except 6 plates |
| Mar 29, 1903 | 164 | Crew begins arriving |
| Apr 8, 1903 | 174 | Boom completed |
| Apr 11, 1903 | 177 | RELIANCE LAUNCHED |
| Apr 13, 1903 | 179 | Stepped mast and bowsprit |
| Apr 17, 1903 | 183 | Set up topmast. (Shamrock III carries away rigging. One crewmember killed) |
| Apr 20, 1903 | 186 | Rigging nearly complete |
| Apr 25, 1903 | 191 | Successful trial run |
| Apr 26, 1903 | 192 | Second trial run |
| Apr 28, 1903 | 194 | RELIANCE delivered to Iselin. RELIANCE leaves for New Rochelle |
| May 11, 1903 | 207 | New three foot longer boom and 18 inch longer gaff put on RELIANCE |
| May 21, 1903 | 217 | Begins series of five races off Glen Cove, NY |

| | | |
|---|---|---|
| June 17, 1903 | 244 | RELIANCE's topmast carried way. Replacement sent overnight from Bristol. |
| June 19, 1903 | 246 | RELIANCE resumes racing |
| June 29, 1903 | 256 | Important four race series begins off Newport. RELIANCE wins all of them |
| July 17, 1903 | 274 | NYYC annual cruise begins. RELIANCE wins all but one race |
| July 27, 1903 | 284 | After one official trial race RELIANCE is selected by NYYC Race Committee |
| Aug 16, 1903 | 304 | RELIANCE and SHAMROCK III measured in Erie Basin drydock. SHAMROCK III given 1 minute 57 second time allowance |
| Aug 20, 1903 | 308 | First Race held. RELIANCE wins. Next two weeks nine races are attempted, with six race starts of which three times the boats fail to finish before the race is called. |
| Aug 22, 1903 | 310 | RELIANCE wins |
| Sep 3, 1903 | 322 | RELIANCE wins third race in fog as Shamrock III gets lost on course. |
| Sep 4, 1903 | 323 | Victory lap! RELIANCE visits Iselin estate in New Rochelle NY |
| Sep 11, 1903 | 330 | RELIANCE hauled out |
| **1913** | | RELIANCE Scrapped |

**Exhibit 7: Timeline of Life of RELIANCE** From NGH's Naval Architecture and Engineering Notes December 1899 to January 1908, NGH's diaries for 1902 – 1903, (Both courtesy of Halsey C. Herreshoff). NYYC Report of the 1903 America's Cup, with additional comments from *Temple to the Wind*, Chris Pastore.

| SAILING VESSELS – Ordered September 1902 through September 1903(2) | | | | |
|---|---|---|---|---|
| Name | No. | Type | Date Ordered | L.W.L |
| Ingomar | 590 | Schooner | Sept 13, 1902 | 86’1” |
| Irolita | 591 | Cutter | Sept 13, 1902 | 50’ |
| Kewana | 592 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Astrid | 593 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Zara | 594 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Joker | 595 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Bat (a) | 596 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Ben | 597 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Curlew | 598 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Indian (b) | 599 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Flight | 600 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Red Wing | 601 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Cricket | 602 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Scud | 603 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Papoose III | 604 | Bar Harbor Class | Oct 3, 1902 | 30’9” |
| Reliance | 605 | Cutter | Oct 16, 1902 | 90’ |
| | 606 | Centerboard Sloop | Oct 16, 1902 | 11’6” |
| The Flight | 607 | Centerboard Sloop | Jan 27, 1903 | 24’4” |
| Rugosa | 608 | Keel Sloop | Feb 7, 1903 | 28’9” |
| | 609 | Centerboard Sloop | May 5, 1903 | 15’ |
| Mimosa III | 610 | Keel Sloop | Sept 25, 1903 | 30’ |
| Illusion | 611 | K/CB Sloop | Sept 28, 1903 | 21’ |
| **POWERED YACHTS – Completed September 1902 – January 1904(2)** | | | | |
| Name | No. | Type | Date Completed | L.O.A. |
| Sunbeam | 229 | Fast Mahogany Launch | Sept 1902 | 58’8” |
| Wana | 230 | Steam Yacht | Sept 1902 | 132’3” |
| Adrienne | 231 | Passenger Launch | Jan. 1903 | 49’6” |
| Helvetia II | 232 | Passenger Launch | Jan. 1903 | 49’6” |
| Delaware Junior | 233 | Mahogany Launch for yacht Delaware | Jan 1903 | 28’ |
| Friday | 234 | Shop Tow Boat | Feb 1903 | |
| Mist | 235 | Fast Mahogany Launch | Mar 1903 | 59’ |
| Mermaid Express | 236 | Steam Yacht | June 1903 | 89’3” |
| North Star II | 237 | Mahogany Launch | July 1903 | 28’ |
| U.S.N. | 238 | Mahogany Launch | Aug 1903 | 28’ |
| U.S.N. | 239 | Mahogany Launch | Sept 1903 | 28’ |
| 240 (c) | 240 | Launch | July 1904 | 30’ |
| Haida | 241 | Mahogany Launch | Oct 1903 | 26’ |
| Bruge | 242 | Mahogany Launch | Dec 1903 | 45’6” |
| Swiftsure | 243 | High Speed Launch | Jan 1904 | 51’8” |

Notes:
(a) Bat’s dinghy is in the Museum’s collection
(b) On display in the Museum’s Hall of Boats
(c) Owned by the Museum and on display at T.F. Green Airport

**Exhibit 8: Sailing and Powered Vessels** designed and built contemporaneously with RELIANCE (Note: Listing of many of the powered vessels also mentions they were taken from previous molds). HMCo Construction Record, from *Guide to the Haffenreffer-Herreshoff Collection*. Hart Nautical Collections MIT Museum, 1997

**Herreshoff Manufacturing Company Organization**

(Date of this organization chart is not certain. It is believed to be after 1917 when the HMCo was a stock company and James G. Swan was brought in as general manager and A. Loring Swasey as chef designer. More research is needed)

- President's Office (Treasurer and Secretary)
- General Manger (Office Manager, Comptroller/ Assistant office Manager, Cost Analysis Statistical Dept.)
- Planning Committee
- Purchasing Department
- Personnel Director
- Security & Safety Division
- Engineering & Design
- Material Control
- Service & Repair
- Supervisor (Upper Yard)
- Supervisor (Lower Yard)

**1899 Payroll**

| Shop | Headcount | Daily Pay Rates ($)* |
|---|---|---|
| Carpenter Shop | 91 | 1.75 - 4.00 |
| Machinists | 27 | 1.75 - 5.00 |
| Steel Construction | 26 | 1.50 – 5.00 |
| Boiler Shop | 23 | 1.50 – 5.00 |
| Smith Shop | 13 | 1.50 – 3.75 |
| Sail-makers | 14 | .50 – 4.00 |
| Draughting (sic) Room | 3 | 3.00 – 3.50 |
| Watchmen | 2 | Weekday 1.50 Nightly / Sunday 2.00 |
| | | |
| Main Office – Including NGH & JBH | 3 | 45.00 – 125.00 weekly |

* Hourly workers put in ten hours per day for a six day week

**Exhibit 9: Organization of HMCo** based on research done by Roger Williams University as part of a collaborative effort with the museum to delve into HMCo and the question "Why did Henry Ford visit HMCo to understand advanced manufacturing?" Source: 1899 HMCo payroll records. Herreshoff Marine Museum Archives

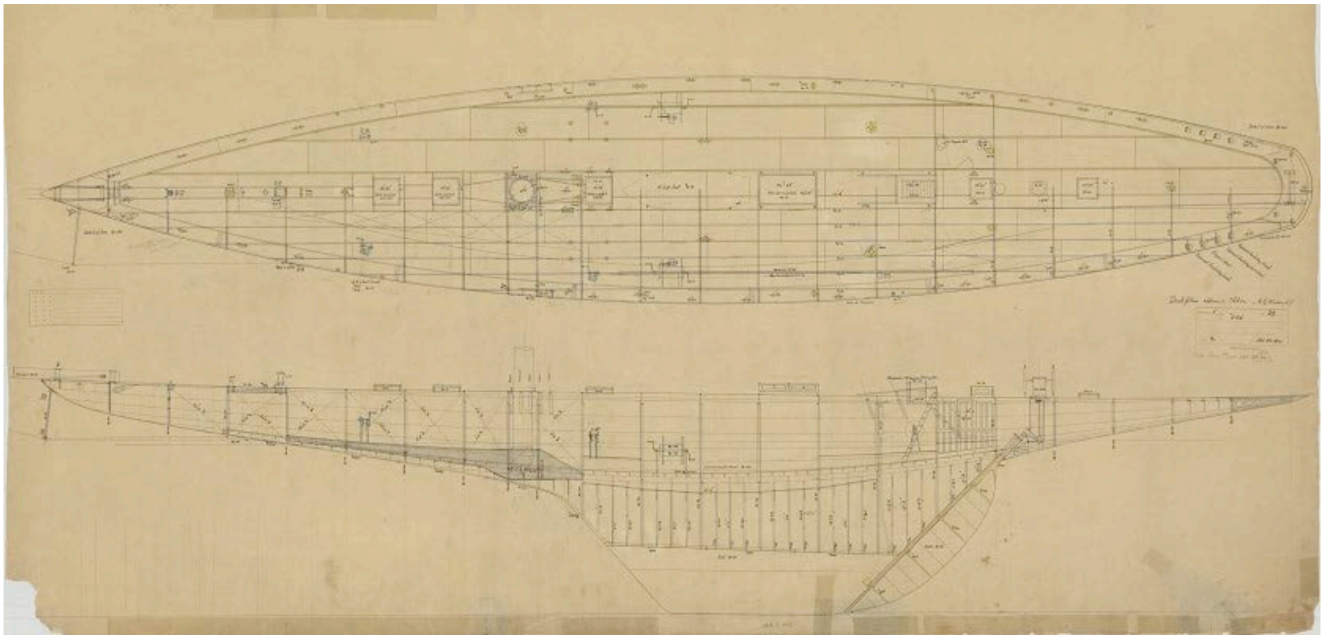


**Exhibit 10: Construction Plan of RELIANCE**. Dwg 1-29. Courtesy Curator, Hart Nautical Collections, MIT Museum

**Exhibit 11: RELIANCE below deck** looking forward with the mast step in the foreground showing diagonal bracing and web-frame with flanges (bulbs) and angle fasteners to hull and deck. Source: Herreshoff Marine Museum Archives. Photographer unknown.

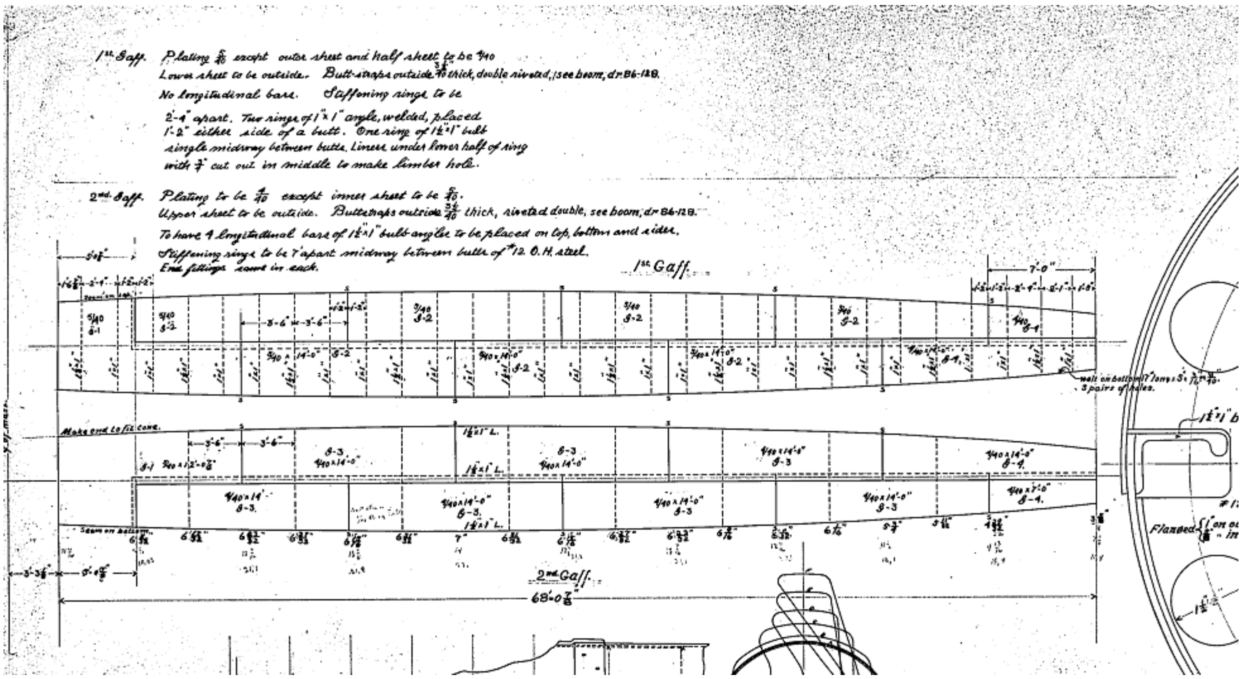



**Exhibit 12: RELIANCE Differences in construction of gaffs #1 and #2**.See note in upper left corner. Dwg 86-147. Courtesy Curator, Hart Nautical Collections, MIT Museum

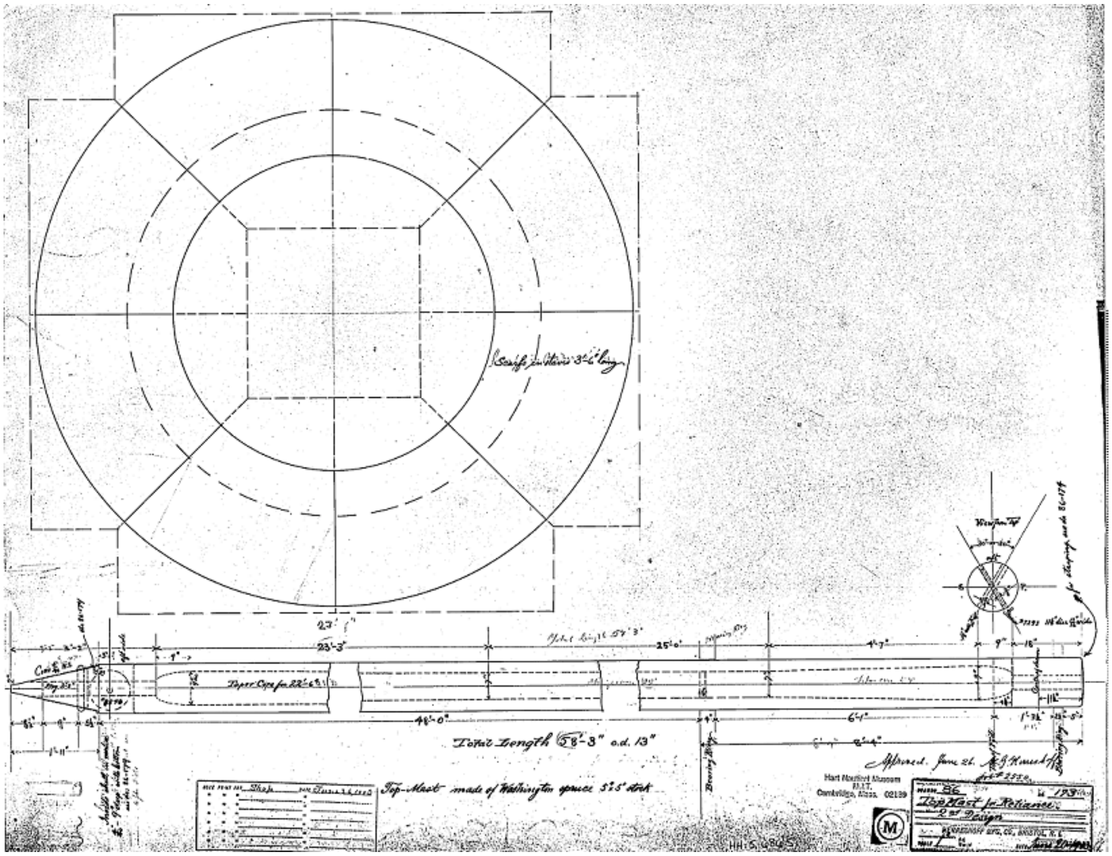



**Exhibit 13: RELIANCE Construction and internal hollow structure of Topmast**. Dwg 86-173. Courtesy Curator, Hart Nautical Collections, MIT Museum

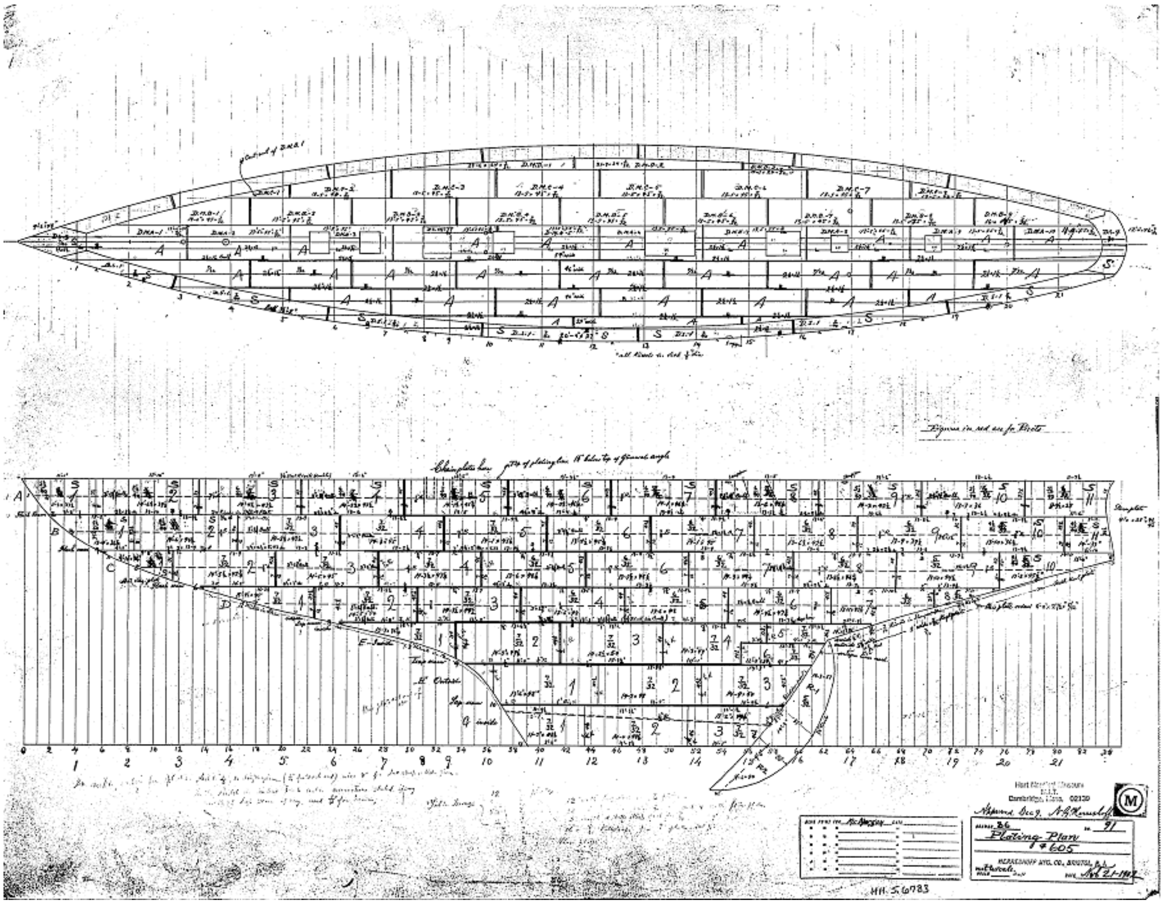


**Exhibit 14: RELIANCE Hull and Deck Plating Plan showing common plates**. HMCo Dwg 86-91. Courtesy Curator, Hart Nautical Collections, MIT Museum

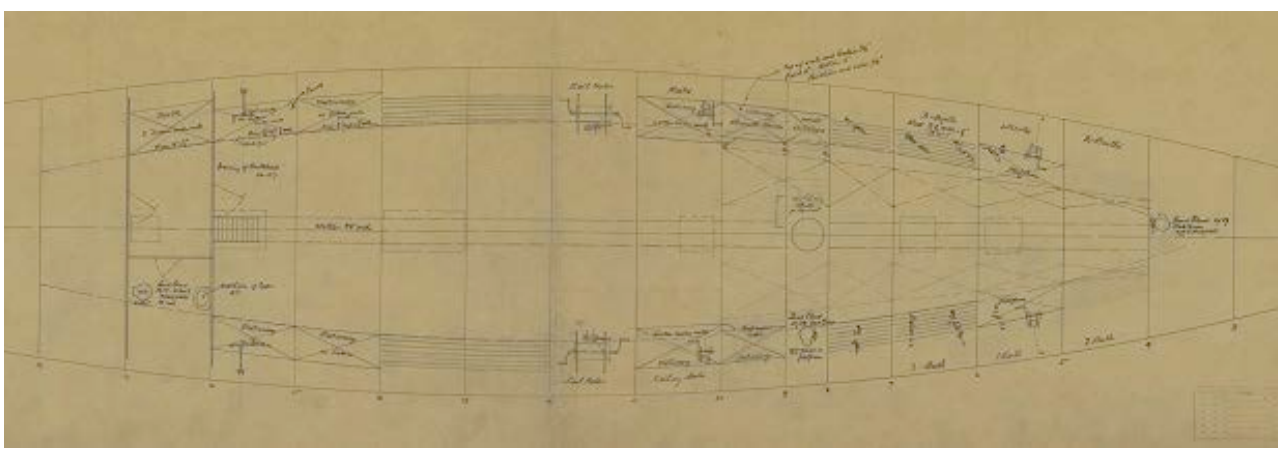


**Exhibit 15: RELIANCE Interior Arrangement**. Dwg 86-163. Courtesy Curator, Hart Nautical Collections, MIT Museum

| Yacht | Year | Technology Insertion |
|---|---|---|
| **Vigilant** | 1893 | An all-metal (steel and Tobin bronze) construction. First America's Cup yacht with bronze hull plating. Keel centerboard |
| **Defender** | 1895 | First yacht to use bulb angle iron frames from rollers especially made for HMCo. First Cup boat with cross-cut sails. DEFENDER had an Aluminum deck beams and deck, aluminum topside plating, Tobin bronze plates below the water line and diagonal strapping. Wooden mast for the 1895 races was replaced with a lighter hollow steel mast that allowed extra ballast to be added for the 1899 trials. 55.7% ballast to displacement ratio |
| **Columbia** | 1899 | Steel frame, deck beams and plates to the water line. Tobin bronze plates below the waterline. Wooden deck. Originally with an Oregon pine mast that was replaced with a hollow steel mast and telescoping topmast. Her mast, boom and gaff were hollow steel. 54% ballast to displacement ratio |
| **Constitution** | 1901 | First vessel with longitudinal framing, two sets of "swinging spreaders". Winches below decks. 55.5% ballast to displacement ratio. |
| **Reliance** | 1903 | 93 tons of lead, steel frames, sheer and margin plating, Tobin bronze plating on hull and aluminum plating on deck. Longitudinal framing and cross bracing. Hollow steel mast, boom and gaff. Hollow wooden spars. Two speed winches below deck for halyards, backstays and sheets. 55% ballast to displacement ratio. With RELIANCE Capt. Nat perfected the use of "proof testing" fittings and blocks and use of a strain gauge on rigging. |

**Exhibit 16: Technology insertion** for each successive America's Cup Boat.

**Exhibit 17: Foredeck of CONSTITUTION** under construction. Source Herreshoff Marine Museum Archives. Photographer Katherine K. Herreshoff 1901.

