

HOT BuOYS S.V. Rigging Part 2



Alternatives to
Bermuda rig must:

- Suit owner's need;
- Suit the sailboat,
- Stand local winds;
- Be affordable.

The purpose of this presentation

Is to explain how:

- Basic objectives of a cruising sailor,
- Coupled with logic and live testing,
- Evolved into the rig I designed for HOT BuOYS



Previous presentation summary

A rig designer should not cookie cutter a Bermuda rig onto every sailboat.

Instead, a rig designer should consider:

- Sailor's abilities;
- Owner's goals;
- Local conditions; and
- Sailboat's size.

Previous presentation summary

The Bermuda rig may work well in some situations. However, cruising sailors tend to have small crews and smaller budgets.

Cruising sailors tend to reef big full baton mainsails for safety. When reefed, mainsails provide little windward progress. Therefore, the maintenance and use of mainsail means makes their use questionable.

Standard words of caution:

This presentation is not intended to convince you a different rig is best in your situation. Rather, it explains why the Bermuda rig was removed in my situation.

Changing the rig on a sailboat is not simple. Pay particular attention to standing rigging and test and retest.

Why are Bermuda rigs popular?

Most likely you own a Bermuda rig. They became popular among weekend sailors, coastal sailboats, and racers when sailing triangular race courses.

Despite being used for cruising and not racing, larger cruising sailboats tended to stick with the Bermuda rig. Other options were largely discounted in favor for the familiar.

So, who should you listen to?

Listen to boat designers?



If all they know is one style rig, which rig will they tell you is suitable?

This experienced Indonesian boat builder knows one style rig.

Local talk versus knowledge



A sailor that sees only Indonesian perahu rigs would not consider a Bermuda rig.

Talk is based on someone's limited personal experience.

Knowledge comes after you experience trying to use talk to solve your own situation.

Keep an open mind



Thank you for
allowing me to share
what I know.

Much of it came after
very difficult lessons.

(Some pictures here are from crew
member Daniel.)

In my case, I know:

The designer should not have specified a big full baton Marconi sail and Bermuda.

It was not suitable for its first owners.

A big 65 foot long by 40 foot wide trimaran with a Bermuda rig can go very fast. Too fast for a retired couple.

Reefing a big Bermuda rig isn't easy with a limited crew and hinders performance.

Foranox: For an ox



Another photo from Daniel. An ox has limited vision.

You are about to venture into my waters.

Alternatives to Bermuda rigs

I sail in the Pacific ocean area and S.E. Asia. It is easy to see alternatives. Most sailboats here do not use a Bermuda rig.

Instead, most sailboats use crab claw sails.

These sails successful traveled the Pacific for thousands of years.

Crab claw sails fall into a family of sails that are called “lifting sails”.

Terminology 101

Bermuda rig

A modern design utilized on racing and pleasure sailboats.

They have curved driving sails. The sails utilize the wind to pull a sailboat forward. They also push the sailboat's bow downwards.

The mainsail is frequently called a Marconi. Yes, that is the radio guy.

Crab claw rig

A traditional Pacific design used for centuries or more.

It has flat lifting sails. The sails utilize the wind to pull a sailboat forward. When upwinding, much of the sail area is nearly horizontal and a low pressure develops above the sail. This low pressure zone lifts the sailboat upwards.



HOT BuOYS sail at the loft

I like the idea of being lifted.

I don't like the concept of sails
under high tension.

Other lifting sails



This dhow is a traditional African (Egyptian) sailboat. Its lateen sail acts much like a kite. It pulls the dhow forward and upwards.

Bermuda rigs push downwards



The wind's force on the Bermuda rig for the left sailboat has driven the bow almost below the waterline. Most of the wind is being spilled. Would a lifting rig be safer?.

When I raced a catamaran, we only went as fast as we were willing to drive the front of our lee bow below the water. If we pushed the limit too much, we would have flipped over. Is the sailor in blue safe? Is it safe to cross an ocean in a boat like this?

So why not?

Its simple. The lives of people, and long term costs of ownership, mean nothing to the initial manufacturers. They are only concerned with making the sale.