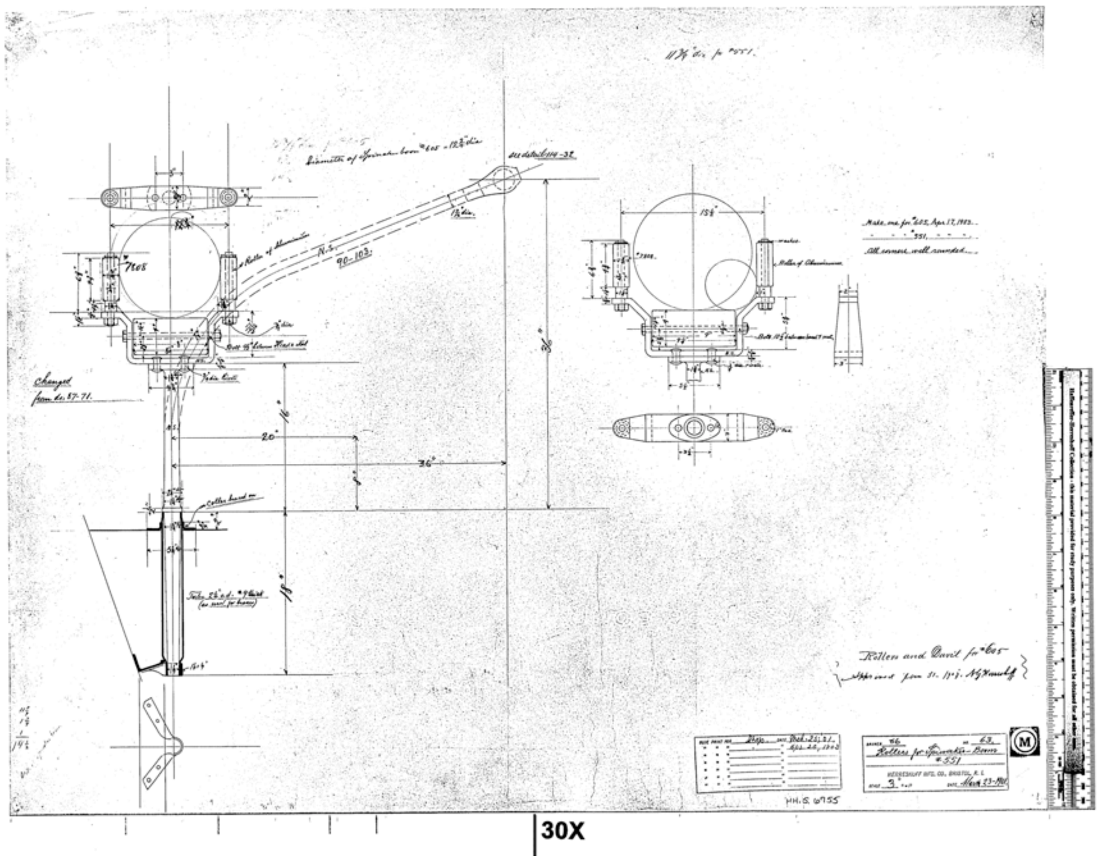



**Exhibit 18: Spinnaker boom launching mechanism**, HMCo Dwg 86-63. Courtesy Curator, Hart Nautical Collections, MIT Museum

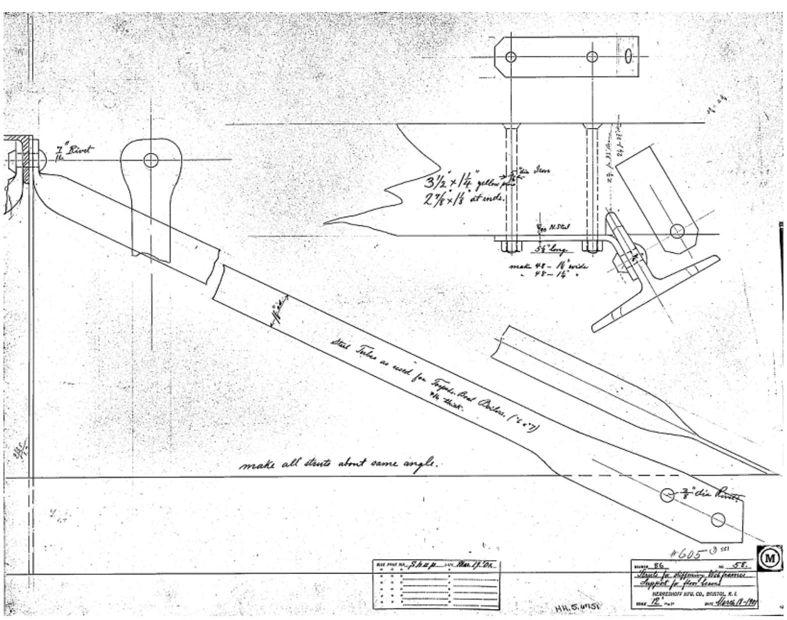



**Exhibit 19: Web frame stiffening struts from boiler tube materials,** HMCo Dwg 86-58. Courtesy Curator, Hart Nautical Collections, MIT Museum

**RULES and REGULATIONS**

Herreshoff Manufacturing Company

The regular working hours are from SEVEN A.M. to SIX P.M. with a recess of one hour from twelve to one. The bell will be rung five minutes of seven and five minutes of One o'clock as a signal to assemble. At the tolling of the bell, at seven and one, all employees are expected to be in their respective places and commence work. At twelve and six o'clock the bell will be rung to signal to stop work.

No workman may quit work, nor make any preparations to quit work, until the signal is given or until permission is obtained from the foreman.

Each workman will report his regular time, and overtime, if any, of the previous day to his foreman before commencing work. The foreman will be at his office at five minutes of seven to receive his workmen's time.

Time will be kept for each full hour and half hour worked each day and will be made up once a week ending Saturday noon, or night, as the case may be, and payment therefore will be made on the succeeding Wednesday after six p.m. AT the Company office.

No wages will be paid out excepting at the regular time on pay day unless at dismissal from the Company's employ. Any workmen finding errors in his pay will report the same to his foreman immediately for rectification.

Each workman is to do the work given him by the foreman in charge in a cheerful manner and to the best of his ability. It is expected that, during the working hours, the workmen will give their undivided attention to their work and it must be expressly understood, by each of the employees of this Company, that prolonged conversations and discussions are prohibited. Anyone using tools from the tool room will be charged with them and will be responsible for them until returned.

Any tools, or implements, belonging to the Company that are injured or broken by carelessness of a workman, a proper portion of the cost to replace, or repair such breakage or injury will be deducted from his wages.

No material of any kind is to be taken away from the premises without a special permit from the office.

Workmen will not be called for visitors during work hours.

By a messenger applying at the office, a workman will be excused from work if the case seems imperative.

Visitors are not allowed in the shops except by special permit from the office.

Any information regarding shop affairs, or work at hand, will be given out AT THE OFFICE ONLY.

Any workman found guilty of reporting or giving out any information regarding work they are on, or anything regarding shop affairs, will be discharges

The habitual violation of any of the foregoing regulations, negligence and slovenliness in respect to their work, any ungentlemanly or offensive act that would disturb harmony among the workmen, also the frequent use of vile language will be considered sufficient reason for dismissal

Attachments placed upon wages will be considered sufficient cause for dismissal

Each foreman is to verify the time given in by the workmen every day and to give immediate notice at the office of any violation of these rules by any employee of the company; he is also to see that all lights are out and every thing, in his department, is in proper and safe condition after working hours, before he leaves.

Smoking will be allowed between 12 and 12:55 noon, in the blacksmith shop and boiler house. It is strictly forbidden while at work and all other parts of the premises

**Exhibit 20: Work Rules** reprinted from original displayed in the Herreshoff Marine Museum Board room



# SALTS New Schooner Project:

## Classic Yachts and an Approach to Design Process for the 21st Century [Featured in the CYS 2014 DVD]

**Authors Fabio Fossati** Dept. of Mechanical Engineering, Politecnico di Milano, Milano -Italy
**& Stephen Duff** -Dept. of Architecture, University of Oregon -USA

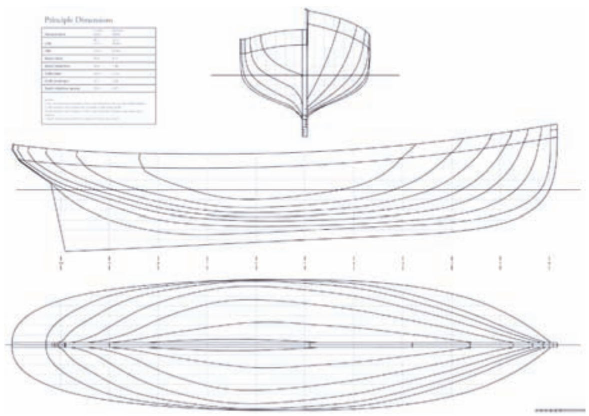


**Figure 1** – Line plan of design study #4g (Gartside, 2007)

**Figure 2** – SALTS schooner wind tunnel scale model

## Abstract

The Sail and Life Training Society is building a 35m wooden sail-training schooner for unlimited operations. SALTS has an ambitious international agenda of analytical and experimental investigations including a parametric study of hull form as it relates to stability at high angles of heel, a towing tank campaign to investigate the behavior of keel profiles, and a wind tunnel campaign to investigate sail plan behavior. This paper is an overview of the project with focus on the experimental investigation of rig aerodynamics conducted in the boundary layer wind tunnel at Politecnico di Milano. Results of the investigation are presented. The implications of obtained data on the design of classic yachts and the SALTS' schooner are discussed, set in the context of aerodynamic efficiency, helm balance and vessel stability.

## About the Authors *For complete bios see the paper on the Proceedings DVD*

**Fabio Fossati** Mechanical Engineer, PhD in Applied Mechanics and Professor of Applied Mechanics. He is scientific coordinator of wind tunnel testing of sailing yachts at the Wind Tunnel of Milan Polytechnic. His research concerns numerical and experimental fluid dynamics of sailing yachts with special reference to sail plans aerodynamics and hull appendages. He was in charge of testing at the Wind Tunnel for PRADA Challenge America's Cup team in 2003, Luna Rossa in 2007 and BMW ORACLE in 2010. At the Polytechnic, he teaches fluid mechanics, naval architecture and mechanics of the sailing yacht. Needless to say, he is also a keen sailor

**Stephen Duff** teaches design, structures and seminars on naval architecture, Dept. of Architecture, Univ. of Oregon. Annually he directs the Vancouver Canada Architecture and Urban Design Program. For 24 years he has sailed with SALTS. He is the society's principal design consultant; for the last five years on the new schooner and related research- wind tunnel and towing tank tests; aero-hydrodynamic studies using CFD and velocity prediction software; stability studies; FE analyses of hull and rig structure; and the development of a suite of bespoke parametric design and analysis tools He is an avid whitewater and sea kayaker.

The Classic Yacht Symposium™ 2014

# SALTS New Schooner Project: Classic Yachts and an Approach to Design Process for the 21st Century

**Fabio Fossati** - Dept. of Mechanical Engineering, Politecnico di Milano, Milano - Italy
Stephen Duff - Dept. of Architecture, University of Oregon - USA

**ABSTRACT**

The Sail and Life Training Society (SALTS) is building a new purpose-designed 35m wooden sail-training schooner for unlimited international operations. Working with an international team of consultants, SALTS has initiated an ambitious agenda of analytical and experimental investigations to support design, including a parametric study of hull form as it relates to stability at high angles of heel, a towing tank campaign at the Wolfson Unit to investigate the behavior of three keel profiles, and a wind tunnel campaign at Politecnico di Milano to investigate the sailplan behavior. This paper presents an overview of the project and, in particular, focuses on the experimental investigation of schooner rig aerodynamics conducted in the boundary layer wind tunnel at Politecnico di Milano University. The majority of the results of this extensive investigation are presented. The implications of obtained data on the design of classic yachts and the ongoing design of SALTS' new schooner are discussed, set in the context of aerodynamic efficiency, helm balance and vessel stability.

**INTRODUCTION**

The Sail and Life Training Society (SALTS) is a registered Canadian charitable organization based in Victoria, BC, that has been taking young people to sea in traditional wooden sailing vessels since 1974. With program demand far exceeding existing capacity, and drawing on the experience of four major construction projects and over 300,000 nautical miles of sailing, SALTS has set out to build a new purpose-designed, deep-sea sail-training vessel. The new wooden boat will be rigged as a two-masted square topsail schooner, and has a current design displacement of 229 tonnes, length overall of 35m and sparred length of about 43m. While the design and character of the new vessel are rooted in the traditions of classic historical workboats, the new schooner will be designed using state-of-the-art techniques and methodologies to meet rigorous safety and function-driven design criteria.

Compared to typical modern sailing vessels the traditionally-rigged sailing ships present significant differences due to square rigged sail equipment to keel draft and profile and due to hull lines; they also present generally lower freeboard to beam ratio values demanding attention on interactions between righting moment, heeling arms and the resistance to side force relationship.

In the last decade The Society of Naval Architects and Marine Engineers (SNAME) has supported several studies to improve the operator knowledge of traditional sailing vessels wind-heel stability based on full scale measurements of wind speed and direction and heel angles on board of Pride of Baltimore II [9], [10].

In particular with reference to the squared rigged sail equipment aerodynamics a CFD based model for predicting the forces and heeling moment on a squared rigged vessel has been proposed in [8] and was validated using both wind tunnel tests and full scale testing. In [9] the numerical model was refined and used to calculate the heeling moment on the U.S. Brig Niagara and the Chesapeake Bay topsail schooner Pride of Baltimore II leading to an excellent agreement between the model and experimental values in some cases while in other cases there was a significant error.

In support of the design process, SALTS is working with an international team of consultants to bring their expertise to bear on critical aspects of the design. An ambitious agenda of experimental and analytical campaigns have been carried out, aiming to inform particulars of design, while more broadly contributing to the body of knowledge pertaining to vessels of this class, particularly those of traditional or classic design.
The present paper presents an overview of project and of the major research programs and in particular will focus on an experimental investigation of schooner rig aerodynamics conducted in the boundary layer wind tunnel at Politecnico di Milano University. Over the course of a five-day wind tunnel campaign, fifteen sail plans were tested at different wind angles - five principal suits of sails, followed by ten variations of important sail plan geometries including mast rake, sail size and sail position.
The objective of this paper is to present the results of the detailed investigation of the aerodynamics of a traditional square topsail schooner rig, and the provision of data useful for design development, in terms of balance assessment and performance prediction. The implications of data obtained from this campaign on the design of classic yachts and the ongoing design of SALTS new schooner will be discussed, particularly as related to aerodynamic efficiency, helm balance and vessel stability

## PROJECT ORIGINS AND GENERAL DESIGN OBJECTIVES

Since its founding, SALTS' custom has been to build and sail conversions or replicas of traditional wooden workboats, such as the society's current schooners the *Pacific Swift* and the *Pacific Grace*. When the new vessel was first conceived, initial discussions focused on what class of boat to build. Early on however, it was decided that rather than building a replica of an historical precedent, a new design would be developed along the lines of the class, but tailored to meet SALTS' particular needs.
SALTS' mission is to take young people to sea on character-building trips of 5-10 days duration off the coast of British Columbia, and on longer deep-sea voyages to international destinations. The new boat will serve both programs, but it is being designed specifically for offshore sailing. With SALTS' existing boats as reference, general design objectives include increasing the separation of spaces below decks to increase safety and efficiency, enhancing the livability of crew quarters, improving ship-wide storage systems, and refining numerous details of layout.
Paul Gartside, naval architect for the *Pacific Grace*, was commissioned to produce four preliminary design studies (the fourth shown in Figure 1). The general arrangement matched that of SALTS' existing schooners, with two accommodation compartments for trainees forward, and an integrated navigation station and crew cabin aft.

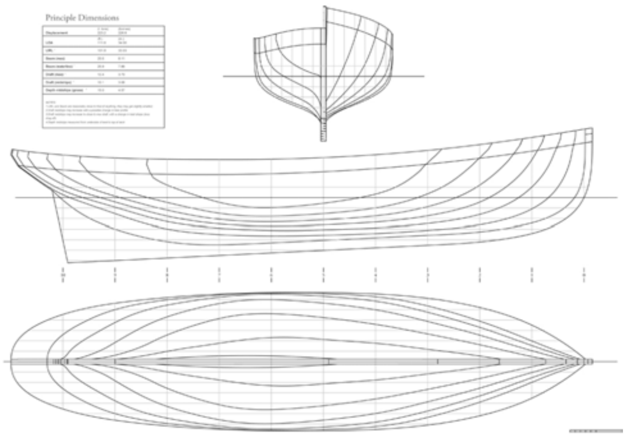



Figure 1 – Line plan of design study #4g (Gartside, 2007)

## PRELIMINARY DESIGN

### Hull form

Preliminary design of the hull envelope began with the translation of Gartside's #4 study into a 3d model in *Rhino*.
Concurrently with the above, an analysis of the hulls of related precedents was undertaken to better inform the next phase of design. This led to the increasingly detailed analysis of the lines and hydrostatic properties of a small population of exemplary full-keel displacement hull precedents using what later evolved into *Open Sea*™ tools [1]. Based on these data and contemporary understandings from the literature, initial parametric hull form targets were selected, some of which were later refined following consultations between co-authors from SALTS and the Wolfson Unit [7].

### Rig and Sail Plan

Preliminary design of the rig and sail plan also involved the analysis of precedents, and was influenced by years of sailing experience at SALTS. Given the age and inexperience of the trainees who will work the boat, limits on the size of the mainsail and jibs were imposed, and certain rig details were fixed.
The square topsail rig was chosen more-or-less before we began, as it works brilliantly for SALTS. The flexibility of the rig supports the wide range of sailing conditions the new boat will experience, and yards to climb out on and braces to pull enhance the sail-training mission.

For downwind sailing, we can fully dress the foremast with square sails by setting split courses on jack stays forward of the mast. Purists may scoff at these uncommon sails, but they can be safely set from the deck and struck very quickly without sending people aloft; they eliminate the stability-degrading weight of additional yards, were the boat rigged as a brigantine; and they do not conflict with a foresail raised on hoops. They also afford useful, if unusual, sail combinations: windward course, foresail, and square topsail set with the mainsail can be a powerful combination on a broad reach.

Initial comparison of sail-area to displacement and sail-area to wetted surface ratios with known precedents gave rise to a concern that the boat might be underpowered in light airs, but sail areas have adjusted to a point we think was viable. For downwind sailing the vessel will also carry a triangular raffee to set above the upper yard, and we aim to rig a large fisherman staysail. The latter is unusual and difficult to rig in combination with the square topsail, as the braces intersect the plane of the sail. By decreasing the chord length of the sail (and increasing its aspect ratio), running braces out to spreaders and shrouds, and possibly fitting brace tricing lines, the combination is workable, as determined through 3d design studies and later confirmed when SALTS built the wind tunnel model.

The rig evolved through several preliminary iterations, one of which was drawn up for presentation and fund raising purposes (Fig. 2). At that time, the masts had significant but not severe rake and the mainsail had an aspect ratio higher than that found on large traditional schooners. Aesthetically, however, the overall impression of this sailplan was unsatisfactory. This is largely attributable to the angle of the leeches of the main and fore, and the combination of proportions and geometries of individual sails not working well together.

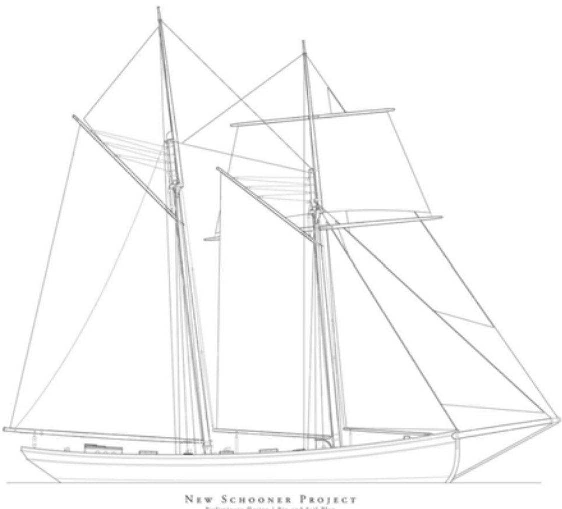



Figure 2 – Preliminary sail plan (2010-2011)

**DESIGN DEVELOPMENT: AN INTEGRATED DESIGN PROCESS**

At the onset of the first phase of design development, we felt we had a fairly comprehensive but still evolving understanding of the complex web of design criteria that needed to be addressed. In order to move towards a viable solution that addressed the numerous and often competing design objectives, it became necessary to explicitly adopt a fully integrated design process. In the sail-training community, other approaches are more common. A method favoring authenticity or sailing performance may emphasize hull form and aesthetics at the expense of human comfort, storage space or other functional needs. Conversely, prioritizing interior space and designing for human needs may compromise aesthetics, stability, or sailing performance. Both approaches can lead to unsatisfactory results. A fully integrated design process means that the full gamut of design objectives can simultaneously and satisfactorily be addressed.

In order to support this design process, an ambitious agenda of analytical and experimental investigations were carried out. These directly supported the development of the current design, and we hope they will also contribute to the body of knowledge pertaining to vessels of this class.

Early on, a parametric study of hull form and vessel stability at high angles of heel was carried out, and lead to a definitive baseline hull for the pending experimental campaigns. Towing tank and wind tunnel campaigns allowed us to investigate the behavior of different sail plans and different keel profiles. Data from these studies were critical to the proper management of aero-hydrodynamics and related issues of good helm balance and vessel stability, and revealed the limitations of rule of thumb design approaches.

Our ability to proceed in this fashion stemmed from the convergence of a number of technologies – the above-mentioned experimental research campaigns, powerful 3d modeling software, our ability to customize our digital design, modeling and analysis tools using the using the graphical algorithm editor *Grasshopper* in conjunction with the NURBS surface modeling software *Rhinoceros*.

In terms of human resources, the project has been both significantly motivated and effectively subsidized by the academic interests of the design principal and his academic and research colleagues. Without this kind of support, proceeding with this kind of rigor and thoroughness would have been impossible. With a current total project budget of just over $6 million, it may be possible to hold research and design costs to 6-8% of the total budget.

The present paper focuses on the experimental investigation of schooner rig aerodynamics conducted in the boundary layer wind tunnel at Politecnico di

Milano University and the implications of data obtained from this campaign on the ongoing design of SALTS new schooner, particularly related to aerodynamic efficiency, helm balance and vessel stability.
For an overview of the project and for more details on the evolution of the new vessel design and development of the current design readers can refer to [1].

## WIND TUNNEL CAMPAIGN

### The facility

The experimental investigation was conducted in the twisted flow boundary layer wind tunnel at Politecnico di Milano, Italy. A peculiarity of the facility is the presence of two test sections of very different characteristics, offering a very wide spectrum of flow conditions.

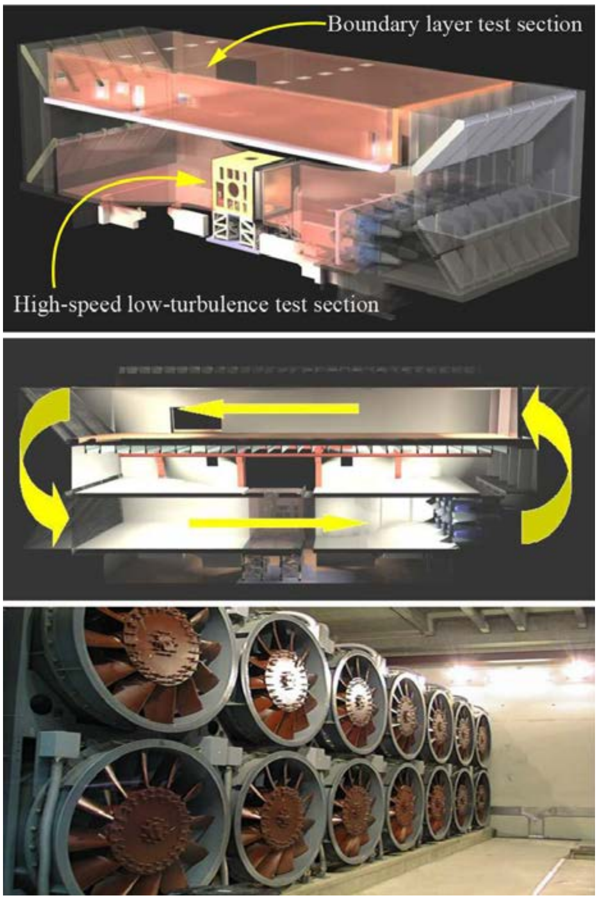



Figure 3 – Politecnico di Milano Wind Tunnel

The wind tunnel is a closed circuit facility in vertical arrangement having two test sections, a 4x4 high speed low turbulence and a 14x4 low speed boundary layer test section (Figure 3); the overall wind tunnel characteristics are summarized in Table 1.
The Wind Tunnel is operated through an array of 14 axial fans organized in two rows of seven 2 x 2m independent cells. 14 independent inverters drive the fans allowing for continuous and independent control of the rotation speed of each fan. This fully computer controlled facility can help in easily obtaining, in conjunction with the traditional spires & roughness technique, a very large range of wind profiles simulating very different flow conditions and different geometrical scales.

| **Politecnico di Milano Wind Tunnel – CIRIVE** | | | | |
|---|---|---|---|---|
| Tunnel Overall Dimensions: **50×15×15** $[m]$ | | | | |
| Maximum Power (Fans only): **1.5** $[MW]$ | | | | |
| Test Section | Size $[m]$ | Max Speed $[m/s]$ | $\Delta U/U$ % | Turb. Int. $I_u$ % |
| Boundary Layer | **14×4** | **16** | **< ± 3** | **< 2.0** |
| Low Turbulence | **4×4** | **55** | **< ± 0.2** | **< 0.10** |

Table 1: Overall wind tunnel characteristics.

The large 36m x 14m x 4m size of the boundary layer test section used for this investigation facilitates very large-scale wind engineering simulations: for aerodynamic studies of yacht sails, it enables the testing of large scale models (typically 1:10 - 1:12 for IACC yacht models) with low blockage effects at a maximum speed of 16 m/s.
A twisted flow gradient can be created, reproducing both the increase in incident apparent wind speed and the rotation of apparent wind direction away from a yacht's heading that are experienced in real life with increased height.
In this case smooth flow and no twist conditions have been used as a reference: a detail of the mean wind velocity and the wind turbulence intensity vertical profiles used for the present tests are shown in figure 4.
For more details on the facility readers can refer to [2].

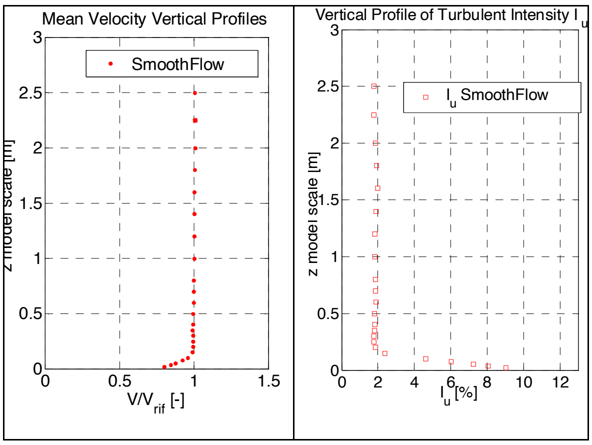



Figure 4 – Mean wind velocity and turbulence index vertical profiles at scale model

**Test Apparatus, Program, and Procedure**

The large size of the low-speed test section permits the use of quite large yacht models. This means the sails are large enough to be made using normal sail making techniques; the model can be rigged using standard model yacht fittings; and most importantly, deck layout can be reproduced around the sheet winches, allowing all the sails to be trimmed as in real life.

A complete 1:15 scale working schooner model was built by SALTS at their shipyard in Canada, closely matching details of the boat's design and the technology of the rig (Fig. 5).

Figure 5 – 1:15 scale model at 60° AWA

The measurement of the overall wind loads on the hull and yacht sailplan is achieved using a six components force balance, which was placed inside the hull and fitted in the wind tunnel's 13m diameter turntable.

Figure 6 shows the 6 components Strain Gauge balance and related measure reference system.

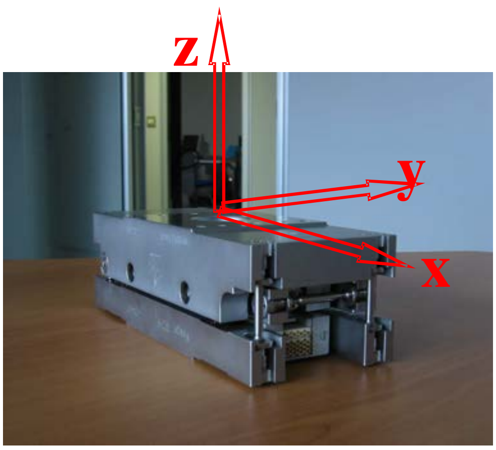



Figure 6 – The dynamometer reference system

The balance is placed inside the yacht hull in such a way that the X axis is always aligned with the yacht longitudinal axis and permits highly accurate measurement of the three forces (vertical, longitudinal and lateral) and the three moments around the three principal axes (Fig. 7)

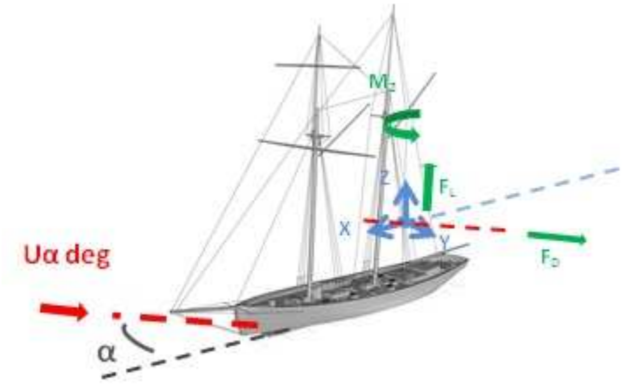



Figure 7

The model was manufactured using an internal structural frame that is rigidly connected to the dynamometer. A rigid aluminum chassis served as the foundation for the entire model. Mast steps, deck structures, rig fittings, travelers, and servos were mounted directly on the chassis. A fiberglass yacht hull body was suspended off the chassis, 3 mm clear of the turntable, and a curved cardboard surface was fitted to simulate design deck sheer (Fig. 8).

The standing rig was built with correctly tapered masts and spars, wire shrouds and stays, and simulated ironwork (Fig. 9). Model sails were designed and built by Doyle Sailmakers.

The model was equipped with remote controlled winches, allowing remote sail trimming from the wind tunnel control room.

Figure 8 – Deck layout

Figure 9 – Detail of the standing rig.

3 video-cameras were placed in the wind tunnel in order to help sails trimming procedure.
One camera was placed on the wind tunnel floor looking at the yacht stern (Fig. 10), another one was placed on the roof (Fig. 11) looking along the mast direction in order to check the mainsail flying shape, and the last allowed for observations of jibs and stays from the waterplane (Fig. 12).

Figure 10 – stern camera view


Figure 11 – Top camera view


Figure 12 – Waterplans camera view

The data acquisition procedure provides direct digital data acquisition by means of National Instruments Data Acquisition Boards and suitably written programs according to Matlab standards.
The data acquisition program visualizes the actual forces acting on yacht model so it is possible to evaluate the influence of trimming the sails on the forces acting on the yacht in real time.
Figure 13 shows the data acquisition software user interface: the aerodynamic forces due to the actual sail trim are measured in the yacht reference system and are visualized on the screen in real time (referenced as "new" in the left column of the virtual panel), together with the previous acquired force system corresponding to the previous attempted trim (referenced as "old" in the right column of the virtual panel) so that the sail trim can be optimized by means of trial and error procedure.
For more details on testing procedures and measurement set-up readers can refer to [3].

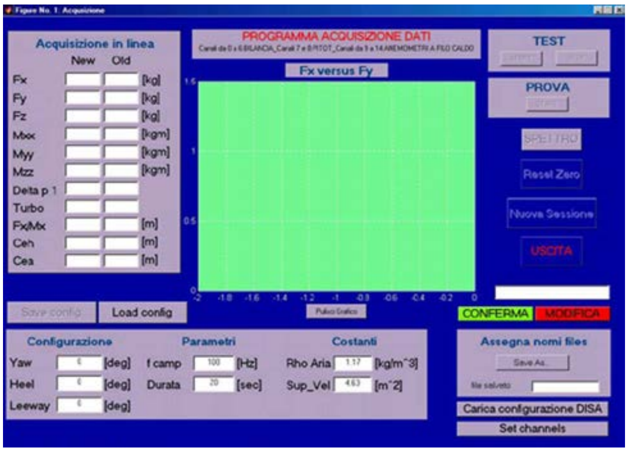



Figure 13: Data Acquisition Software

## Wind Tunnel Test Program

Campaign objectives included a detailed investigation of the aerodynamics of a traditional square topsail schooner rig, and the provision of data useful for design development in terms of balance assessment and performance prediction.

Over the course of a five-day wind tunnel campaign, fifteen sail plans were tested—five principal suits of sails (Fig. 14), followed by ten variations of sail plan geometries: mast rake, mainsail size, and headsail size and position.

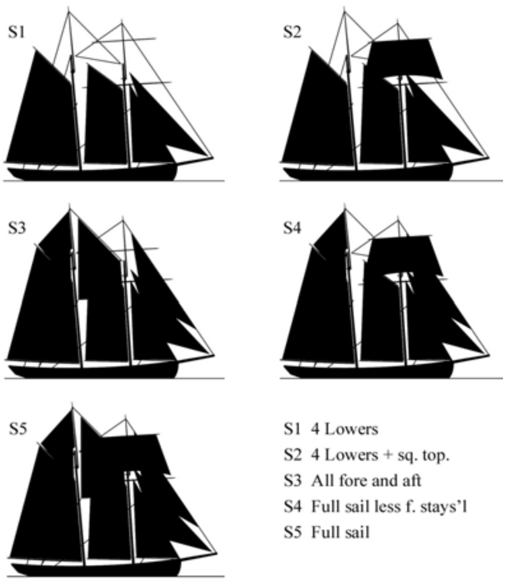



Figure 14 – The five principal suits of sails tested

With reference to the five principal suits of sails, the S1 sailplan (mainsail + foresail + forestaysail + jibsail) was initially tested (Fig. 15).

Figure 15 – S1 sailplan layout: 4 lowers

Adding the square topsail lead to the S2 configuration (Fig. 16).

Figure 16 – S2 sailplan layout: 4 lowers and sq. top

Addition of the main topsail generated the S4 configuration (Fig. 17).

Figure 17 – S4 sailplan layout: full sail less fore staysail

The S5 layout was created by adding a fisherman staysail to the S4 configuration (Fig. 18).

Figure 18 – S5 sailplan layout: full sail

Finally, (Fig. 19) the square topsail was removed leading to the all fore-and-aft S3 configuration (named also S3-JT-h2).

Figure 19 – S3 sailplan layout: all fore and aft

These five principal suits of sails were followed by ten variations of sailplan geometries: mast rake, mainsail size, and headsail size and position.
In terms of headsail position, two different jib topsail heights were tested on the S3 configuration: the higher named S3-JT-h1 (Fig. 20) and the lower S3-JT-h4 (Fig- 21).

Figure 20 –S3-JT-h1 sailplan layout (Jib topsail higher)

Figure 21 – S3-JT-h4 sailplan layout (jib topsail lower)

With reference to foresail size effects a smaller Jib Topsail were considered and tested always with reference to the S3 sailplan layout (named S3-JT-L-h2 and shown in Fig. 22).

Figure 22 – S3-JT-L-h2 sailplan layout (smaller jib topsail)

Finally a smaller jib was tested on the S1 sailplan configuration (Fig. 23) with its tack down hard against the bowsprit (named S1-JT-k-h4).

Figure 23 – S1-JT-k-h4 sailplan layout (smaller jib at lowest height)

**Main Extensions**

With reference to S1 and S3 configurations main extension options were tested (named S1-ME and S3-ME respectively) leading respectively to 3.3% and 2.2% area increasing.

Figure 24 – S1 main extension option

Figure 25 – S3 main extension option

**Rake Changes**

With reference to the S1 and S3 configurations, increasing the rake of the masts was also examined: two higher rake options were tested (named S1-rA and S3-rA); with an increased rake of 7° for the main mast and of 5.5° for the fore mast (Figs. 26-27).

Figure 26 – S1 increased rake option

Figure 27 – S3 increased rake option

**Changes in the Longitudinal Position of the Jib**

With reference to S1 configuration at the higher rake setting, two alternate longitudinal positions were tested by changing the fore-and-aft position of the tack, as shown in Fig. 28 (named S1-rA-jib-fore and S1-rA-jib-aft, respectively).

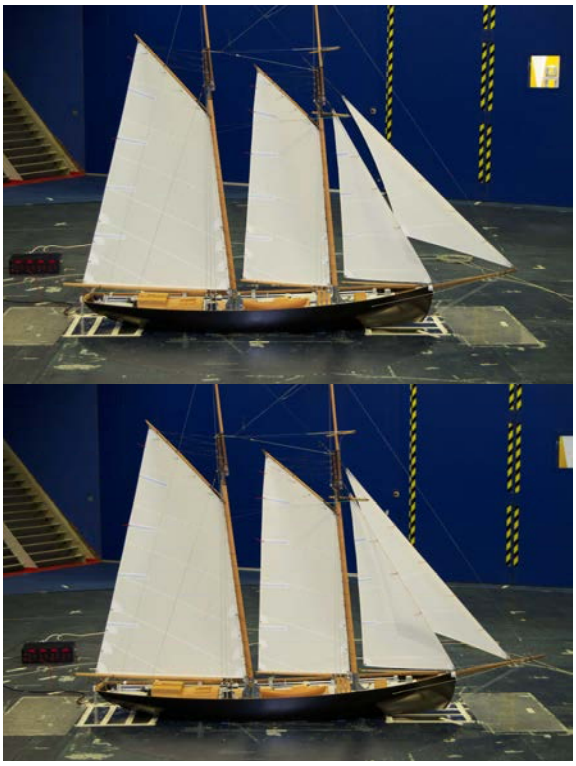


Figure 28 – S1 (rake increased) jib longitudinal position options

### Testing Procedure

Models were tested in the upright condition at six fixed apparent wind angles from 30° to 150°, under constant dynamic pressure (Fig. 29). Windage tests were also performed on the bare hull and rigging at apparent wind angles from 0° to 180° (Fig. 30).

Figure 29 – S2 at 90° AWA and S3 at 40° AWA

Figure 30 – windage tests

Sails were trimmed to achieve maximum driving force by monitoring real-time force data while observing the sails directly from the control booth and using live video-feed from three cameras positioned in the wind tunnel. The sails were then depowered according to a consistent scheme, with data recorded in steps, as heeling force was reduced to approximately 50% of observed maxima. At each trim condition, 30 seconds of data were recorded at 100Hz sample frequency. Time histories and mean values for all measured quantities were stored in a file, and subsequently corrected for residual zeroes error due to temperature effects.

### Data Analysis

The usual way of analyzing wind tunnel data is to compare non-dimensional coefficients, enabling comparison of the efficiency of sail plans of different total area at different conditions of dynamic pressure. The first analysis performed was the variation of non-dimensional driving ($Cx$) with heeling ($Cy$) force coefficients, as given by:

$$Cx = \frac{Fx}{\frac{1}{2}\rho S v^2}$$

$$Cy = \frac{Fy}{\frac{1}{2}\rho S v^2} \qquad (1)$$

Figure 31 shows a comparative plot of $Cx$ vs. $Cy$ for sail plan S4 (Fig. 17) at four of the apparent wind angles tested. Each run at each AWA is plotted as an independent data point. It can be seen that there are some settings at the highest values of heeling force coefficients where the driving force is lower than the maximum value.
These non-optimum values were obtained by over-sheeting the sails, such that the mainsails generally had a tight leech and the airflow separated in the head of the sails.

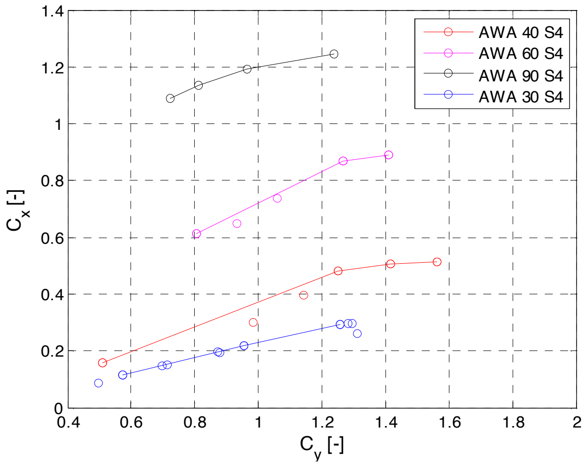



Figure 31 – Variation of $Cx$ vs. $Cy$ for sail plan S4

After maximizing the driving force, the sails were adjusted to reduce the heeling force, initially without reducing the driving force. In Figure 31 envelope curves have been also drawn through the test points with the greatest driving force at a given heeling force: data from non-optimal sail trim falling below the envelope curves are excluded from the subsequent analysis.
Heeling and yaw moments were measured and subsequently used to determine the center of effort positions of each sail plan tested. The center of effort height, *Ceh*, is obtained by dividing the roll moment by the heeling force component in the yacht body reference system. A plot of center of effort height vs. heeling force for four apparent wind angles is shown in Figure 32. Values are referred to the balance origin which is 10 mm above the waterline. As can be seen, the center of effort height tends to reduce as the heeling force coefficient reduces. This is explained by

the way in which the sails were depowered—that is, according to a depowering scheme consistent with real life sailing proceedures.

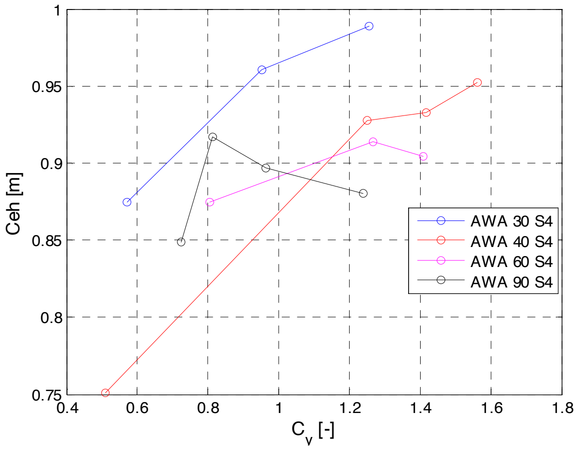



Figure 32 – Variation of *Ceh* for sail plan S4

The center of effort longitudinal position, *Cea*, is obtained by dividing the yaw moment by the heeling force component in the yacht body reference system. A plot of *Cea* vs. heeling force for sail plan S4 at four apparent wind angles is shown in Fig. 33. Increasing value of Cea means the center of effort is moving forward along the yacht sailplan and in this case it should be noted that depowering scheme leads to variations of center of effort longitudinal position in both aft and forward directions.