Racing sailors what to only buy something that meets racing rules. Rules are built around the Bermuda rig.

Insurance firms like the *conventional*.

No insurance, no racing.

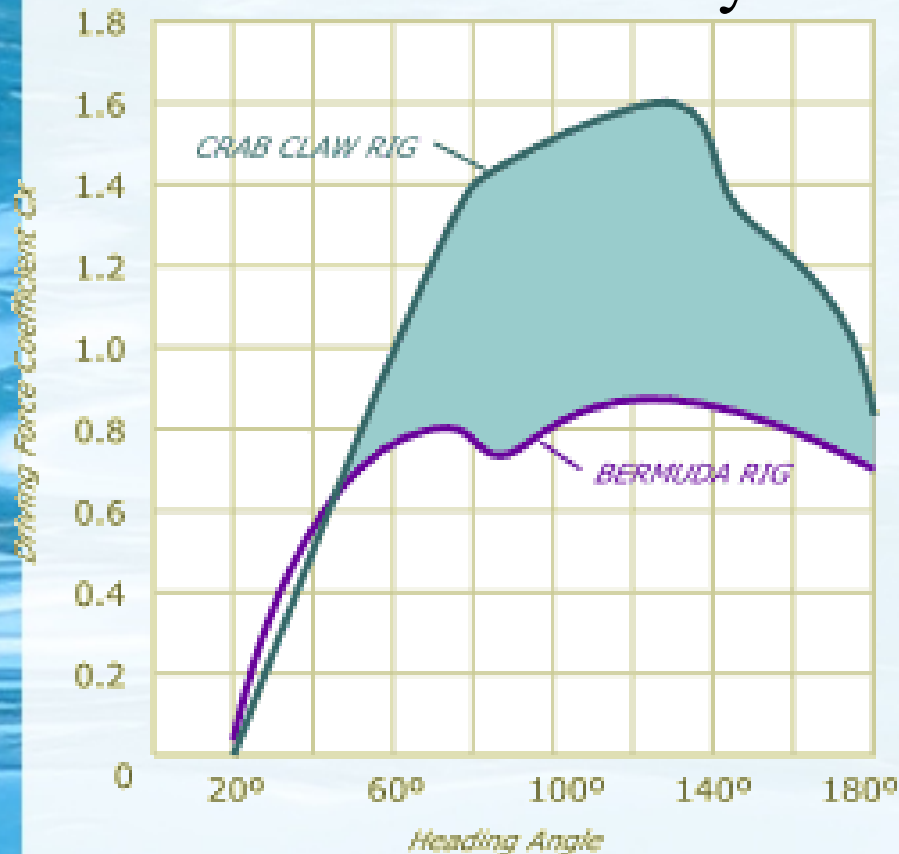
Why not scientifically different rigs in wind tunnels?

Unless you only listen to local talk, you already know researchers have already done the tests.

Stop reading this. Now! If all you want to here is local talk.

'Planform Effect of a Number of Rigs on Sail Power'

By C.A. Marchaj



The crab claw sail demonstrates its superiority to a Bermuda rig right from the close-hauled condition.

Its superiority increases when the boat bears away. On reaching, with the heading angle 90 degrees, the driving force coefficient of the crab claw rig delivers about 90% more driving power than the Bermuda rig.

Bermuda rigs, with a single mast mid-ship lose consistently in research experiments.

They lost in Italy.

Even an A-frame aft-mast without lifting sails performs better.

WIND TUNNEL AND CFD INVESTIGATION OF UNCONVENTIONAL RIGS

3rd High Performance Yacht Design Conference Auckland, 2-4 December, 2008



Italian researches compared a scale model A-frame aft-mast rig against a scale model race winning Bermuda rig.

Despite the extra drag caused by bigger mast sections, both experimental tests and VPP calculations showed that the aft mast rig *“gives the best performance.”*

Note: Critics of the A frame point to mast drag as a reason to stay Bermuda and ignore overall performance increases.