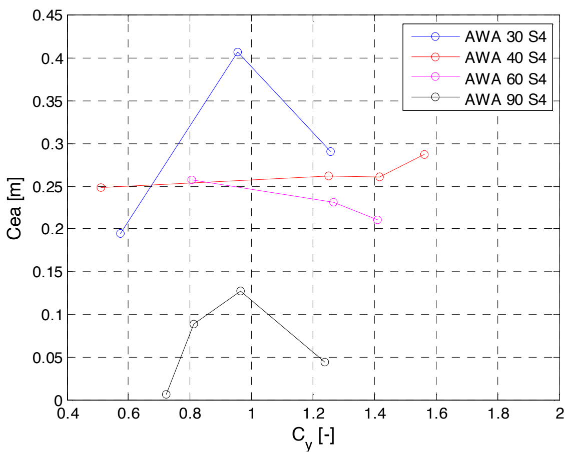



Figure 33 – Variation of *Cea* for sail plan S4

More information can be extracted from the wind tunnel data by transforming them into lift and drag coefficients. Using the driving and heeling aerodynamic force Fx and Fy component in the yacht body reference system the corresponding drag and lift forces components can be obtained as follows:

$$DRAG = -F_x \cos(AWA) + F_y \sin(AWA)$$
$$LIFT = F_x \sin(AWA) + F_y \cos(AWA) \qquad (2)$$

Then the corresponding drag and lift coefficients $C_D$ and $C_L$ can be evaluated according to the following expression:

$$DRAG = \frac{1}{2}\rho V_a^2 C_D(AWA) S$$
$$LIFT = \frac{1}{2}\rho V_a^2 C_L(AWA) S \qquad (3)$$

where the apparent wind speed $V_a$ and apparent wind angle are evaluated in the heeled plane perpendicular to the mast according to:

$$V_a = \sqrt{\left(-V_t \cos\gamma\right)^2 + \left(V_t \sin\gamma \cos\phi\right)^2}$$
$$AWA = \text{arctg}\left(\frac{V_t \sin\gamma \cos\phi}{-V_t \cos\gamma}\right) \qquad (4)$$

In (4) $\gamma$ represent the true wind angle (yaw angle), $V_t$ is the wind tunnel flow velocity corresponding to the mean dynamic pressure at each run and $\phi$ is the heel angle.
As an example in Fig 34, the $C_D$ and $C_L$ measured values at different AWA for S4 sailplan are reported. In particular at each AWA, only the values corresponding to the maximum driving force condition trimming point are shown.

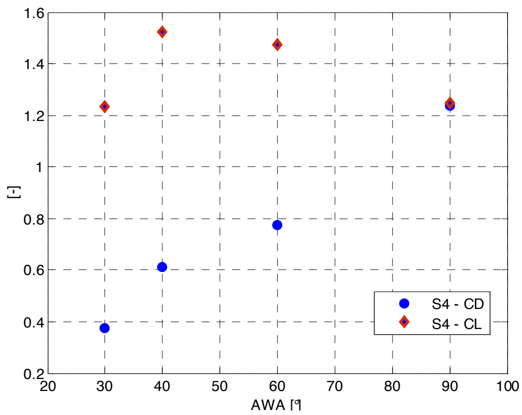



Figure 34 – Variation of CD and CL with AWA

Because both the induced drag and quadratic profile drag vary with the square of lift, it is informative to plot drag coefficient vs. the square of the lift coefficient as shown in Figure 35.

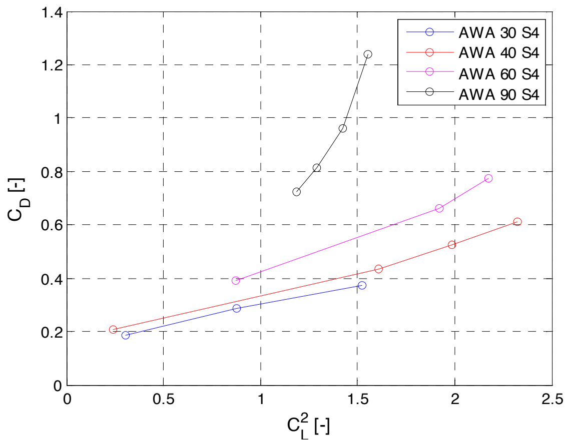



Figure 35 – Drag coefficient vs. lift coefficient^2

As can be seen, for reduced values of $C_L$, drag increases linearly, following a straight line. This linear increase is attributable to the induced drag. The effective height ($H_{eff}$) is a measure of the efficiency of the rig, and can be determined from the slope of the straight line by applying simple aerodynamic theory according to the following equation:

$$Heff = \sqrt{\frac{SailArea}{\pi Slope}} \quad (5)$$

At higher values of $C_L^2$, the values of $C_D$ increase more rapidly with $C_L^2$. This additional drag can be attributed to flow separation from the sails. Residual base drag—caused by viscous phenomena related to windage but not linked to the production of lift by the sails—can be evaluated as the parasitic drag coefficient from the intercept with the zero lift axis of the straight line that runs through the test data at lower values of $C_L^2$.

**Results: principal suites of sails**

In [1] some preliminary results were presented with particular reference to drag and lift aerodynamic coefficients of the five principal suits of sails. These data constitute the fundamental data for VPP analysis.

The wind tunnel data obtained in the experimental campaign can be also used to obtain driving forces and heeling moments for each particular configuration. It is then possible to study the effect on sail forces produced on the yacht by the variation of rig height and sail area associated with each of the considered suit of sails and to the considered variations of sailplan geometries.

Figure 36 show the comparison of the driving force coefficients as a function of the heeling force coefficients obtained by the envelope drawn through the test points of each of the principal suites of sails at 30° AWA.

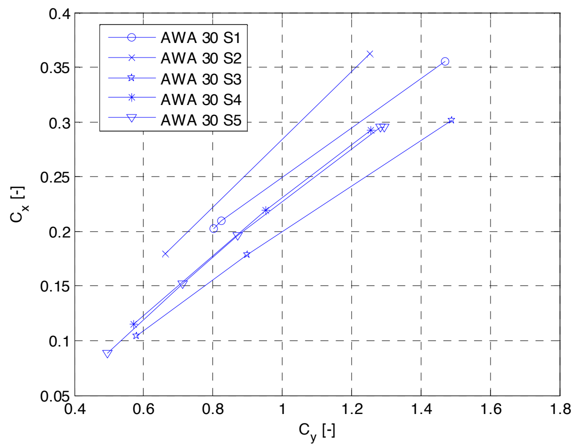



Figure 36 – Driving force vs. heeling force coefficients

Figure 37 shows the center of effort height (at full scale) of each sailplan with reference to the maximum drive force trim at the same AWA (30°). This quantity is measured from the waterline.

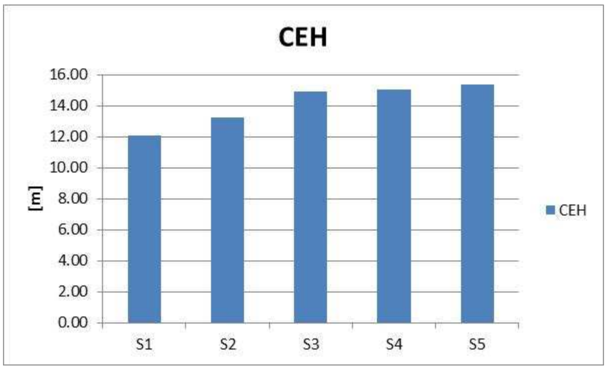



Figure 37 – Center of effort height for the principal suites of sails

Using these data, the relative performance of the rigs can be compared by comparing the driving force at similar apparent wind angles and heeling moments.

Figure 38 shows the driving force coefficient vs. the heeling moment coefficient. In principal, it could be said that the sailplan that produces a higher driving force for a given heeling moment will drive the yacht faster.

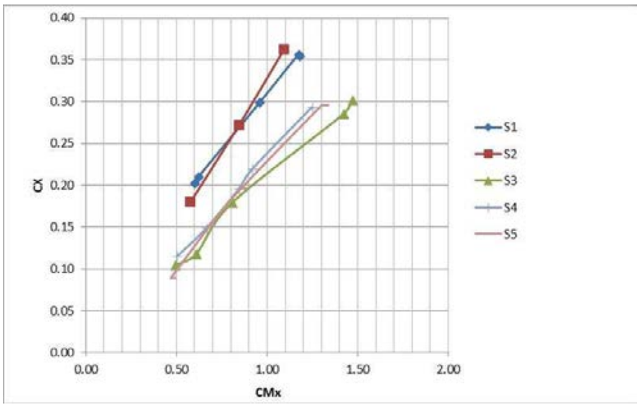



Figure 38 – Driving force vs. heeling moment coefficients

Looking at this picture it could be concluded that the lowers suites of sails seem to be better.

But if we want to consider the changes in sail area on rig performance we have to consider that the force generated by a rig is a combination of area and coefficient so that it is possible for the driving force coefficient to be reduced whilst the driving force is increased due to the increase in sail area.

To account for this we can consider the driving force area coefficient (which represents the driving force at full scale per unit of wind pressure) vs. the heeling moment area coefficient (which represents the heeling moment at full scale per unit of wind pressure) as shown in figure 39 with reference to the considered suit of sails.

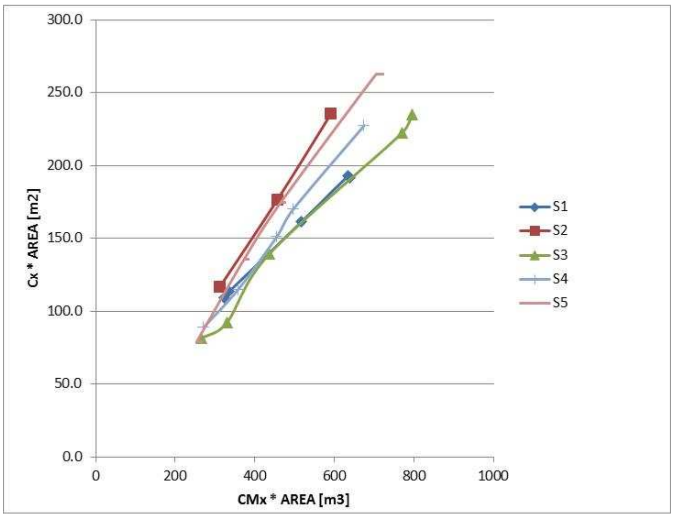



Figure 39 – Driving force area coefficient vs. heeling moment area coefficient

This picture highlights the advantage of square top added to the 4 lowers suit of sails which allows for a higher driving force with the same heeling moment. This leads to the conclusion that S2 sailplan will drive the yacht faster than the S1 suit, without recourse to full VPP calculations.

Similar conclusions can be derived considering the effect of the fisherman staysail in the full sail configuration, by comparing the higher driving force achieved with the S5 configuration with respect to the S4 suit of sails at the same heeling moment.

Concerning the S3 sailplan, Figures 36-38 show that the same driving force coefficient Cx achievable with S4 sailplan can be obtained only with a higher heeling force coefficient Cy as well as with a higher heeling moment coefficient CMx. This means that the same driving force will produce a higher heeling moment on the yacht, leading to a higher heel angle, as shown in Figure 39. Nothing can be said about the potential speed advantage or disadvantage without recourse to full VPP calculations.

Relative performance of the rigs cannot be kept separate from yacht heel under sail as heel also depends on the apparent wind speed. As is well known, the boat heel will be identified by the heel value that balances the heeling moment with the righting moment.

As an example, Figure 40 shows the graph which allows the determination of the equilibrium condition under sail at 30° AWA and 15 knots apparent wind speed. In this figure the righting moment curve [7] is plotted as a function of the heel angle as well as the heeling moment produced by each of the five principal suites of sails: the abscissa of the point of intersection between these curves will give the heel angle produced under sail for each considered sailplan.

It should be noted that all the wind tunnel tests have been performed in upright conditions: to make a first estimate of the heeling moment as the heel angle varies it is common practice to assume as a working hypothesis that the heeling force decreases by the cosine of the heel angle as the heel angle increases.

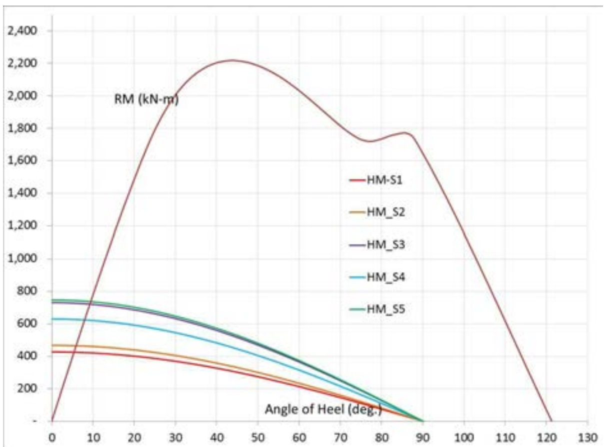



Figure 40 – Heel angle at 15 Knots wind speed

It is important to point out that the heeling arm used in these calculations is the sum of the center of effort height obtained at 30° AWA in maximum driving force condition by the wind tunnel tests (reported in Figure 37) and the vertical position of the center of lateral resistance obtained by the water tank measurements at the estimated sailing side forces in the same conditions [5].

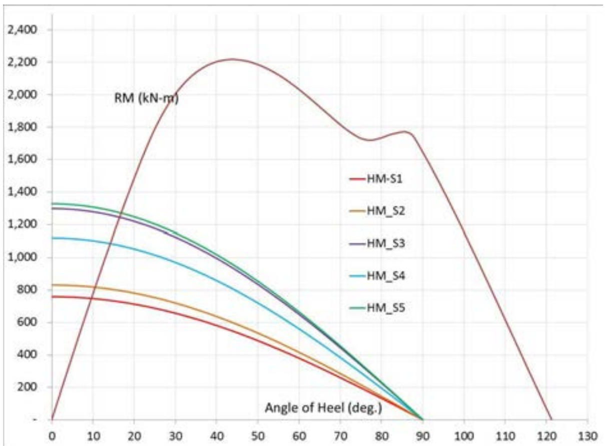



Figure 41 –Heel angle at 20 Knots wind speed

Figure 41 shows the calculation results obtained when considering a 20Kn breeze at 30° AWA. Table 2 summarizes the foreseen heel angles obtained with each of the principal suits of sails tested.

| | 15 Kn | 20 Kn |
|---|---|---|
| **S1** | 5.40 | 9.61 |
| **S2** | 5.91 | 10.53 |
| **S3** | 9.25 | 16.46 |
| **S4** | 7.97 | 14.20 |
| **S5** | 9.46 | 16.83 |

Table 2

Yacht balance is another important issue which cannot be kept separate when evaluating the relative performance of the rigs. In this case the longitudinal position of the center of effort plays a key role.
Figure 42 shows the center of effort longitudinal position (at full scale) of each sailplan with reference to the maximum drive force trim at the same AWA (30°). This quantity is measured form the origin on the waterline where the stem enters the water (i.e. aft of station 0).

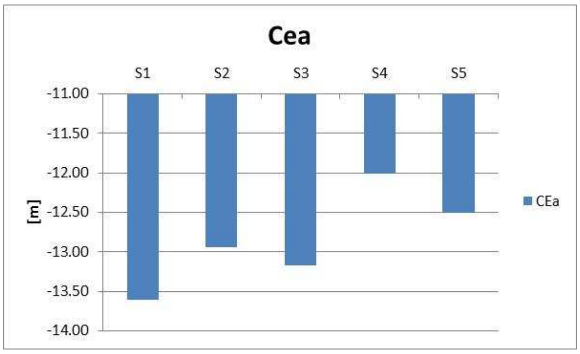



Figure 42 – Center of effort longitudinal position for the principal suites of sails

Initially, helm balance was addressed by considering the lead between geometric centroids of the sail plan and hull profile, although the limitations of this approach were well understood.
It it very interesting to note that the aerodynamic CE positions are quite different from the geometric centroids of each sailplan. Notably, results obtained in the wind tunnel show a lower and more forward placement of the aerodynamic center of effort than the relevant geometric point for all the considered sailplans.
Figure 43 summarizes the situation.

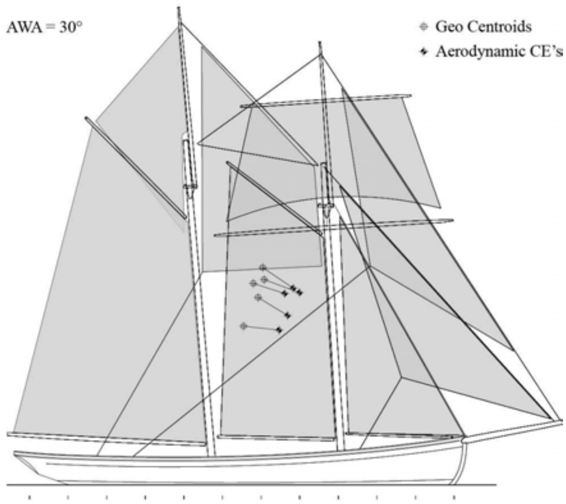



Figure 43 – Geometric and aerodynamic centers

According to the fully integrated design process previously mentioned, the aero-hydrodynamics of the traditional square topsail schooner and the yacht balance issue will be re-considered in a subsequent paragraph.
With reference to the variations of sailplan geometries that were considered, results obtained by the wind tunnel investigation for each particular configuration will be provided next.

**Results: Headsail Position Variations**

With reference to headsail position variations, as an example, Figure 47 shows results obtained with reference to the all-fore-and-aft suit of sails in terms of driving force area coefficient vs. the heeling moment area coefficient moving from the S3 layout (Fig. 44) to the layout with the Jib topsail higher, named S3-JT-h1 (Fig. 45), and with the Jib topsail lower, named S3-JT-h4 (Fig. 46).

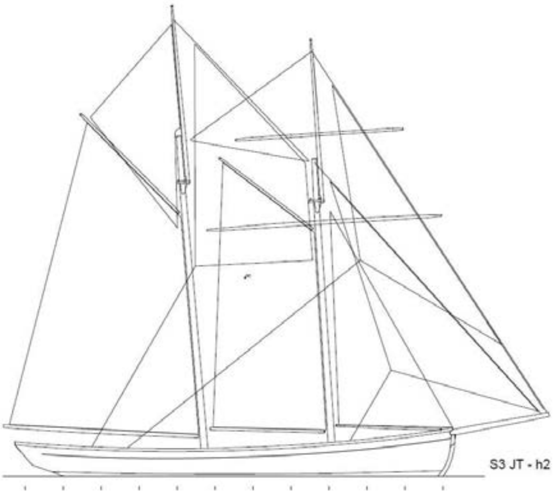



Figure 44 – S3 sailplan layout: all fore and aft

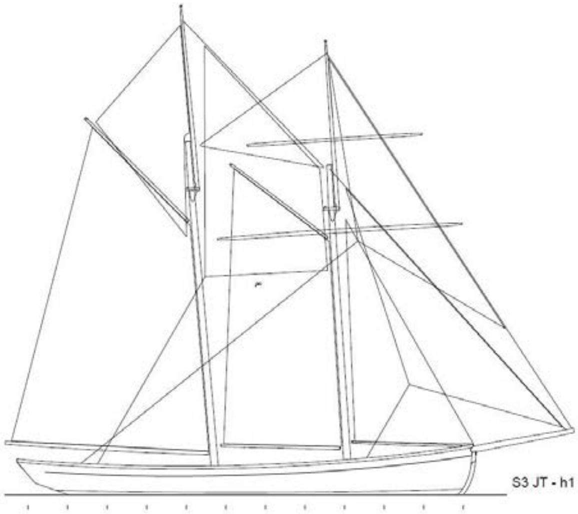



Figure 45 –S3 sailplan with Jib topsail higher – S3 JT-h1 layout

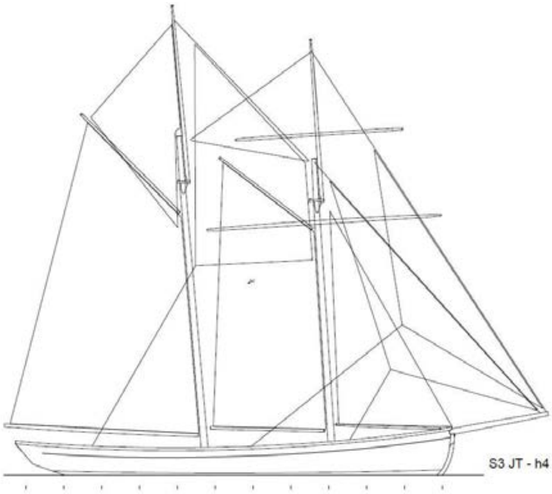



Figure 46 –S3 sailplan with Jib topsail lower – S3 JT-h4 layout

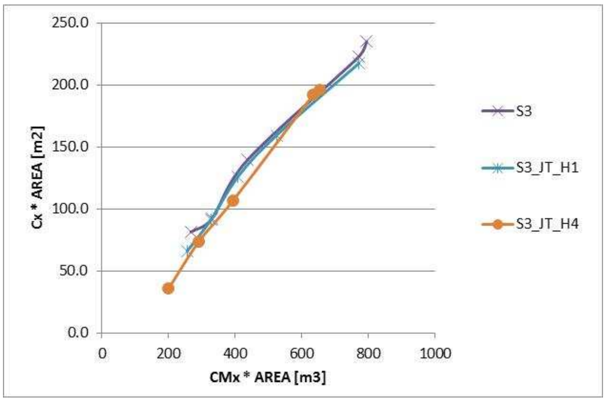



Figure 47 – Driving force area coefficient vs. heeling moment area coefficient

As can be seen lower position of Jib topsail leads to a 20% less driving force than the standard S3 layout and also the higher position of Jib topsail leads to a 5% of driving force loss.

The variation of aerodynamic centers associated with variations in headsail position are essentially negligible, as illustrated in Figures 48 – 49.

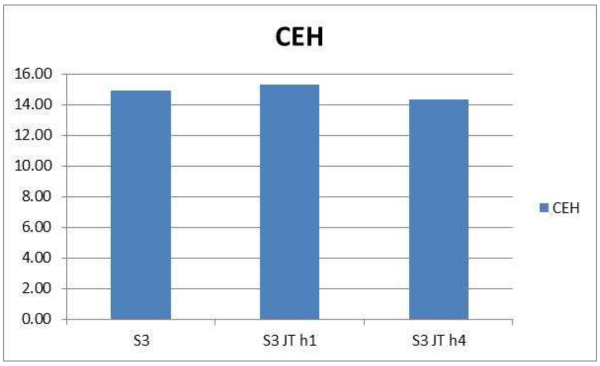



Figure 48 – Center of effort height

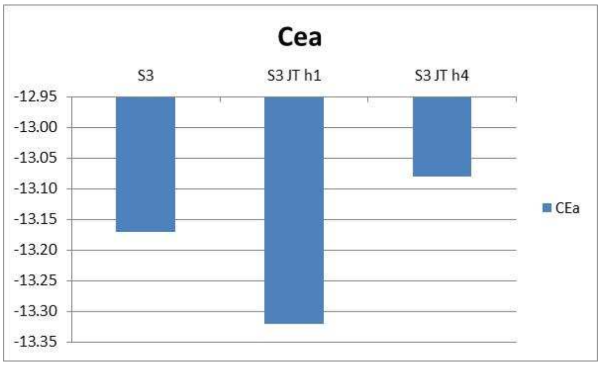



Figure 49 – Center of effort longitudinal position for the principal suites of sails

**Results: Mainsail Size Variations**

With reference to variations in mainsail size no particular advantages are highlighted by test results both in case of 4 Lowers as well as in case of the all fore and aft suits of sails as shown in figures 50-51.