The Emperor Has No Clothes:

Comments by John Dalziel



Marchaj's paper was a wake up call to those who believe the modern Bermuda rig is the epitome of aerodynamic progress. His tests showed a lateen was superior to wind-ward, and the gunter, crab claw, and lugsail were all superior overall to the Bermudan.

This picture is of a proa with a crab claw sail.

Race trials by monthly French magazine Voiles & Voiliers

Classement	Type	1 ^{er} triangle	2 ^e triangle	Moyenne
1 ^{er}	Pince de crabe	3'43" (3)	4'23" (2)	4'03"
2 ^e	Optimist (livarde)	4'55" (9)	3'13" (1)	4'04"
3 ^e	Marconi	3'16" (1)	5'06" (4)	4'11"
4 ^e	Lattée	4'05" (6)	4'25" (3)	4'15"
5 ^e	Jonque	3'42" (2)	5'12" (6)	4'27"
6 ^e	Wishbone	3'59" (4)	5'21" (7)	4'40"
7 ^e	Aurique	4'08" (7)	5'26" (8)	4'47"
8 ^e	Latine	4'44" (8)	5'10" (5)	4'57"
9 ^e	Au tiers	4'04" (5)	5'58" (9)	5'01"
10 ^e	Voile carrée	10'39" (10)	Pas de second tour	

In a side by side test, the crab claw lifting sail was fastest.

A Marconi sail (used in a Bermuda rig) placed third.

Watch the sea trial video

Watch the sea trials of HOT BuOYS when a very light breeze and small sail:

- Made progress to wind
- Allowed a big multi-hull to tack
- Tacked without touching a single line

Video is uploaded on Youtube search for
HOT BuOYS Trimaran

How about asking other sailors?

If you are a cruising sailor, ask cruisors:

- Who have multiple rig experience;
- Who cross oceans;
- Who build or maintain their sailboat;
- Who do not have unlimited budgets.

Non-Bermuda rig owner



Wakataitea's owners love their rig! This James Wharram designed rig features a crab claw sail. It is located behind the mast and has two spars. The rig uses a relatively short wooden mast held up by synthetic rope.

Low stress rig: Means less stressed owners



Wakataitea owners report their small crab claw sail works well with no giant mast or high tension rigging.

No high maintenance expense for a full baton mainsail.

Explaining the lifting sail



This lifting sail (padewakang) has spars on top and bottom edge. Notice it is curved like an upright C.

In a lifting the sail, the winds act more vertically than horizontally. The wind flows upwards along the front face of the sail. The telltales should go upwards. The current of air upwards draws air from the backside of the sail and it travels upwards too. The result is a low pressure zone near the top edge of the sail. Overall, the sailboat is pulled upwards out of the water and towards the low pressure zone.

Think of this like a kite.

Why not a big kite?

A kite is perhaps the ultimate lifting sail. However, this was not pursued:

- Going to wind was important and this is questionable for kite sails;
- Sudden squalls might damage or send a kite sail into the sea. \$\$;
- The overall size of the kite would have to be pretty large for HOT BuOYS; and
- A large kite it would be hard to manage.



Lifting sails worked for Pacific islanders.
There sure seems to be a lot of them in just
one photo. Hawaii's Bishop Museum photo.

Sizing it up to a cruising yacht



A concern I had was how to apply a lifting sail to a large multi-hull.

I wanted one mast.

No bad tack please!

The bad tack



The wind on this tack is pressing the sail up against the mast. That is not good, hence the term the bad tack.

A lateen sail does not have a spar in the foot of the sail. The bad tack prevents it.

Despite bad tack:



If the boat doesn't have to tack, a spar in the foot is possible and can be raised on the mast's good tack.

This felucca has a spar in the foot. This one is sailing on the good tack. So, how does it get away with a spar in the foot? The answer is in the background. This isn't the open ocean. The wind is constantly from one direction.