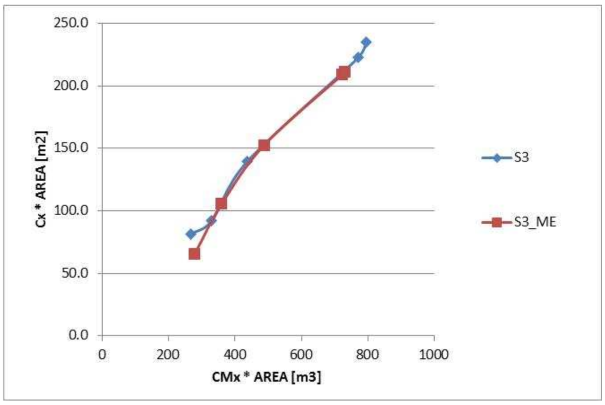



Figure 50 – Driving force area coefficient vs. heeling moment area coefficient

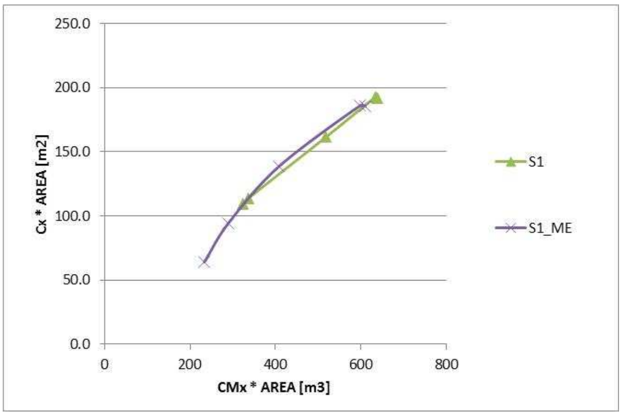



Figure 51 – Driving force area coefficient vs. heeling moment area coefficient

As can be seen in figures 52-53 the longitudinal position of the aerodynamic center of effort is shifted aft by the main extension in both cases.

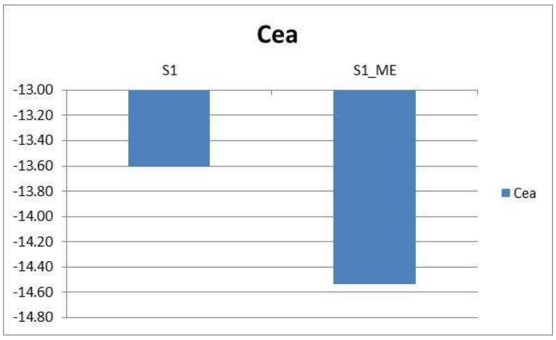



Figure 52 – Center of effort longitudinal position for the 4 lowers suite of sails

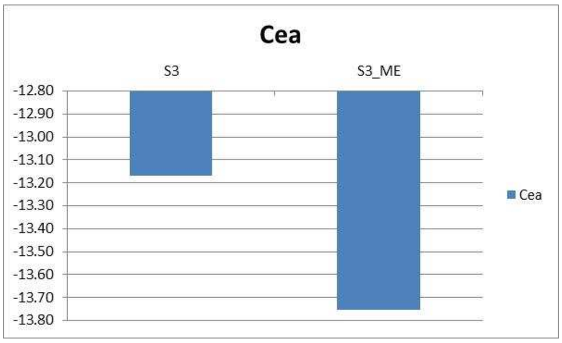



Figure 53 – Center of effort longitudinal position for the all fore and aft suite of sails

**Results: Mast Rake Effects**

With reference to mast rake effects, figure 54 shows results obtained with the all fore and aft suit of sails in terms of driving force area coefficient vs. the heeling moment area coefficient when increasing rake to 7° for the main mast and 5.5° for the fore mast respectively (Fig. 55).

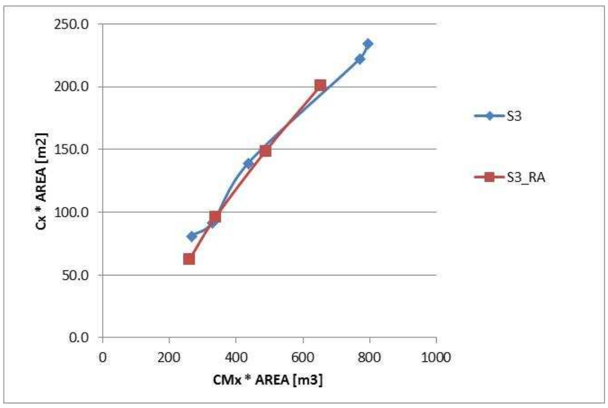
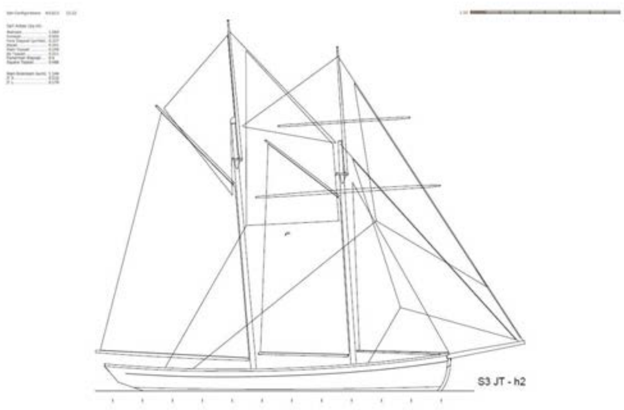
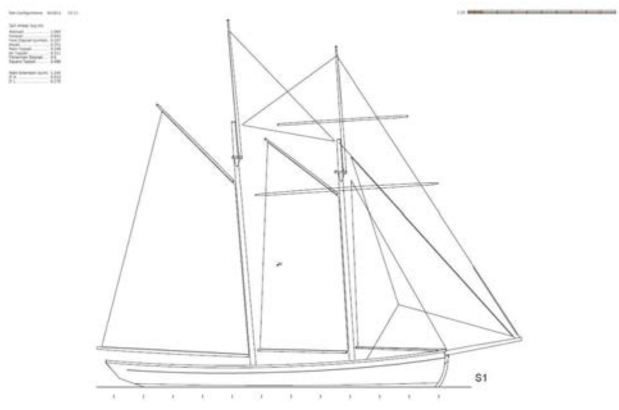
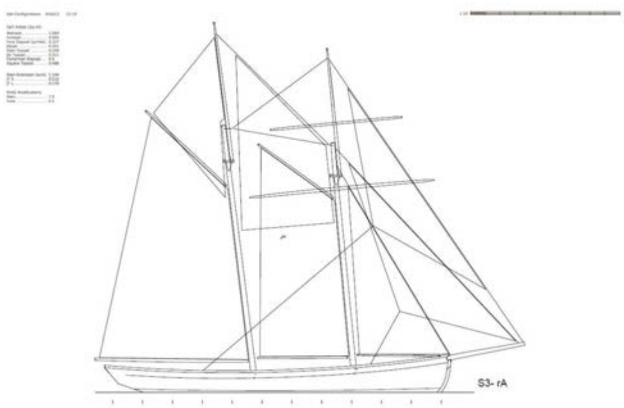



Figure 54 – Driving force area coefficient vs. heeling moment area coefficient







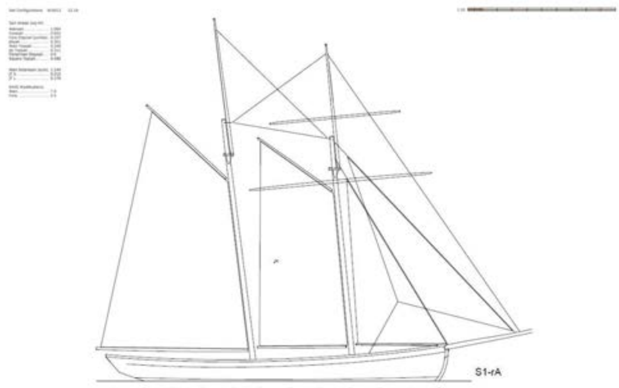


Fig. 55 – All fore and aft suit of sail vs. rake increased option

Fig. 57 – 4 lowers suit of sail vs. increased rake option

Figure 56 shows to the same results with reference to the 4 Lowers suit of sails (Fig. 57).

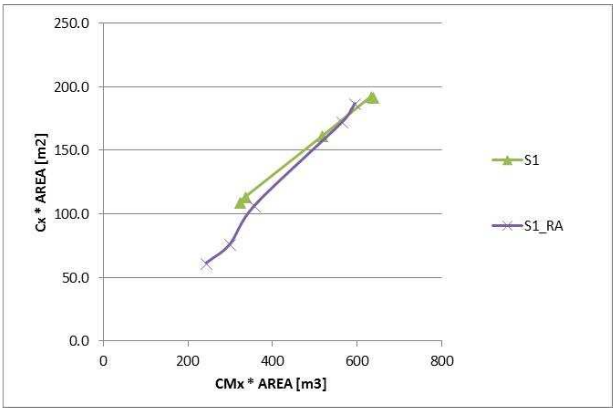



Figure 56 – Driving force area coefficient vs. heeling moment area coefficient

No particular advantages are highlighted by test results in terms of achievable driving force.

The aerodynamic center of effort height is actually not affected by the rake variation (Figs. 58 – 59) while, as can be expected, more significant effects are induced on the center of effort longitudinal position as shown in figures 60-61.

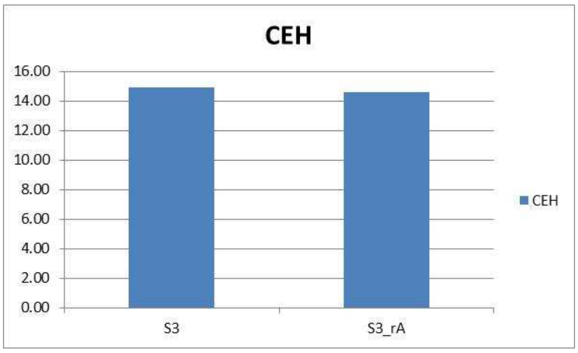



Figure 58 – Rake effect on center of effort height (All fore and aft)

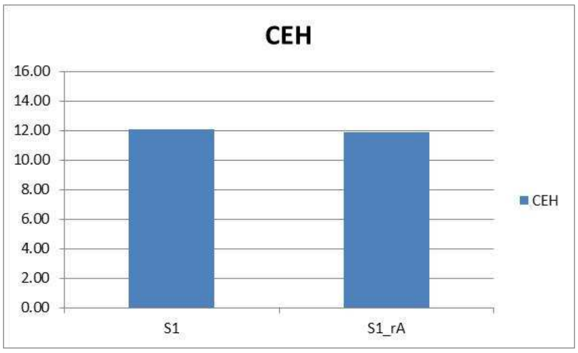



Figure 59 – Rake effect on center of effort height (4 Lowers)

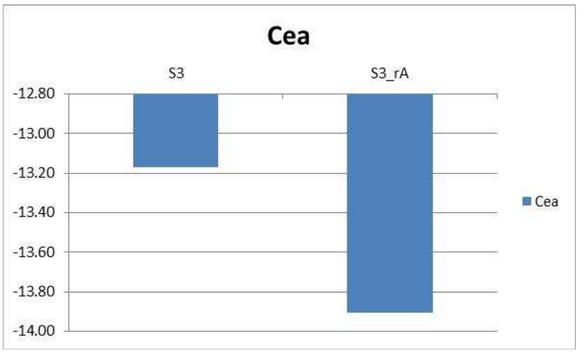



Figure 60 – Rake effect on center of effort longitudinal position (All fore and aft)

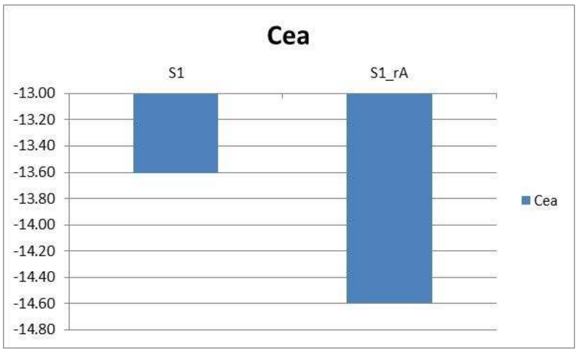



Figure 61 – Rake effect on center of effort longitudinal position (4Lowers)

**Jib Longitudinal Position Changes**

With reference to jib longitudinal position variation, figure 62 shows results obtained with S1 (rake increased) in terms of driving force area coefficient vs. the heeling moment area coefficient when shifting the jib fore and aft (Fig. 63).

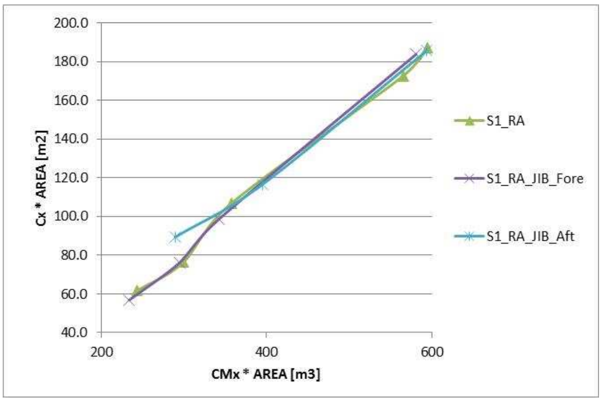



Figure 62 – Driving force area coefficient vs. heeling moment area coefficient

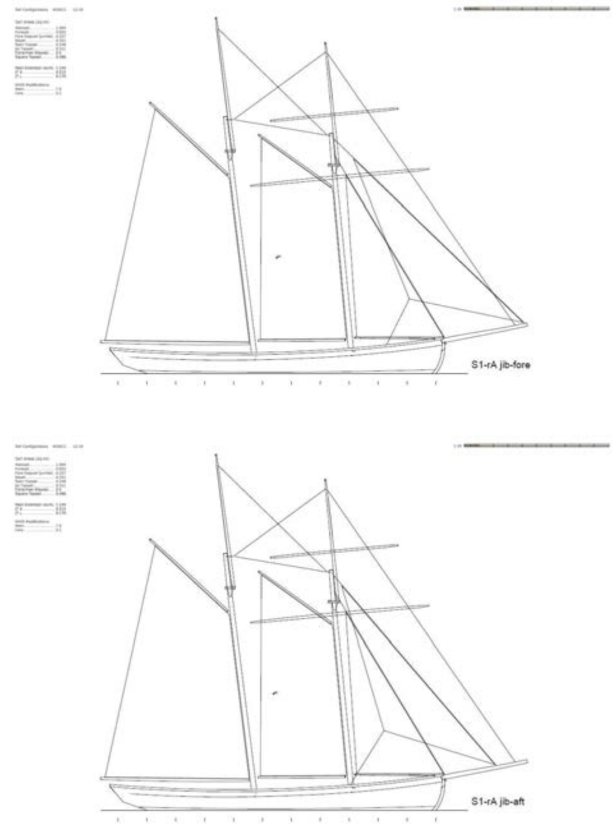



Figure 63 – jib fore and aft options

No particular advantages are highlighted by test results in terms of achievable driving force, nor significant effects are highlighted in the centre of effort position (Figs. 64-65).

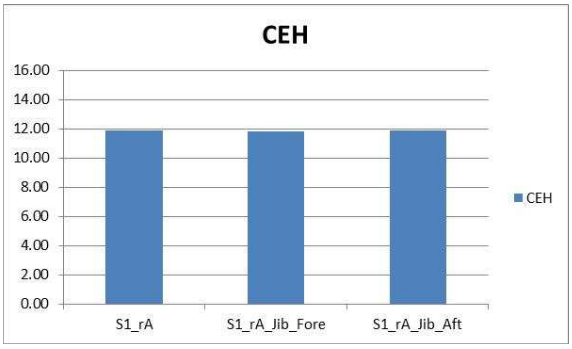



Figure 64 – jib fore and aft shift effect on center of effort height (4Lowers)

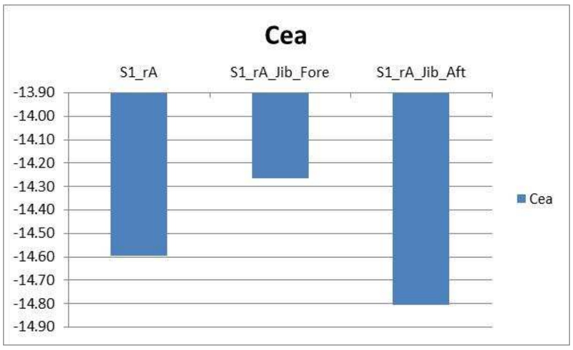



Figure 65 – jib fore and aft shift effect on center of effort longitudinal position (4Lowers)

**Results: Headsail Size Changes**

With reference to headsail size effects, Figure 66 shows driving force area coefficient vs. heeling moment area coefficient obtained with a smaller Jib Topsail (named S3-JT-L-h2) in the all-for-and-aft suit of sails, in comparison with the original S3 sailplan layout.

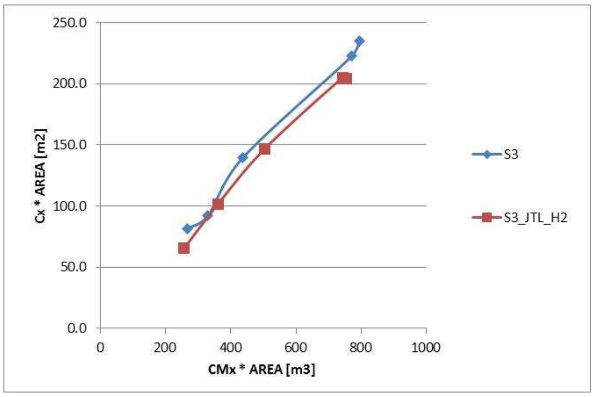



Figure 66 – Headsail size reduction effects on driving force area coefficient vs. heeling moment area coefficient (All fore and aft)

As can be seen smaller Jib topsail option leads to a 15% less driving force and the aerodynamic center of effort position is slightly shifted aft as illustrated in Figures 67-68.

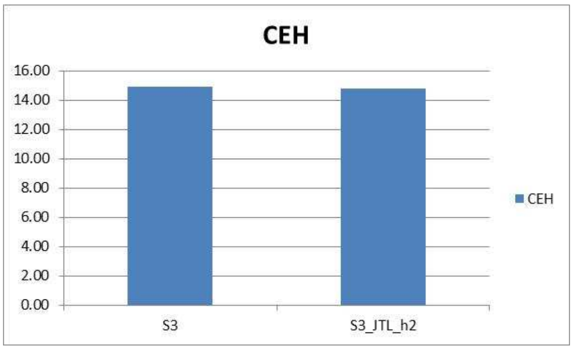



Figure 67 – Foresail size reduction effects on center of effort height (All fore and aft)

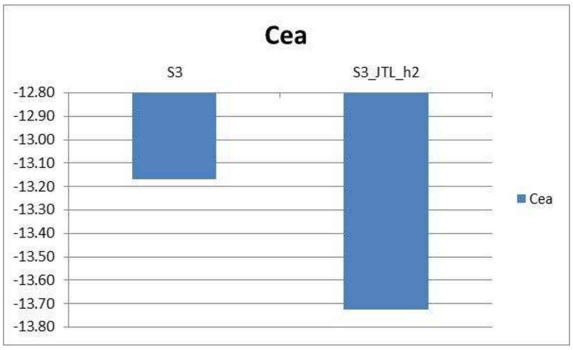



Figure 68 – Foresail size reduction effects on center of effort longitudinal position (All fore and aft)

Similarly, results concerning the 4 lowers suit of sails with a smaller jib at the lower height (named S1-JT-k-h4) are shown in figures 69-70-71 in comparison with the original S1 sailplan layout.

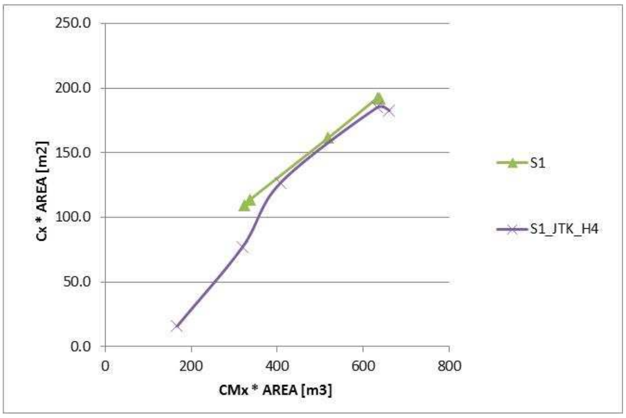



Figure 69 – Headsail size reduction effects on driving force area coeff. vs. heeling moment area coeff.

Also in this case no advantages are highlighted by the headsail size reduction in terms of driving force while more significant effects are induced on the center of effort longitudinal position as shown in figure 71.

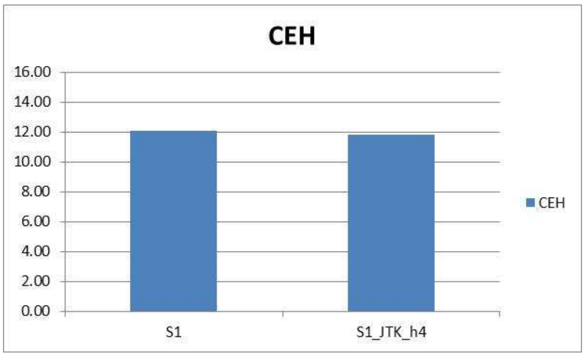



Figure 70 – Foresail size reduction effects on center of effort height (4 Lowers)

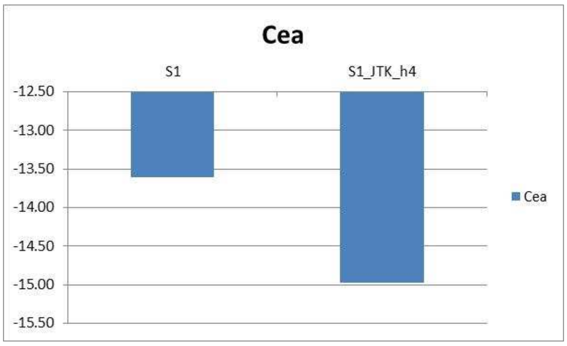



Figure 71 – Foresail size reduction effects on center of effort longitudinal position (4 Lowers)

## AERO-HYDRODYNAMICS AND BALANCE

According to the fully integrated design process previously mentioned, the results obtained from the wind tunnel can be also used with results available from the towing tank to properly manage aero-hydrodynamics, and in particular to investigate the behavior of different sail plans related to good helm balance.

In particular, the wind tunnel data obtained in the experimental campaign can be also used with results available from heeled and yawed tests carried out in the water tank to produce an estimate of the rudder angle required in order to hold a steady course.

As described in [1], a three-day towing tank campaign was conducted at the Wolfson Unit at the University of Southampton, England to provide an evaluation of upright hull resistance to determine powering requirements, a quantification of the effect of changes in keel draft and profile on resistance and side force providing, in particular, the position of CLR in response to changes in keel profile, side force, and rudder angle.

A 1:15 scale model of the hull and three interchangeable keels was towed using a dynamometer that allowed the model freedom to heave and pitch, but provided restraint in yaw, sway and roll. Three keel configurations and the bare canoe body (Fig. 72) were tested in the upright condition at full-scale speeds ranging from 5 to 16 knots. Heeled and yawed tests were conducted with the three keel configurations across a test matrix of varied speed, heel, yaw and rudder angles.

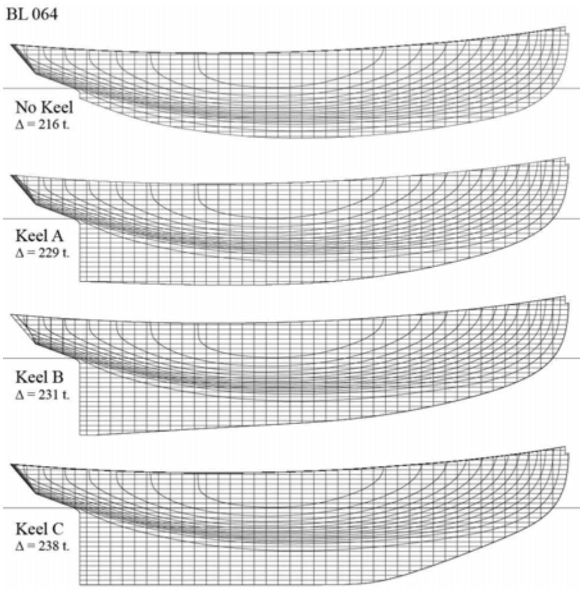



Figure 72 – Canoe body and test keel profiles

The longitudinal positions of CLR can be obtained by dividing the measured yaw moments by side force, and these can also be plotted against $SF^2$, as shown in the lower part of Figure 73 ([1], [5]).

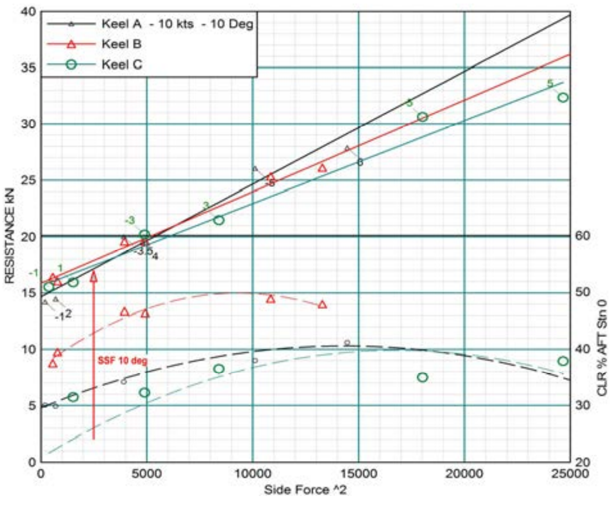



Figure 73 – Resistance and CLR position vs. side force squared for keels A, B and C at 10° heel

These results, for 10° heel and at higher angles (not shown here) clearly show the difference in the position of CLR for Keel B compared to Keels A and C; to achieve good helm balance, only Keel B has a CLR sufficiently far aft to maintain an acceptably low rudder angle.

In particular, tests to determine the effect of altering rudder angle on the position of CLR were carried out and these results can be combined with the measured position of CLR and sailplan center of effort position to produce an estimate of the rudder angle required to hold a steady course.

With reference to the Keel B, column #4 of Tab. 3 (taken from [2]) shows for 2 different heel angles at 10 knots the measured CLR position (expressed as a percentage of LWL aft of station 0) presented with the rudder angle set at zero degrees at the estimated side force SF.

| Heel | speed [Knots] | SF [KN] | CLR aft 0 %LWL | d = delta CLR %LWL | CLR' %LWL | dCLR/dR %LWL/deg |
|---|---|---|---|---|---|---|
| 10 | 10 | 50 | 42 | 2.7 | 39.3 | 2.2 |
| 20 | 10 | 100 | 43.8 | 3.2 | 40.6 | 2 |

Table 3

As is well known, yacht balance is linked to the creation of a condition of equilibrium of the yawing (or turning) moments around the vertical axis. As can be seen from figure 74 (taken from [4]), these moments are produced by the horizontal components of the various forces involved.

Remembering that the torques are produced by equal and opposite forces that do not operate along the same line of action, and that the torque is given by the product of one of the two forces and the moment arm i.e. the distance between the two lines of action, indicated by:

- $F_H$ the aerodynamic heeling force
- $P_{LAT}$ the component of total hydrodynamic lift in the horizontal plane
- $F_R$ the force produced by the rudder
- $F_M$ the sail forward drive force
- $R_I$ the hull drag
- $F_{LAT}$ the aerodynamic side force in the horizontal plane
- r the distance between the centre of pressure of the rudder and the centre of lateral resistance measured in the horizontal plane
- h the vertical distance between the centre of effort and the centre of lateral resistance
- d the distance between the centre of effort and the centre of lateral resistance in the horizontal plane

Considering heel angle θ, the equilibrium of moments means we must have:

$$r * F_R \cos\vartheta = F_M * h \sin\vartheta - d * F_H \cos\vartheta$$

(eq.6)

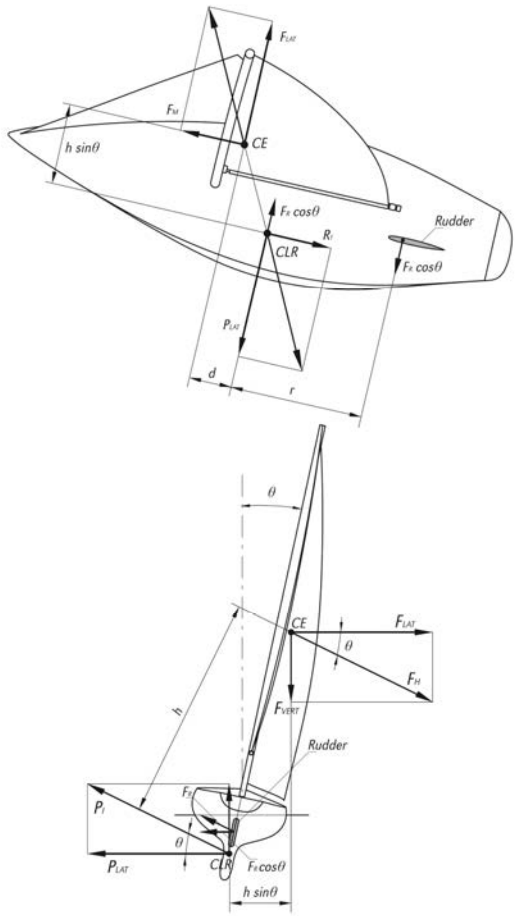



Figure 74

Dividing both terms by cos θ we have:

$$r * F_R = F_M * h * tg\vartheta - d * F_H$$

(eq.7)

and remembering the equilibrium equation

$$F_H \cos\vartheta = P_{LAT}$$
$$F_M = R_I$$

(eq.8)

we can restate the turning equilibrium solely as a function of the hydrodynamic forces:

$$r * F_R = R_I * h * tg\vartheta - d * P_{LAT} / \cos\vartheta$$
(eq.9)

Defining the hydrodynamic drag angle

$$\varepsilon_H = a\tan\left(\frac{R_I}{P_{LAT}}\right)$$
(eq.10)

the forward shift "d = delta CLR" of the Centre of Lateral Resistance which can guarantee the yaw turning equilibrium with neutral helm balance can be evaluated by the following equation setting the rudder force $F_R$=0:

$$d = \tan\varepsilon_H * h * \sin\vartheta$$
(eq.11)

As can be seen this distance d depends on the hydrodynamic drag angle, the heeling arm h and the heel angle θ
In column #5 of Table 3, values of the forward shift "d = delta CLR" evaluated from the towing tank tests are reported so that the corrected Centre of Lateral Resistance position CLR' (expressed as a percentage of LWL aft of station 0) are reported in column #6 for comparison directly with sailplan center of effort position.
Finally, in column #7 of Table 3, the rate of shift of CLR with rudder angle (%LWL per degree) is reported.
Using the position of sailplan center of effort position CE measured in the wind tunnel, we can evaluate the out of balance arm and produce an estimate of the rudder angle required to hold a steady course.
As an example Tab. 4 show the results obtained with reference to the 4 lowers suit of sails S1.

| Heel | speed [Knots] | SF [KN] | CLR' %LWL | CE aft 0 %LWL | Out of balance arm %LWL | Steady rudder angle [deg] |
|---|---|---|---|---|---|---|
| 10 | 10 | 50 | 39.3 | 45.4 | 6.1 | 2.8 |
| 20 | 10 | 100 | 40.6 | 45.4 | 4.8 | 2.4 |

Table 4 - Yacht balance (4 Lowers Sailplan)

These calculations have been repeated for each of the fifteen variations of sailplan geometries tested and obtained results are reported in Tab. 5.
As can be seen mast rake, mainsail size, and headsail size and position lead to an increase of the weather helm angle.
The longitudinal position of the Center of Effort, CE, reported from the wind tunnel tests are for the sails trimmed for maximum driving force at AWA=30 deg. The helm data could of course be re-analyzed with the CE position achieved during the depowering scheme, but this would be associated with a loss of drive.

| Suit of Sails | CE aft 0 AWA=30° %LWL | Steady rudder angle 10° heel | Steady rudder angle 20° heel |
|---|---|---|---|
| S1 | 45.4 | 2.8 | 2.4 |
| S2 | 43.2 | 1.8 | 1.3 |
| S3 | 43.9 | 2.1 | 1.7 |
| S4 | 40.1 | 0.3 | -0.3 |
| S5 | 41.7 | 1.1 | 0.6 |
| S3 JT h1 | 44.4 | 2.3 | 1.9 |
| S3 JT h4 | 43.6 | 2 | 1.5 |
| S3_JTL_h2 | 45.8 | 2.9 | 2.6 |
| S1_JTK_h4 | 49.9 | 4.8 | 4.7 |
| S1_ME | 48.5 | 4.2 | 3.9 |
| S3_ME | 45.9 | 3 | 2.6 |
| S1_rA | 48.7 | 4.3 | 4 |
| S3_rA | 46.4 | 3.2 | 2.9 |
| S1_rA_Jib_Fore | 47.6 | 3.8 | 3.5 |
| S1_rA_Jib_Aft | 49.4 | 4.6 | 4.4 |

Table 5 – rudder angle required to hold a steady course

Finally, it should be noted that the metacentric height and initial sailing stability are directly related to the question of balance. The stiffer the yacht, the higher the equilibrium sailing side force and the lower the hydrodynamic drag angle for a particular heel angle [6]. The position of the resistance vs. side force squared lines in Fig. 73 are fixed by the geometry of the hull, but the sailing side force will migrate left and right as the boat is made more tender (lower side force) or stiff (higher side force) by changes in its center of gravity.

## CONCLUSIONS AND ON-GOING WORK

The present paper focuses on the experimental investigation of the aerodynamics of a traditional square topsail schooner rig, conducted in the boundary layer wind tunnel at Politecnico di Milano University.
The results of this extensive investigation have been presented in detail and the implications of data obtained from this campaign on the design of classic yachts and the ongoing design of SALTS new schooner have been discussed, set in the context of aerodynamic efficiency, helm balance and vessel stability.
It is hoped that a useful contribution is being made to the sail-training world and to the larger body of knowledge related to design and research on traditional square topsail schooner rigged yachts: actually for classic schooner build programs and for many future sail-training projects that will not have the benefit of data obtained from towing tank and wind tunnel

campaigns, the data here presented can be used by designers to take a more rational approach and additional work may lead to useful guidelines for design.
On-going work includes a CFD campaign at the University of Oregon to further study the effect of changes in keel profile on the location of CLR, as a means to inform the design of a final test keel.
Aerodynamic and hydrodynamic data will be integrated for VPP simulation and further design analysis.
Finally data from the wind tunnel will be soon used to begin the analysis of anticipated rig forces, prior to detailed engineering of the rig.

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## ABOUT THE AUTHORS:

**Fabio Fossati** Mechanical Engineer, PhD in Applied Mechanics and Full Professor of Applied Mechanics. He is scientific co-ordinator of wind tunnel testing of sailing yachts at the Wind Tunnel of the Milan Polytechnic. His research work is mainly concerned with numerical and experimental fluid dynamics applied to sailing yachts with special reference to sail plans aerodynamics and hull appendages. He was in charge of testing carried out in the Wind Tunnel for the PRADA Challenge America's Cup team in 2003, for the Luna Rossa team in 2007 and for the BMW ORACLE Racing America's Cup syndicate. In 2010. He is currently Research Associate of the International Technical Committee of the Offshore Racing Congress deeply involved in the ORC International VPP development. At the Polytechnic, he teaches Elements of Fluid Mechanics, Elements of Naval Architecture and Mechanics of the Sailing Yacht of Master's course in Yacht Design at Politecnico di Milano since 2001.

**Stephen Duff** teaches design, structures and occasional seminars on naval architecture in the Department of Architecture at the University of Oregon. Each spring, he directs the Vancouver Architecture and Urban Design Program in Canada. For 24 years, he has worked with the Sail and Life Training Society (SALTS) in Victoria, BC, sailing on SALTS' ships off the coast of British Columbia and on longer deep-sea voyages. He is the society's principal design consultant, and for the last five years has been working on the design of a new sail-training schooner and a series of related research projects. The research agenda includes wind tunnel and towing tank campaigns in England and Italy; aero-hydrodynamic studies using computational fluid dynamics and velocity prediction software; parametric studies of stability; finite element analyses of hull and rig structure; and the development of a suite of bespoke parametric design and analysis tools called *Open Sea*™. He is also an avid whitewater and sea kayaker.

# Manufacturing: The Quissett 12½ Spars
## [Featured in the CYS 2014 DVD]

**Author Alec E. Brainerd**
Artisan Boatworks, Rockport, ME

**Figure 1** – Gaffs with jaws assembled following CNC machining to shape the jaws and cut the slots for the throat halyard tangs; just one of the production line operations enabling completion all of the woodworking in just six weeks.

## Abstract
On January 4, 2012 a storage building at the Quissett Harbor Boatyard in Falmouth, MA, was gutted by fire. Thankfully no one was injured and only three boats were lost. Unfortunately, the most serious damage was in the spar loft where the spars for Quissett Harbor's entire fleet of Herreshoff 12½s were destroyed. The contract awarded Feb. 12, 2012 required delivery on or before June 1st. The task posed many challenges from obtaining the wood to estimating what efficiencies might be gained in such a large production. This paper discusses how Artisan Boatworks faced its challenges and replaced the spars in a timely and cost effective manner.

## About the Author
Alec Brainerd is the president of Artisan Boatworks in Rockport, Maine. Artisan Boatworks is a well-known builder and restorer of classic Herreshoff yachts. Notably, Artisan Boatworks has recently built several wooden H12½ replicas to original specifications.

The Classic Yacht Symposium™ 2014

# Manufacturing: The Quissett 12½ Spars

**Alec E. Brainerd**
Artisan Boatworks,
Rockport, ME

**INTRODUCTION/ BACKGROUND**

On January 4, 2012 a storage building at the Quissett Harbor Boatyard in Falmouth, MA, was gutted by fire. Thankfully no one was injured and only three boats were lost. Unfortunately, the most serious damage was in the spar loft where the spars for Quissett Harbor's entire fleet of Herreshoff 12½s were destroyed.

This paper discusses how Artisan Boatworks replaced those spars in a timely and cost effective manner.

**THE CONTRACT**

The contract between Quissett Harbor Boatyard and Artisan Boatworks Inc., dated barely a month after the fire on February 12, 2012, read as follows:

*ARTISAN to supply Sitka spruce spars and oak boom crutches for Herreshoff 12½s and other boats as listed in the following specifications.*

*Masts: 35 Doughdish, 8 Herreshoff, and 1 Cape Cod. Fitted with masthead cones or shoulders for spliced shrouds, throat halyard blocks, fiberglass chafe bands,* *goosenecks, heel tenons, spinnaker pole rings or track, topping lift block and jam cleats.*

*Booms: 34 gaff-rigged and one marconi-rigged Doughdish (9 w/stainless track). 8 gaff-rigged and one marconi-rigged Herreshoff (7 with bronze or ss track). 1 Cape Cod, and one Haven (both with stainless track). All booms fitted with gooseneck cheeks, sheet blocks, and outhaul blocks & cleats and/or holes for outhauls as required.*

*Gaffs: 34 Doughdish (8 with stainless track), 8 Herreshoff (7 with bronze track), and 1 Cape Cod with stainless track. All gaffs to have laminated, riveted oak jaws, throat toggles to match track, and 3 wooden peak halyard thumbs. After ends rounded, with holes for outhauls. All gaffs with track to have full-length spruce riser. Gaffs without track to have wooden keeper for peak halyard eye splice.*

*Jib Clubs: 34 Doughdish (8 with stainless track), 9 Herreshoff (8 with bronze track), 1 Cape Cod with stainless track, 1 Haven with stainless track, and 2 S-Boat. All jib clubs fitted with forward end sockets and sheet block/bales. After ends rounded with holes for outhauls.*

*Spinnaker poles: 45 octagonal Doughdish/Herreshoff, 2 S-Boat, and 1 Ensign. All Spinnaker poles to have end fittings at each end, and 2 pad eyes in middle.*

*Boom Crutches: 35 Doughdish oak scissor type, 6 Herreshoff oak scissor type, 3 teak Bullseye post type, 4 mahogany Herreshoff post type, 1 S-Boat oak scissor type, and 1 teak S-Boat post type. Scissor type to have hooks riveted to feet.*

*All materials and workmanship are to be of the highest yacht quality. Spars to be of close, straight grain Sitka spruce, solid except for masts, which will be glued in two halves. Spars and crutches shall be delivered to Quissett Harbor Boatyard on or before June 1st, 2012. Spars and crutches to have 8 coats of varnish, all hardware installed, be labeled with boat or owners name, and be ready for rigging. Hardware is to be supplied by Quissett Harbor Boatyard. Specific details, as shown on scale drawing supplied by Artisan Boatworks, and as pertains to individual boats, may be changed as required.*

**THE CHALLENGE**

Quissett Harbor Boatyard owner Weatherly Dorris was intent that her loyal customers receive not only better quality spars than they had lost, but that the new spars be rigged exactly as before, and that those customers not miss a single day of their upcoming season which began in only four months.

Without going into details, I will acknowledge that it was a fixed price contract. It was a challenge to estimate what efficiencies might be gained in such a large production, as well as a bit of a worry if things didn't go exactly according to plan.

**WOOD**

Another challenge for us, and ultimately a primary reason we were awarded the project, was our ability to obtain the required wood.

Many of the spars lost in the fire were those belonging to fiberglass Doughdishes built by Bill Harding and Eddy & Duff, the spars for which were built from Northern White Spruce. Although less expensive than Sitka spruce, it is not nearly as strong, and is readily available in boards pre-planed to 1½″ thick. Therefore, although Herreshoff specifies a maximum mast diameter of 3-3/8″, most Doughdish masts measure just 3″ at the partners.

Weatherly specified Sitka Spruce for the new masts, a wood that has the highest strength-to-weight ratio of any wood (other than bamboo), which is why it was used extensively in the early wood-framed airplanes.

Another important consideration for spar stock was dryness. Sitka Spruce nearly doubles in strength when dried from green to 12% moisture content. And, once dried, any twisting, warping, checking, and splitting will have already occurred, insuring stability of the finished product.

Sitka Spruce grows in a relatively narrow band along the Pacific Northwest coast, and once cut, requires three or four weeks in a kiln to properly dry. Most lumber suppliers who deal regularly with boatbuilders maintain only a limited supply of "spar grade" Sitka, but luckily, Richard Simon at America's Wood in Washington, ME, was able to locate a large batch of sixteen to twenty foot long Sitka Spruce planks, rough cut to two inches thick and from six to eight inches wide—and it was about to emerge from the kiln.

Rich ordered about 10,000 board feet, which was shipped from Washington State, sorted for size and quality, and delivered to Artisan Boatworks on February 28th. Ultimately, 2,123 board feet of Sitka Spruce was used in this project.

**TOOLING**

When considering making many similar parts, one immediately thinks machine. We were aware of spar lathes having been successfully employed by other boatbuilders, and I was looking forward to designing and building one myself. Bernie Shaw (a well-known builder of fiberglass production sailboats such as the Dark Harbor 20 and Wianno Senior) had such a lathe. His shop is located just south of here in Thomaston, so we paid him a visit.

Bernie's lathe consisted of a router mounted on a 30′ long sliding rail whose depth of cut was controlled by a curved tapered plywood pattern screwed to the wall behind it. The wooden "blank" was pre-cut eight-sided and set up with an intermediate bearing which spun on skateboard wheels. The ends of the lathe were from a standard wood turning lathe, and powered by an industrial sewing machine motor that provided a slow and variable speed.

The spar lathe at Shaw Yachts had proven itself to be an impressive timesaver, but we needed to build two hundred and twenty seven spars in ninety-two days—all fully varnished with hardware installed. We did the math, and determined that a lathe would be great if we didn't have the time crunch, but in our case, many hands and a well-refined system was the answer.

**PRODUCTION**

We began by building a laminating table four feet wide by sixteen feet long (the length of a mast) and 30″ high. The masts were to start out as blanks, sixteen feet long and four inches square, glued up in two halves. The dimensions of the table allowed us to glue up ten mast blanks at a time, which were clamped together with closely-spaced plastic-covered 2X4 cross-pieces placed across the ten blanks and secured by eight-inch screws driven through the gaps between mast blanks and into the table.