A middle mast = A bad tack

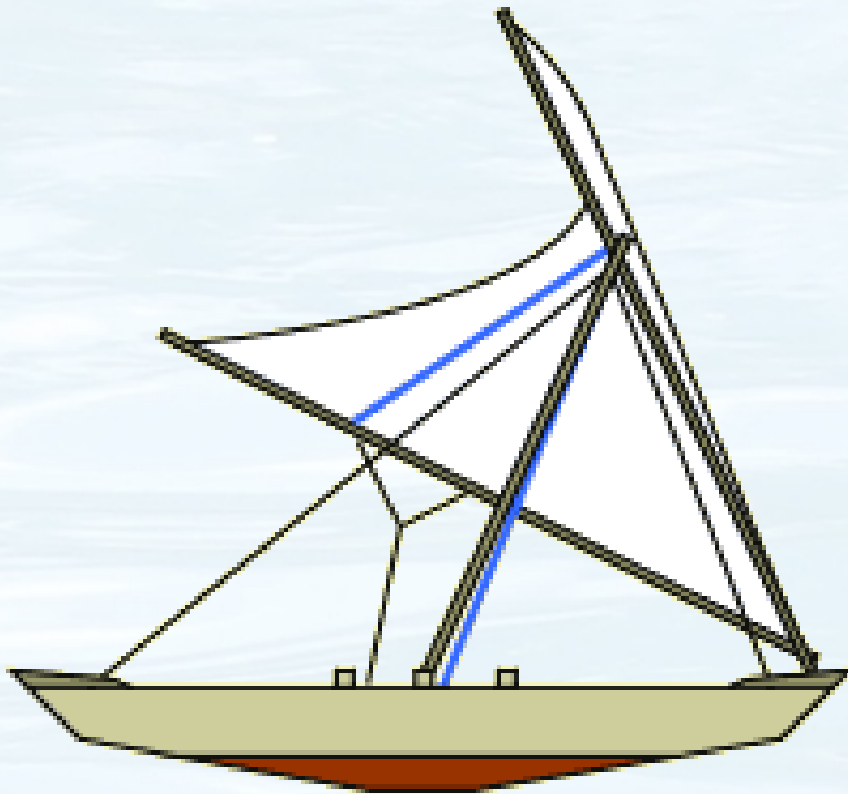


I didn't like the idea of paying good money for a sail only to have it pressed up against the mast.

So I looked for examples of others who already solved this problem.

Solving the bad tack

- Pacific sailors figured out a solution. It is called a proa.
- Since a proa solved the problem, it is able to have a spar in the foot. This helps overcome the shape problem you see with the dhow.



A proa has no bad tack.

A proa uses a single canoe hull (wa'a) with a very flat leeward side. An ama is always kept to windward side. Proa's and similar boats don't tack. Instead they shunt. The rudder is hand carried to the front of the boat. The foot of the sail is hand carried to the back. In this manner the front becomes the back of the boat. There is technically no front or back to a proa.

While the crab claw sail on a proa was a nice solution, it wasn't something I could copy.

HOT BuOYS is a trimaran with hulls that are not shaped the same front and back.

The flying lateen solution



A California sailor came up with an idea to solve the bad tack. See: www.flyinglateen.com

Instead of supporting a lifting sail from one mast, he hung the sail off a tripod of masts. It has no bad tack, however, I decided against this solution since:

- It requires multiple masts and two spars in the sail.
- One spar is overhead.
- High loads of big sail.

Then I had two ideas

The foresail of this rig is hung from the mast. I could do the same.

However, I can do better than that.



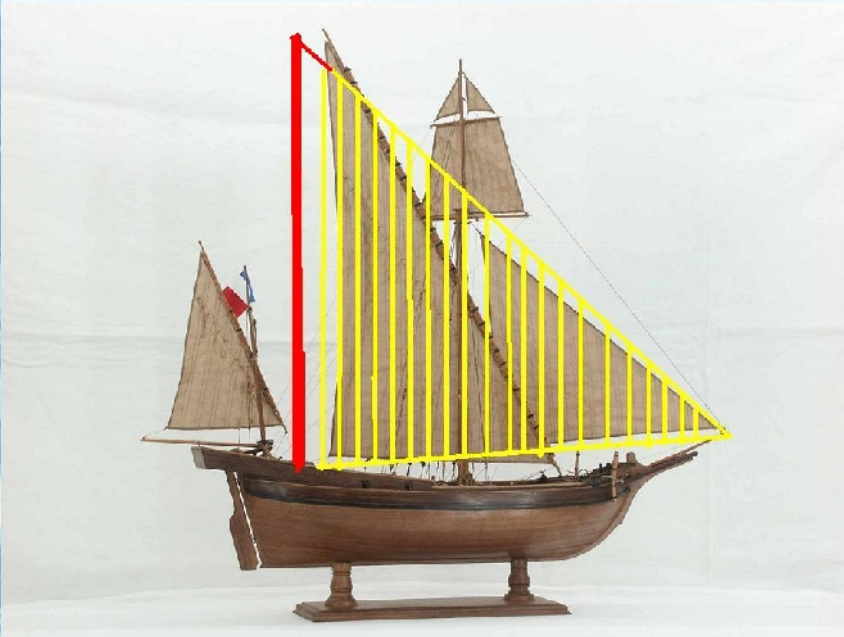
The mast is in the way

Eventually, I found boatdesign.net and a discussion about getting the mast out of the way. Designers were experimenting moving the mast to the back.

With a mast out of the way, one large lifting sail would have no bad tack.

Moving the mast solves the problem.

With an aft-mast just one sail!



The two big sails of this boat form a triangle. Lets just make one larger lifting sail and hang it from a mast located in the back.

Another example of lifting rig



Caravels can be seen on ancient Roman coins. This rig suffers the bad tack problem.

This photo is of a caravel. They are still in use today and date back at least 2000 years. They have simple low tension lifting sails. The spar attached to the top of the sail is in the centerline.

Solving the bad tack problem



With the mast in the back, there is no mast in the way. The sail is self-tacking. A spar in the foot holds a better shape than a lateen.

With a mast in the back, a top spar is not needed. A bolt rope within the sail will hold a sail up.

HOT BuOYS sail has a 14mm Dynema line sewn into the sail.

HOT BuOYS Sail: What is it?



The sail of my boat is shown with the 1st trial mast. The 14mm Dyneema bolt rope both supports sail and serves like a spar. A spar within the foot helps with shape and helps channel air upwards. The 2nd mast is 18 feet shorter.

For a video of this sail on sea trial Google HOT BuOYS and look for Youtube video.

But what about sail shape?

Critics will say, *“You can't get enough tension in the bolt rope to get a perfect sail shape.”*

My reply is...*“I gather you are used to racing a Bermuda rig. For those rigs performance and sail shape is critical. However, a lifting sail is more forgiving. It still goes to wind with a shape you are not used to seeing. Further safe cruising and low maintenance are higher priorities to me.”*

Why one spar and not two?

The lateen style and crab claw must have spars in the top of the sail (luff) because the mast is mounted in the middle. Notice in the previous pictures of the dhows how fragile these spars look.

Now consider HOTS BuOYS' size. To maximize the sail area within the triangle formed between tack, and the bottom and top of mast, the luff of HOTS BuOYS's sail is 62ft (18.9m). A spar this long that stands high winds would be heavy and thick. In short, only a 36ft (11m) spar in the foot was practical.

What about balance?

“The rig looks unbalanced. With so much sail area up front won't HOT BuOYS turn downwind? (lee helm)”

My reply is...“Unlike a Bermuda rig, HOT BuOYS balance can be adjusted by simply adjusting the halyard. Lowering the halyard allows the sail to move forward for downwinding. Eventually, the sail will stand on the spar. Raising the halyard pulls the sail aft for upwinding.

The “balance” of a Bermuda rig, is only achieved with the full baton mainsail up. Cruising sailors normally sailed reefed and unbalanced. ”

What about reefing?

“Glad you asked. The time and difficulty of reefing a big Bermuda rig is exactly one of the reasons for the change. Reefing this sail doesn't require anyone to go forward in a storm. No one has to climb atop the pilot house where they could fall off. One person from the cockpit simply winches in a line called the spilling line. This line attaches to the foot of the sail. The location of the lines is important.

See Presentation 4 for more technical details and initial raising/lowering of the sail.”