In a typical morning, once a batch of mast blanks had been glued up, two "shapers" would go to work with oversized worm-drive Skil-Saws and power planes, atop the raised surface created by the glued up masts. We made full-size tapered patterns from quarter-inch plywood for the outside shape which would be laid upon the blank, traced with a ball point pen, and then the taper would be cut to within a sixteenth of an inch with the Skil-Saw whose big blades allowed us to cut through the entire 4 inches in a single cut.

The taper on the first two opposing sides was completed with the power plane, then the spar was rotated ninety-degrees, and the process was repeated. This resulted in a square, tapered blank. Eight siding followed and was laid out using a conventional eight-siding jig and cut with another Skil-Saw set to forty-five degrees—again cut within 1/16″ of the line. As with the tapering, a power plane did the finishing.

Sixteen-siding also was done with a power-plane, but by eye, and the final rounding was accomplished with hollow-soled wooden-bodied hand planes. One person could go from a glued-up square blank to a round tapered spar, ready for sanding, in about an hour. With this technique, two people were gluing up and shaping ten masts per day.

Once the masts were planed round, they were passed on to a crew of four "sanders" who pushed custom-shaped Styrofoam longboards all day every day for a month. These guys would make the final rounding and smoothing with 36 grit sandpaper, then go to 60, and finally to 120 grit.

Efficient material handling was of utmost importance because of our limited space. We made several sixteen-foot-long sawhorses with padded cradles that could be moved to accommodate the length of the spar as it was being shaped and sanded. As batches of spars were finished, they were stacked in custom made racks like cordwood. Once all of a particular type of spar was sanded round, the tenons were cut and the masthead cones were fitted as a group.

While two guys were shaping and four were sanding, we had two additional carpenters laminating the gaff-jaws, making boom crutches, cutting the tenons, and generally completing the woodwork. Forty-three gaffs require eighty-six gaff-jaws. To make these, we made up four laminating jigs, and glued up four jaws per day for twenty-two days so that they would be ready in time for assembly.

Once the jaws were assembled, the gaffs were sent to a local CNC machinist, who shaped the jaws and cut the slots for the throat halyard tangs. With this kind production line operation we were able to complete all of the woodworking in just six weeks.

**VARNISH**

Shaw & Tenney of Orono, ME, make canoe paddles and oars that they varnish by dipping them into a large-diameter pipe filled with varnish. Once extracted, they are hung to dry over a sloping metal tray that drains the excess varnish through the dipping hole and back into the pipe. The resulting finish is perfect except for the small drip at the very bottom that easily can be scraped off. This is the same technique used by wooden fly-fishing rod makers, but we were unaware of anyone trying it with spars as long as sixteen feet.

The film thickness achieved with dipping is equal to about four brushed-on coats, but we needed to find a varnish that could dry at that thickness in a reasonable amount of time. After considerable research, we settled upon AwlGrip's Awlspar Classic M3131—an extremely fast drying, high-build, no-sand, single-part varnish. Using it, up to four full coats can be applied in a single eight-hour day, leaving the spar ready to sand and re-coat the next day.

All the boom crutches, spinnaker poles, and jib clubs were dipped in a 4″ PCV pipe installed in our loft floor, and then hung to dry. We dipped each spar twice, and then lightly sanded and finished each one with a coat of Epifanes high gloss varnish, which has better ultraviolet resistance qualities than the Awlspar. We learned that an extra drying day was necessary between dips, even with the heat cranked up to 72 degrees. When attempting the second dip without the extra drying day, we discovered that the first coat was not dry enough to withstand the Awlspar solvents, and alligatoring was the result.

For the longer masts, booms, and gaffs, instead of dipping, two people would place a spar in holders on the varnish bench where it was suspended it by screws we'd driven into each end. There it would be varnished, starting in the middle and each person working towards an end. After the varnishing was complete, the spar was picked up by the screws and set in the drying rack. The process was repeated with the next spar, and the next, etc. By the time the two varnishers got to the last of a batch of 45 spars, the first one was ready for another coat, and in this manner four coats could be applied in a one day, just as with the dipping.

Handling was the key to this operation. Just consider the space that 45 sixteen-foot long masts take up, all of them freshly varnished and suspended.

**HARDWARE**

The most labor intensive and time consuming aspect of the Quissett spar project was installing the hardware. Some pieces were easy as long as all 45 boats got the same piece in the same place. However, each boat was slightly different. Some had bronze hardware; some had stainless; some got new; some got hardware recovered from the fire; and most had a combination of new and old. Weatherly had put together a spreadsheet with a line item for each boat and a column describing each piece of hardware and where it was to be mounted. We tried to install as much of it as possible in assembly line fashion, but ultimately it became necessary to complete each rig individually, and surprisingly, the hardware and packaging ended up consuming as many hours as spar building and varnishing.

**PACKAGING**

When putting together our bid for this project, it was easy to say "Sure, we'll deliver them for you!" We handle spars for boats of this size all the time, usually transporting them in padded cradles atop the boat, or on the padded roof rack of our truck.

However, packaging 45 individual rigs, each consisting of five spars and a boom crutch, in such a way as to not damage them, proved to be a monumental task. Every spar had protruding hardware, and for three days Artisan Boatworks more closely resembled an Amazon.com shipping warehouse than a boatyard. Using literally thousands of feet of plastic bubble wrap, each spar was individually wrapped, then bundled together and labeled with the boat's name, and stacked on a flatbed trailer.

**CONCLUSION**

The Quissett spar project at Artisan Boatworks was particularly interesting when compared to the techniques that might have been employed by HMCo. Labor was comparatively inexpensive back then, and labor laws allowed for an average sixty-hour workweek. Rather than investing in expensive tooling, as a modern automobile manufacturer does today, HMCo employed systems that allowed many men to work simultaneously on a single project.

ALERA, the first boat of the New York 30 class was built in just six weeks from contract signing, and wooden fishing and cargo schooners of that era were known to have been built outdoors in a matter of four to six weeks. These vessels were not built with labor-saving machinery or super-human carpenters, but with many skilled workers and extremely well organized methods.

**ACKNOWLEDGMENTS**

Thanks to Weatherly Dorris and her crew at Quissett Harbor Boatyard. While working tirelessly to rebuild the boatyard, their customers' interests always came before their own.

Thanks also to Steve Holt at Shaw & Tenney and Tim Taylor at Awl Grip for their technical assistance.

Thanks to Maynard Bray for his editing.

Most of all, thanks to our hardworking crew at Artisan Boatworks for a job well done.


**ABOUT THE AUTHOR:**

**Alec Brainerd** is the president of Artisan Boatworks in Rockport, Maine. Artisan Boatworks is a well-known builder and restorer of classic Herreshoff yachts. Notably, Artisan Boatworks has recently built several wooden 12½ replicas to original specifications.

The Classic Yacht Symposium™ 2014

# Herreshoff Centennial Papers

## [Featured in the CYS 2014 DVD]

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## Herreshoff Tradition: a Modern and Not Just an Historical Phenomenon

**by Fabio Fossati Dept. of Mechanical Engineering, Politecnico di Milano**

Personal thoughts on the relevance of the Herreshoff Centennial Designs to yachting today, including the author's discussions with Olin Stephens. Written by an internationally recognized researcher in the application of fluid dynamics to sailing yachts and leader of wind tunnel testing of America's Cup yachts.

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## Herreshoff 12½ Footer

**by A. Sidney DeWolf Herreshoff**

Written by Sidney Herreshoff May 12, 1974 this paper was first published in the Herreshoff Marine Museum Chronicle Vol. 13, Spring 1985. No one knew the H12½ better than Sidney; he trialed the first boat in December 1914 and was a leader in the evolution of the class over its 30 years of production at the HMCo. In this paper Sidney discusses the origins, design, construction and performance of the class.

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## The Herreshoff 25s, The Beverly Yacht Club and Buzzards Bay - 1914

**by David Cheever**

Reprinted from Herreshoff Marine Museum Chronicles Vol. 23, 1994. A brief account of an outstanding effort to establish a 25-foot waterline one design racing fleet at Beverly Yacht Club in 1914. It never fully flowered and is peppered with "ifs" and "might have beens". It is offered as a matter of historical record.

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## The BB25 ARIA

**by Herreshoff Museum Staff, Ed McClave and Paul Bates**

This three-part paper begins with the 1994 Herreshoff Marine Museum Chronicles article of the donation of ARIA by Paul Bates. Following is an extract from Ed McClave's CYS 2014 BB25 paper discussing the strategy of MP&G's 1992 "museum restoration" of ARIA. In part three, Paul Bates reports on the additional work planned for 2014 to complete ARIA as an improved and more complete museum exhibit for the class centennial. Attend the Herreshoff Regatta this summer to see the results.

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## The H12½ BULLDOG – Origins and Refurbishment for Museum Display

**by Curator Carlton J. Pinheiro and David P. Curtin**

The paper begins with the 1979 account by curator Carlton Pinheiro of the donation of BULLDOG to the museum, the origins of the Buzzards Bay Boys' Boats and a brief construction history of the class. In the second part David Curtin, member of the Herreshoff Marine Museum Board and Chairman, Collections & Exhibits Committee, reports on the current restoration of BULLDOG for the class centennial. Work on BULLDOG was desirable as a number of issues existed in her condition- structural problems (e.g. sprung planking), matters of detail (e.g. plywood replacement of bulkheads, non Herreshoff fittings) and finish (e.g. peeling varnish and deck covering). The new work is guided by a set of principles;

- Refurbishment to display standards representing the boat as close to "as-built" as possible
- Retain as much of the original wood as possible to reflect its usage history.

# PROCEEDINGS DVD

– See you in 2016 –

The Classic Yacht Symposium™ 2014

# Herreshoff Tradition: a Modern and Not Just an Historical Phenomenon

**Fabio Fossati**
**Dept. of Mechanical Engineering, Politecnico di Milano, Milano - Italy**

## BACKGROUND

This short note was inspired by the beautiful opportunity offered by the Herreshoff Marine Museum/SNAME team invitation to participate in the 2014 Herreshoff Centennial Celebration. Strolling and browsing into the Herreshoff Marine Museum website I found really exciting, as was done in CYS 2012, the purpose also for the 2014 CYS edition to feature classic Nat Herreshoff designs that are celebrating 100 years- which this year means, on closer view, no less than three Herreshoff Centennial Classes: Newport 29, Buzzards Bay 25 and Buzzards Bay Boys Boats (H12½). And, on top of all that, a few hours later the # 8 issue of *Yachting Quarterly* magazine (summer 2005) entirely devoted to Herreshoff Mfg. Co. winked at me while I was looking for another volume in my bookshelf ….

In the following I will try to sketch out some personal thoughts I would be pleased to share with the thousands of people who have a connection to these boats and more important to people nowadays involved in yachting in general, taking into account the mental outlook induced in this world of specialization and compartmentalized marketing.

## PERSPECTIVE

That's how it goes sometimes: in the dark age of modern cruising boats with the features of "half hull missing" (in particular from the max beam section to the stern) equipped with Biminis and oxygen tents, two steering wheels (at least), and by topsides featured as camping vans- **the three classic Nat Herreshoff designs** celebrating 100 years in 2014 give us pause for thought about the emerging movement in which a number of new boats are being built to original centennial designs!!
What's up?

As mentioned above, new boats have been built in the ALERION class, as have several Buzzards Bay 25s and a dozen Herreshoff 12½s. To complete the list of designs celebrating 100 years in 2014 (among the several hundred designs produced by Nat Herreshoff in his more three-quarters of a century active yacht design) the Newport 29 Cruising Class often pointed out as Capt. Nat's best all-around design, the recent case of IOLANTHE makes her very much part of this movement, to say nothing of replicas of the big schooners like ELEONORA and ELENA. What all of this means is the Herreshoff tradition is becoming a modern and not just an historical phenomenon and it's out of the question if these classic designs are reinterpreted in modern or traditional construction methods and/or using modern or traditional materials.

I would like to underline we are focusing and talking about "classic" i.e. new boats built according the original spirit in a faithful manner by leaving the design essentially unchanged. This is completely different from the "modern classics" we have learned to live with, which might be classic by the looks, but are a new design. And last but not least, leaving the design essentially unchanged means also that despite the construction material and method used the new boats must be identical in every aspect and can therefore race competitively as one-designs.

I previously mentioned one of my favorite *Yachting Quarterly* magazines, the summer 2005 issue entirely devoted to Herreshoff Mfg. Co. Almost at the end of the volume it is said that Rod Stephens, co-designer of J-Class RANGER with his brother Olin, after the 1937 America's Cup visited Nat Herreshoff in Love Rocks This reminded me of another case that it is worth mentioning here concerning another example of new boatbuilding according to original design.

In 1932 a committee composed of members of local yacht clubs around Long Island Sound was formed, including members of Seawanhaka, Larchmont and American Yacht Clubs. Their goal was to develop a new class of racing sailboat to compete with Sound Interclub and Atlantic classes. One of the proposals was the Olin Stephens Dark Harbor 20, a 30-foot one-design class sloop; a pretty boat with long overhangs, a fin keel and a fractional Bermudan rig. Twenty-one Dark Harbor 20s were built in the first half of the 20th century. Most of them exist today and are still sailing in the waters of Maine.

Figure 1 Dark Harbor 20 (Sparkman & Stephens)

In 2005 the enthusiasm for this 75-year-old design and the desire to continue the tradition of this one-design class sloop gave rise to a new project between the members of the Tarratine Club, Sparkman & Stephens and Shaw Yacht of Thomaston, ME leading to the reintroduction of Dark Harbor 20, which had to be constructed for the first time in modern fiberglass materials on a production basis at a very reasonable cost.

At that time I had the opportunity to be in touch with Carl Persak the Naval Architect in the S&S office who was in charge of the DH 20 project and he explained the new boats were modelled by Sparkman & Stephens who documented the existing wooden boats thoroughly so that the GRP versions were identical in every aspect, and could therefore race competitively as one-designs.[1]

Obviously if construction material is changed "conformity to originals" means that new fiberglass models have to be designed to match the weight and stability of the original fleet and, as previously mentioned, this is a key point aiming for a "classic" reintroduction and not for a "modern classic".

I had also the great opportunity to discuss in person with Olin Stephens about the genesis of the design of the Dark Harbor when we met during the Argentario Sailing Week in 2006 (Figure 2).

Figure 2 Olin Stephen and the author at the Argentario Sailing Week

That was really a great chance for me linked above all to the extraordinary chance that life has given me to combine the abiding passion for sailing yachts with my professional role as a university researcher and lecturer and, in particular, with the privilege of holding the post of scientific co-ordinator of experiments on sailing yachts at the Milan Polytechnic Wind Tunnel.

Dark Harbor 20 was based on a boat called GIMCRACK a 34'-6" LOA, 23' LWL low-profile day sailer that the company produced in 1932 which had a significant impact on S&S's future designs. The reason for this was that Olin Stephens and the Davidson Laboratory at Stevens Institute developed a full experimental program combining full scale sailing testing and tank tests on scale model with the intention of determining sail coefficients and predicting performance of sailing vessels. *"This, the design for GIMCRACK and the Dark Harbor 20s was really kind of a pioneering job"* he told me and *"having the ability to test a model in a tank at a relatively low cost made it possible to check a lot of new ideas and to make some real progress"* explained Stephens.

Well, you astonish me!!

[1] For a full discussion of the integration of the new DH 20 hulls with the original boats see CYS 2006, *One Design Fleet Management: Maintaining and Preserving the Dark Harbor 20 Racing Fleet through the Pragmatic Application of Technology,* by Nakomis Nelson

Look at the figure below: it shows Capt. Nat placed on a gangway installed at the bow of his motoryacht HELIANTHUS that is towing a scale model!!

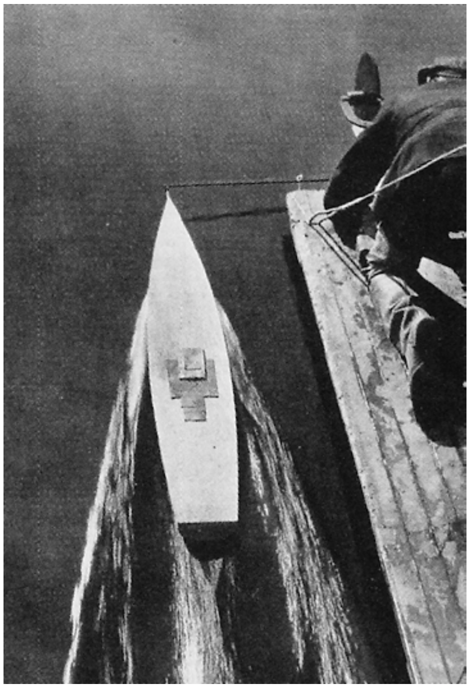

Figure 3 Scale model towing test (taken from [1])

It's simply charming …It's about how much the key of success of some Capt. Nat's best designs, the lines of their hulls, appendages, rigs and sail trimming systems has been influenced not just by his tastes and his aesthetic sensibilities, that in different periods have accompanied the development of his designs, but also by his ability, to work in a mix of "science" and "art". Even before the growth of the methods for calculating yacht performance which came not before the Thirties as demonstrated by the GIMCRACK case.

**CONCLUSION**

In conclusion I really believe the best way to celebrate classic Nat Herreshoff designs of 100 years is to give recognition to the fact that the Herreshoff tradition is becoming a modern and not just an historical phenomenon.

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**ABOUT THE AUTHOR:**

**Fabio Fossati** Mechanical Engineer, PhD in Applied Mechanics and Full Professor of Applied Mechanics. He is scientific coordinator of wind tunnel testing of sailing yachts at the Wind Tunnel of the Milan Polytechnic. His research work is mainly concerned with numerical and experimental fluid dynamics applied to sailing yachts with special reference to sail plans aerodynamics and hull appendages. He was in charge of testing carried out in the Wind Tunnel for the PRADA Challenge America's Cup team in 2003, for the Luna Rossa team in 2007 and for the BMW ORACLE Racing America's Cup syndicate in 2010. At the Polytechnic, he teaches Elements of Fluid Mechanics, Elements of Naval Architecture and Mechanics of the Sailing Yacht at Master's course in Yacht Design at Politecnico di Milano from 2001. And, needless to say, he is also a keen sailor!

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# Herreshoff 12½ Footer

Written by Sidney Herreshoff May 12, 1974, this paper was published in the Herreshoff Marine Museum Chronicle Vol. 13, Spring 1985

Sidney Herreshoff, NGH's oldest son, trials the first H12½, December 1914 (HMM archives)

While managing the campaign for RESOLUTE during the trials in the summer of 1914, Robert W. Emmons got my father (Nathanael G. Herreshoff) to design a small ballasted, sloop rigged boat that would be suitable for teaching small boys how to sail and to become familiar with the characteristics of the type of larger boat to which they would later graduate.

Mr. Emmons had a summer home on Toby's Island at the head of Buzzards Bay. He had several friends from the vicinity of Boston who also had summer homes at the head of the bay. Thus, there were plenty of children who could make good use of such a boat there. At first, the class was known as "Buzzards Bay Boys Boats".

The order for the first fleet of these boats was received by the Herreshoff Manufacturing Company in the autumn of 1914. The first boat was ROBIN, HMC Building No. 744 built for Stuart Duncan at the price of $420. There were 19 boats in the first fleet with building numbers running consecutively to No. 762.

Although these boats have very ample stability afforded by heavy fixed ballast, it is possible to swamp them on account of the large open cockpit. For this reason a large airtight compartment was provided by a watertight bulkhead just forward of the mast. The theory was that although the boat would be out of trim when swamped, she would stay afloat long enough to be towed to shore. This proved to be true at first, but after boats aged, the airtight compartments became unreliable and a few boats were lost. As an additional precaution, the side seats consisted of four buoyant cedar boards which would float free to serve as life preservers. Many years later, once Styrofoam became available, it has been used to give the old boats sufficient floatation.

Of course, originally the gaff rig was used, and still is in use on Buzzards Bay. However, in the early twenty's, there was a call for jib headed "Marconi" mainsails. Several boats were provided with masts extending to about the height of the peak of a gaff rig. The "leg o mutten" mainsail used the original boom and the original jib was continued.

Shortly before World War II, a fleet of 12½ footers was built for Fishers Island. Although built on the same molds, these boats differed from the original by having a short after deck on a level with the sheer and with the tiller raised above this level. This gave more stowage aft. There was no bulkhead so the space forward of the mast was available. Floatation was provided by copper tanks under the side seats. Also my father suggested moving the coamings inboard to provide a wider side deck and thus reduce the likelihood of swamping.

Following the war, after the Herreshoff Manufacturing Company went out of business, the Quincy Adams Yacht Yard built 12½ footers on the original molds and from the Herreshoff drawings. Later this privilege was turned over to Cape Cod Shipbuilding Company. They provided the standard wood 12½ footers until changing to fiberglass construction. At that time, I was commissioned to convert the design to fiberglass and make any improvements I saw fit. The same hull form and ballast was used as with the wooden boats. The cockpit and coamings were very similar to those of the Fishers Island Class, but a raised cabin deck was provided at the forward end of the cockpit. Floatation was provided by a large built in compartment under the cockpit floor so that, with the cockpit flooded, the boat floats on an even keel with considerable buoyancy and stability.

A. Sidney DeW. Herreshoff
May 12, 1974

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# The Herreshoff 25s
# The Beverly Yacht Club and Buzzards Bay- 1914

Reprinted from Herreshoff Marine Museum Chronicles
Vol. 23, 1994

**David Cheever**

**ABSTRACT**

This is brief account of an outstanding effort to establish a 25' waterline one design racing fleet at Beverley Yacht Club in 1914. It never fully flowered and is peppered with "ifs" and "might have beens". It is offered as a matter of historical record.

**INTRODUCTION**

Herreshoff was already the outstanding designer-builder name to conjure with when our story starts in 1914. The Beverly Yacht Club started north of Boston close by Marblehead in 1872, featuring small boat racing. The move to Buzzards Bay was clearly motivated by the fine sou'westers most summer afternoons produced. The calms and fickle breezes in Massachusetts Bay could not compare to the robust breezes south of the cape.

By 1914 when the story begins, the Beverly yacht Club had been through various phases which included catboats, knockabouts and sloops, before waking up to the fact that the greatest good for the greater number could be achieved by several one design classes which avoided the financial pitfalls of over-designing and over-building. After all, it was the rare boat that had a first class racing record after more than four or five years of stiff competition in an open class.

The famous Herreshoff 15 footers started the ball rolling in 1899 with credits to Herreshoff's genius, plus helpful arranging by Emmons, Parkinson and Stackpole. Tradition always had it that the 15 footers had a little of the "COLUMBIA" in their lines and the same applied to the 18 footers. Both classes characterized by long ends which gave them speed and bearing when heeled over in a thrash to windward. To be truthful, this characteristic was not an unmixed blessing, because both classes took a punishing beating in the stiff chop involved in a "stiff sou'wester". Crews were limited to three in these classes.

By 1914, it became evident that long ended small yachts must have changes made because of drooping ends, or hogging, and tendency to leak when unduly punished.

Captain Nat had the answer n his plan. It involved short ends, more freeboard, plus moderate draft for Buzzards Bay conditions. Robert Emmons had been looking for the ideal adolescent-adopted small-racing boat. The result was the tremendously successful 12 footers, which stand as a class alone, after 79 years! Its success was in sou'wester chop, and the genius that was Herreshoff.

The stage was set for an enlarged one design class that would fill the need for mature crews.

**TWENTY-FIVE FOOT HERRESHOFF SPECIAL**

The resulting class measured 32 feet LOA; waterline 25 feet; beam 8 feet 6 inches: draft 3 feet without a centerboard; outside fixed ballast 3000 lbs.; sail area not over 550 square feet.

It is worth taking a look for a moment at the 18 footer previously referred to. They looked for all the world like an enlarged 15 footer, but were 29 feet overall, 8 feet 1 inch beam, draft 3 feet without a centerboard, outside fixed ballast 2,000 lbs., 470 square feet sail area.

It will be quickly noted that the 25 footer with sweet forward lines coupled with short forward overhang made for a much more sea kindly line than the long overhang of former one designs.

Herreshoff Special Class 25 ft. numbered five boats in 1915.

- D.O. VITESSA- Galsenstone
- D.1. WHITE CAP- Wm Amory
- D.2. MINK- Howard Stockton, Jr.
- D.3. BAGATELLE- F. L. & G. B. Dalaney
- D.4. TARANTULA- W. H. Langshaw

These boats raced for four seasons. Season championships are as follows:

- 1914- MINK
- 1915- BAGATELLE
- 1916- MINK
- 1917 until 1920 no racing (WWI)
- 1920- MINK

**AUGUST 1, 1914**

The 1914 season was distinguished by a unique incident, which points up the "ifs", and "might have beens" referred to at the beginning of this account.

The date in question was August 1, 1914, and the facts were related to me by fine old Robert Stone who came to be a close friend in Dedham in the 1970s. On the day in question, the judges for the race were G. P. Robinson and Howard Stockton, Jr. Their report reads "Wind..whole sail southwest, changing to a very heavy N.W. squall; then whole sail south west".

There were four boat classes racing in different directions in the upper reaches of the Bay. In the 25 foot Herreshoff Special Class were MINK, BAGATELLE, VITESSA and WHITECAP. These four were closely bunched and were having their hands full for they were carrying whole sail in a reef breeze. There were three members in VITESSA'S crew. Two of the three men were members of the Stone family and the third was a professional boatman who worked for the family. Bob Stone was about 14 at the time and was not very experienced so was left ashore because three strong men were needed. With no warning the lowering sky became black. The wind shifted almost 180 degrees and all hell broke loose. Strangely enough the 25s found themselves in the middle of a twister. The rain came in blinding sheets and sails were doused on the run. There was no time to secure the crotch; the boom came crashing down over the cuddy and the gaff followed it. The crewman, knowing that there was no time to pass stops, jumped on the gaff and boom with mainsail between and lying on his stomach, wrapped arms and legs around the mainsail, trying to hold it down. Bob Stone was told that, owing to the twister action, the two spars were blown upward on the mast, leaving the struggling man in a perilous position. The whole episode took less time than it takes to write about it. The rest of the crew got the spars on deck again. The crewman was unhurt. The VITESSA was half full of water and it took some time to clear her, for the twenty-fives were not made with self-bailing cockpits. This was in the of interest of keeping the crew weight down low and on the assumption that the new design was so stiff that the vessel wouldn't ship water and it wasn't assumed that she would be caught out in a miniature hurricane!

Right here it should be noted the twister was narrow and localized. The other classes were shaken up, but unharmed and only one other boat withdrew.

**CONCLUSIONS**

This mishap could not have come at a worse time for the fledgling twenty-fives. The middle of the first season of a new design with everyone watching from the porch of the brand new clubhouse. It involved people who were skilled, substantial members, and whose judgment was looked up to. Herreshoff never built another boat for this particular class, and the pendulum started to swing to self-bailing cockpits. Not completely though, because the noble "S" class which appeared in 1919 was a deep cockpit design and one which has given great satisfaction in spite of the curved mast which made reefing a complicated safety measure!

The old 25s were going their unheralded way and even today four of the five are in existence and in good hands. The only missing boat is TARANTULA, which disappeared from the Beverly Book in the 1920s. Many of us would like to find her and hopefully in original condition!

If it weren't for the "ifs" and "might have beens", the class would be appealing today. Day sailing is becoming more and more popular again, while short cruises are a complicated procedure.

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# The BB25 ARIA

Figure 1- Restored ARIA in 1993 ready for delivery to the Herreshoff Marine Museum
[All photos courtesy of Paul Bates]

**ABSTRACT**

This paper about ARIA is presented in three parts. First is a 1994 account from the Herreshoff Marine Museum Chronicles of the donation of ARIA by Paul Bates. Second is an extract from Ed McClave's CYS 2014 BB25 paper discussing the strategy of MP&G's 1992 "museum restoration" of ARIA. In part three Paul Bates brings us up to date with a report on the work planned for 2014 to improve the representation of ARIA to the "as delivered" condition for the class centennial.

**ARIA DONATED TO THE MUSEUM**
**Reprint from Herreshoff Marine Museum Chronicles Vol. 23, 1994**

In 1992, Paul Bates of Noank, CT donated his Buzzards Bay 25, ARIA (ex. WHITE CAP- HMCo #738) to the museum. Paul had owned ARIA for 22 years and during this time, lovingly maintained and sailed her. He participated in such events as the Herreshoff Rendezvous and Classic Yacht Regattas. She was, however, beginning to show her 80 years and needed a fair amount of structural rebuilding. Wishing to preserve as much of the original construction as possible for future generations Paul Bates donated her to the museum for display and research.

Shortly thereafter, the museum commissioned the restoration shop of McClave, Philbrick and Giblin to remove old restoration components and return her to an original 1914 configuration. The final element was to give her a fresh coat of paint in the traditional Herreshoff color scheme of green bottom, white topsides and buff deck.

In June 1993 ARIA returned to Bristol looking as good as she did on launching day in 1914. Within the museum's Hall of Boats ARIA continues to provide inspiration to other Buzzards Bay 25 owners and all Herreshoff admirers.

We are grateful to Paul Bates for his devotion to a special boat and desire to preserve a unique example of our yachting heritage.

**ARIA – 1992**
**Extracted from the CYS 2014 Paper- The Restorations of the Boats of the Herreshoff *Buzzards Bay Twenty-Five Class* by Edward McClave, MP&G**

ARIA (ex-WHITE CAP) was tired and no longer sailing by the late 80s. By an agreement between her owner, the Herreshoff Museum, and another donor, we performed what we call a "museum restoration".

While our business revolves around restoring old boats to entire new sailing lives, that process usually entails replacing a lot, sometimes almost all, of the original structure. I mentioned above the value of old boats as repositories of destructive test data about which construction techniques worked and which did not. We feel strongly that very original, particularly interesting examples of some early boats should not be restored, but should be preserved in museums so future generations can also have the benefit of observing first-hand the effects of age on the particular construction techniques

The intention with ARIA was to make the boat a presentable and interesting exhibit, showing her in her original configuration, without replacing any original material or affecting her value as an historical artifact.

Figure 2- ARIA arriving for restoration at MP&G with rectangular house in place

ARIA's cabin had been altered from the familiar Herreshoff pointed cabin to a rectangular house at some time in her past. She had also been through a few rig changes, but surprisingly, had ended up, after some trading between boats of the class, with an original gaff rig from another boat of the class. We filled in the enlarged hole in the deck by adding to the existing deck planks and then built a new cabin in place on the restored deck. Since ARIA was intended to be a display-only restoration, we did not replace any deteriorated structure. She was cosmetically spruced up to look like she would have looked in her early years. She is on display in the Hall of Boats at the Herreshoff Marine Museum. Her original boom and gaff have been retained so she can eventually be displayed with a stub mast and a mainsail and jib furled on their booms.

Figure 3- Cockpit looking aft in early stages of restoration

Figure 4- Restoring the deck before fabricating the new cabin

ARIA's restoration was not extensive enough to allow any restoration of sectional shape or any adjustment to the sheer. And, in a museum restoration of that type, changes in the hull shape over the course of a boat's lifetime due to aging processes are in fact interesting pieces of destructive test data that should be retained.

Figure 5- ARIA completed in 1993 without adjustment to restore as designed sheer

**2014- COMPLETION OF ARIA'S "MUSEUM RESTORATION" FOR THE BB25 CENTENNIAL**
**By Paul Bates**

The intention has always been for ARIA to be exhibited at the Herreshoff Marine Museum, presented as she was constructed - as close as possible to the day she left Bristol - retaining as much original material as possible.

The lower section of an original mast will be installed in ARIA. This artifact is the recent donation to the Herreshoff Museum of the lower seven and a half feet of one of the five original Beverly Yacht Club "Herreshoff Special Class" sloops, MINK, a sister of ARIA.

This section, donated by Kay, Sue and Jim Chester of Groton CT in memory of their brother Archie Chester, comes with a story, of course. During the Hurricane of 1938 MINK was moored off Shennecossett Yacht Club in Groton. Sam Jones Sr. was aboard during the storm, intending to ride out the hurricane on the mooring. At the height of the storm the mooring pennant parted, and Sam sailed the boat under bare poles through the fleet and up into the flooded marsh. (Meanwhile, his wife Shirley was aboard their Star Class sloop with the same intention of riding out the storm. Realizing the sloop would not survive on the surface, Shirley deliberately capsized (and saved) the Star boat at the mooring and floated herself to shore). MINK's spar was broken, and the Chester's grandfather Captain A.J.A. Chester repaired the mast with a new lower section and an exquisite three-foot long "wolf jaw splice". Archie's father later built the remnant butt of the original mast into a bookcase in the gable end of Archie's boyhood attic bedroom, where it remained until recently. While MINK's repaired mast is in use today as the spar for another of the Herreshoff Special Class sloops, BAGATELLE, this original butt section will be used in ARIA for her exhibit.

In the Fall of 1948 Roger Taylor's father obtained ARIA, which at the time had a Six-Meter Marconi sloop rig. In 1951 the Six Meter rig was traded with Sam Jones for MINK's original gaff rig. (Sam Jones, then owner of MINK, had the original gaff rig in storage having replaced it with an S&S designed Bermuda Sloop rig.) So, MINK's gaff rig went to ARIA and stayed with the boat through Paul Bates' ownership and donation to the museum. Though the original (repaired) mast is now in BAGATELLE, as noted above the plan is to install MINK's original butt section in ARIA, along with her original boom and gaff. A new jib club, spinnaker pole and boom crotch will complete the spars for ARIA's presentation.

Eight blocks, two spar fittings, seven deck fittings, four cleats and a traveler are needed to complete ARIA's hardware for presentation. Her original poured socket turnbuckles will be installed, and appropriate cotton and manila running rigging installed.

With respect to the traveler, the design specifies a thirty-six inch long jib sheet traveler and a thirty inch long main sheet traveler. Later in her career ARIA was campaigned with loose-footed jibs and genoas, and the thirty-six inch jib sheet traveler was relocated aft for main sheet use. During restoration for the museum, the jib sheet traveler was returned forward to its correct service. A correct thirty inch main sheet traveler will be installed for her presentation.

With this work completed, ARIA will as closely as possible represent the 1914 HMCo racing sloop that she is.

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# The H12½ BULLDOG –
## Origins and Refurbishment for Museum Display

Figure 1- H12½s stored and ready for delivery in the early 1930s

**ABSTRACT**

This paper about BULLDOG is presented in two parts. First is a 1979 account by Curator Carlton Pinheiro of the donation of the 12½ footer BULLDOG, the origins of the Buzzards Bay Boys' Boats and a brief construction history of the class. In the second part Dave Curtin, member of the Herreshoff Marine Museum Board and Chairman of the Collections and Exhibits Committee, reports on the current restoration of BULLDOG for the class centennial.

**12½ FOOTER DONATED**
**By Curator Carlton J. Pinheiro**

Reprinted from Herreshoff Marine Museum Chronicles
Vol. 1, No. 2 Fall 1979

William J. Strawbridge has donated the 12½ footer BULLDOG to the Herreshoff Museum. Mr. Strawbridge, a well-known yachtsman and syndicate manager of the successful America's Cup defenses of INTREPID in 1967 and 1970, has long been a Herreshoff yacht enthusiast, having owned the M Class sloop ISTALENA and the 12 meter MITENA, among others.

BULLDOG, more recently named HEFFALUMP, was retired by Mr. Strawbridge in the fall of 1977 after winning the Davenport Hayward Race. This race is between boats of greatly varying size and is conducted with a staggered start. The victory was a fitting conclusion to BULLDOG's successful racing career under Mr. Strawbridge since he acquired her from the original owner about 1938.

According to the Shop records, BULLDOG, hull #992, was contracted on December 1, 1925 and delivered in the spring of 1926 as one of six listed as "Larchmont Class". She carried a new leg o' mutton rig and was delivered to Henry L. Maxwell at a cost of $1000. This class boat was 15′6″ LOA, 6′0″ beam, 2′6″ draft, 1500 lbs., with a 750 lb. keel.

The 12½ footer class was started in the fall of 1914 when Robert Emmons of Monument Beach, Cape Cod asked N. G. Herreshoff to design and build a safe and seaworthy small boat for training youngsters on the waters of Buzzards Bay. The first group of 19 of the "Buzzards Bay Boys' Boats" sailed in the season of 1915 and became an immediate success. The hull numbers were #744 to #762. A number of the "first editions" are still actively sailing and NETTLE (#762) is on exhibit in Mystic Seaport. These gaff-rigged "first editions" are easily distinguished by a rowing thwart and no seats forward.

A choice of leg o' mutton or gaff rig was offered in the mid 1920's. The gaff rig remained popular on the Cape, and Marconi fleets sprang up on Narragansett Bay, Marblehead, North East Harbor, and Fishers Island. The class has been designated as Buzzards Bay Boys' Boat, 12½ WL "J & M", Buzzards Bay Class, Herreshoff 12½ Footer, Herreshoff 12 Footers, H-12, Bullseye, Narragansett Bay Class and Doughdish.

Starting on October 3, 1914, the Herreshoff Manufacturing Company built about 390 of these famous boats. Hull #1518, the last Herreshoff made 12½ was contracted on June 16, 1943. The famous oak trim was changed to mahogany about 1936, but the boats remained basically unchanged during the almost three decades of construction. Prices varied from $420 in 1914 to $1000 in the 20's to about $800 in the 30's to $775 in the 40's.

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**2014 REFURBISHMENT of BULLDOG**
**By Ballentine's Boat Shop,**
**Commentary by David P. Curtin**

The 12½ BULLDOG, has been on display at the Herreshoff Marine Museum since her donation in 1977. Her condition was as presented at the end of her last sailing season and her rig had been changed to gaff headed, popular amongst the class in many areas and as originally presented for the first boats. In 2013 a new display was developed to showcase the Active Herreshoff Racing Classes of today. Prominent are the H12 ½ and the S Class. This brought heightened attention to the Herreshoff 12 ½ and along with the Centenary of the boat in 2014, it was decided to undertake works to better present her for viewing and study.

Work on BULLDOG was desirable as a number of issues existed in her condition and general state. These included structural problems (e.g. sprung planking), matters of detail (e.g. plywood replacement of bulkheads, non Herreshoff fittings) and finish (e.g. peeling varnish and deck covering). At odds were the classic concerns around restoration versus preservation, getting the boat to be more representative of the original as built and "tidying her up" without losing her aged character or making her "all glossy and new like". Through discussion with the interested parties it became clear that everyone had similar clarity of vision as to the desired outcome but preparing and agreeing on a detailed work-order was very impractical. For example, how much repair work if any should be done to the bright works? To refasten or not; re-timber or not? How to describe the works, whether to remain with the flaking varnish "character/patina", keep the patina, remove the flaking varnish but don't refinish the wood, strip/refinish and varnish but don't end up looking all new and unused? Paradoxes abounded! To resolve these concerns we chose to progress with a set of desired outcome principles and then to rely on the selection of very experienced experts and boatyard to attain the expectation.

Ballentine's Boat Shop, in conjunction with Doughdish LLC became a natural choice as they have restored and cared for a great variety of Herreshoff 12½s for many years and have a significant range and depth of expertise. They also now build the H12½ replica, the Doughdish. To describe the required work we settled on the principles basis through discussion and the concept of a "refurbishment" to display standards representing the boat as close to as-built as possible while retaining the aged and used wood characteristics. Similarly as much of the original wood (coamings, sidedecks, transom, toerails, floorboards and timbers etc.) would be retained as possible to reflect its usage history. The boat should be back on display by the time of this publication.

Following is a description of some of the findings and approaches. The boat was initially chosen amongst four candidates as being the most representative and "retrievable" with original wood and with integrity of form. On arrival at Ballentine's the boat was completely stripped with the removal of all extraneous fittings and materials such as plywood bulkheads, deck covering and toerails. The deck was found to have been fiberglassed in places. The coamings were original; made of two single pieces of oak, well worn and thinned over time. They were framed in place before being lifted off as one single unit to preserve their delicate structural integrity and allow better access for work including refinishing the deck. The hull was stripped inside and out, as was the transom that had been painted to deck level with the uppermost crown area left bright.

The hull planking was sprung in several places. Seams were cleaned out, old fastenings removed where possible and then refastened in all areas of question. It was agreed not to replace the timbers, but to work with what was in place as the original. An excellent outcome was achieved that now has the original sprung planks refastened to their original timbers.

The transom was more problematic in that it had three difficult issues which were made all the more so with the desire to finish it bright to show its structure. These were extensive blackening from the iron drifts joining the transom boards, opening of the board joints and an area of black rot eroding the wood especially over one of the iron drifts. This led to splining the board. The transom is now finished bright and displays how a transom would have looked, along with all of its history of scars in one of its last seasons, before the inevitable decision to resort to fillers and paint. The complexity of repairs clearly illustrates why owners went to painted transoms, especially in their lower areas – as BULLDOG's transom had.

The decking was structurally in good condition once all the plasticized covering – not canvas – and fiberglassing was removed. It was refastened, filled and canvassed with #10 cloth before painting. The bulkheads were rebuilt and planked horizontally with 3/8″ cedar and the aft one fitted with a hatch. The forward bulkhead has no hatch as it formed a watertight flotation compartment. The original air venting plates remain intact for the forward compartment. The original seats are being refinished and will sit on new seat supports based on original design. The oak coamings and signature oak sheer strake were carefully prepared with light staining to preserve their patina and age earned nicks and scratches before satin varnishing. The hull will be finished in a matt white that, along with the painted canvas deck and natural aged patina of the oak, should represent the hull as the original BULLDOG of 1924.

An outstanding job of refurbishment is resulting for a boat to be used in the Museum solely for display purposes to illustrate the Herreshoff 12½ as one of the few remaining active racing classes of Herreshoff yachts after 100 years.

**RESTORATION DETAILS**


Figure 2- Forward bulkhead returned to the cedar planking and caulked – reopened here for deck work. The original bronze air ventilation holes have yet to be cleaned up and replaced, one at the bottom of the bulkhead and one in the deck just forward of the mast and behind the coaming for through airflow and preservation.


Figure 3- Sample of issues for attention: cracked transom, flaking varnish, peeling deck "canvas".

Figure 4- Foredeck planking was refastened and canvassed. Replacement of original toerail covering edge of the finished canvas. Note original patina preserved in brightwork.

Figure 5- Pre transom repairs as delivered to Ballentine's

Figure 6- Post transom repairs

Pre and post transom work (Figures 4 & 5). Note rot in lower starboard area under paint. In the varnished transom the state of the wood can be clearly seen. Note the dutchman to starboard replacing the rotten wood and the black marks of the underlying iron drifts in the same location to port. The shrinkage between the planks are splined. The yard had initially considered painting the transom but the Museum requested it be kept bright to illustrate the underlying issues leading to a paint decision….."next season"!

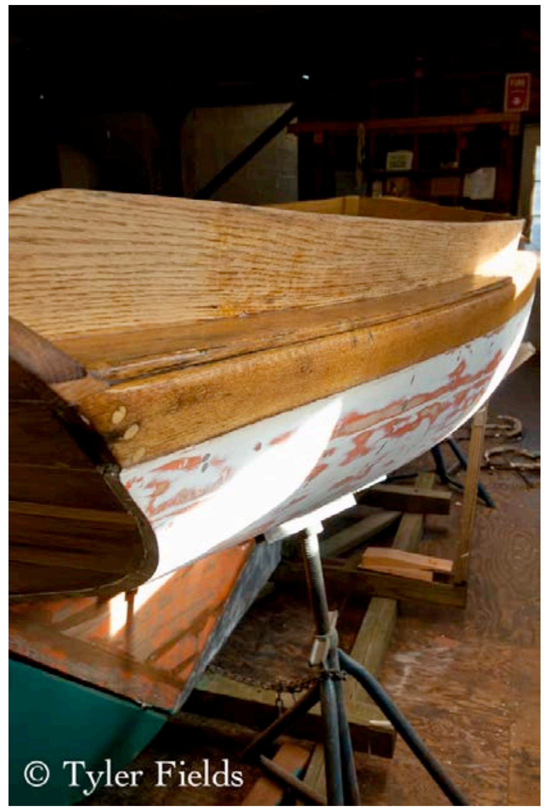

Figure 7- The project is nearing the end of the cleaning, refurbishing and reassembly phase with a very pleasing outlook for the future with much of the original character preserved.

**ACKNOWLEDGEMENTS**

The Museum wishes to recognize the outstanding efforts, attention to detail and generosity of the Doughdish LLC division of Ballentine's Boat Shop. Their depth and breadth of experience in many restorations and builds- especially in Herreshoff 12 ½ boats- was a cornerstone for the decision to undertake this project and its successful completion. A number of the craftsmen, through their own enthusiasm, also donated time to the overall effort sponsored by Doughdish LLC. The photographic credits belong to Mr. Tyler Fields who has documented the project. We are very grateful to everyone at Doughdish LLC.

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