But what is this sailed called?



Some sailors focus too much on terminology instead of asking, *Is it safer and work?*

This felucca has a lug sail. It suffers from a bad tack. The mast is not behind the sail. However, the sail shape looks similar. Does that mean HOT BuOYS' sail is really a lug sail? Semi-lug sail? Semi-lateen? The amazing sail? (Maise is my last name.)

Eliminating downwind sails

The HOT BuOYS rig doesn't have a forestay. Instead two forward leading side stays support it.

With no forestay to get in the way, the large foresail can be let out farther and farther as the boat travels downwind.

- Crew do not need to risk changing sails between upwinding and downwinding.

Bermuda rigs can't do this!



Owning a big sail boat basically forces you to innovate. I can't even find shoes that fit me here in S.E. Asia. (Yes, these people are standing.)

When going downwind, the stays prevent the sails from being let out far. To counter this problem, Bermuda rigs fly special sails for downwinding.



An aft-mast can permits two forward leading sidestays to replace the forestay. No forestay in the way of this foresail.

The mast in the back:

- Is new thinking.
- Shotover, designed by Lock Crowther, with a huge foresail holds record time in Australia's Brisbane race.
- Smaller mainsail or no mainsail at all.

Other examples of mast aft



- Check out the extensive thread on boatdesign.net
- Article on Wikipedia
- The Hong Kong Cat built in Thailand
- Also Google posts by Brian Eiland

Brand new aft-mast multihulls



- Gradually eliminating the mainsail altogether has led some builders to now offer multi-hulls with just one foresail supported by mast on the back.

How was it possible to retrofit?

The loads created by a big mast and sail are large. Careful consideration of the existing boat must be made before doing a retrofit. HOT BuOYS trimaran was constructed with two strong box walls that extend across the beam of the boat. The original Bermuda mast was mounted above the forward box wall. The new mast was located above the rear box wall. Both box walls were built the same way.

Four new chainplates were mounted on the back and side of the sailboat. They were mounted on a thick layer of fiberglass and epoxy, and reinforcement was added to the interior walls.

I invented a unique way to attach the rigging that shares and evens the loads among multiple chain plates (Presentation 3).

If this was such a good idea...

The innovation of the HOT BuOYS rig is combining a simple traditional lifting sail with a mast mounted in the back. Designers of traditional sailing crafts with lifting sails have tended to only have access to simple organic materials. Further, they have had no need to innovate since their sailboats tend to be smaller.

Western world designers who have had access to modern materials appear to only have Western eyes. All they see is Bermuda rigs and so naturally use these type of sails.

I appear to be the first person who has had access to both high tech materials, exposure to traditional sails, and a need to innovate a new kind of rig for my very large sailboat.

New materials: New options



Owner and designer of HOT BuOYS rigging Philip Maise goes aloft to remove crane lifting strap..

Traditional rigs were limited by organic material strength. Big rigs were not possible. Or, multiple masts were required.

New materials

Traditional rig builders had no access to:

- Aluminum extrusions,
- Nylon, Dacron, Dyneema, Spectra, Vectran etc.
- Fiberglass, epoxy resin, carbon fiber
- Galvanized steel, stainless steel

These materials allow:

- One light mast to replace several heavy masts
- One sail to replace several

Don't listen to “experts”



In the emergency waiting room of a Malaysian hospital I sat with four broken ribs and reflected. The picture above hung on the wall. Be sure to read Presentation 3 for lessons learned. A mast must stand local conditions. My new mast now withstands higher loads.

The new rig for HOT BuOYS



24% shorter, HOT BuOYS new rotating wing mast supports one efficient lifting sail. It has a dynamic compounded backstay.

Summary

Traditional lifting sails:

Are a valid alternative to Bermuda sails;

They are proven more efficient and versatile;

They can be sized smaller for easier use.

New materials offer new options.

Big tall masts don't stand local conditions.

Coming up in Presentation 3

Sea trial #1 and lessons learned.

Sea trial #2, demasting in squall, and lessons learned.

Dynamic compounded backstay rigging.

Using superior locally available components.