**Links and Excerpts that Helped me choose my base wing design**

Tspeer On Rigid wing sails http://www.tspeer.com/

“Rigid wing rigs take the wingmast a step farther, and elimiate the sail entirely. A single, symmetrical airfoil does not produce high lift and as a result the acceleration of a yacht so equipped is very poor. So rigid wing rigs typically have two or more symmetrical airfoils hinged so that they form a slotted flap when deflected. This produces more lift than the wingmast/sail combination.

The main wing element of these airfoils was designed to a similar aerodynamic philosophy as the wingmast sections **- providing for a smooth forward movement of the transition point as angle of attack increases, so as to have robust characteristics at low Reynolds numbers.** **The NACA 0012 provides a good section for the flap because of its front loading, which allows the whole flap to be used for the airfoil's pressure recovery.** Any tendency of the flap to form a leading edge pressure peak can be suppressed by adjusting the slot gap.”

Tspeer from Forum

http://www.boatdesign.net/forums/sailboats/lift-drag-coefficients-sails-foils-1253.html

One of the best combinations from landsailing competition has proven to be two NACA 0012 sections, with the forward element 60% of the chord and the flap 40% of the total chord. The hinge line is normally located at about 90% of the forward element chord, and the links extending from the flap leading edge (through slots in the forward element trailing edge) sized so the flap just clears the trailing edge of the forward element. A flap deflection of 20 degrees will typically provide best performance. Higher flap deflections may increase CLmax, but the drag also increases rapidly from, say, 30 degrees to 40 degrees flap deflection.

In general, one can use a thick section for the forward element, but the flap should be a thin section. The thin flap section would normally produce sharp pressure peak at the leading edge that would lead to leading edge stall. However, when used as a flap, this pressure peak can be suppressed by moving the flap closer to the trailing edge of the forward element, making the gap smaller. There is an advantage to having the flap and forward element overlap somewhat when the flap is deflected. However, this adds complexity to the mechanism to keep the two elements from interfering when tacking.

Maximum lift coefficients for multi-element rigid wing sections are probably in the range of 2.5 - 3.0+. One must do considerable tuning and adjustment of the slots and flap deflections to optimize the performance.

Harbor Wing <http://www.harborwingtech.com/products_hwt_x-1.htm>

Forum Post w/ specific questions.

http://www.boatdesign.net/forums/multihulls/understanding-wing-technology-34697-5.html

From SA:
I try to answer questions. Please understand that while I have been doing this for a long time, I do not have reams of data comparing one wing section with another and confirmation that the on the water performance validates the predictions. We just haven't had the time, money and inclination to work that hard. We are pretty smart and we take what we feel are logical steps, but we simply don't have an "optimal" solution. We have "what we have done" and "what works".

1) **What has proven to be the most effective section shape used for the main wing? Is it a standard NACA section? If so, # please?**
*The current #1 elements have been reverse designed using XFOIL or other proprietary foil design software. This has lead to foil shapes that are blunter than the standard 000 NACA series. Cogito's #1 element is 19% section. So is the X wing. Magnus Clark reduced the thickness of the Canadian wings based on a study he did using XFOIL. He has not shared this with me, but from what
I HAVE seen, I am not convinced that he is right and am not scampering around the change my wing shapes. A NACA 0018 WILL NOT BE A BAD CHOICE. It is close enough, but
increasing the LE radius makes the wings a bit more stall tolerant, you can do this yourself or you can wait and plot out the nose sections on the plans.*

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2) **Should the rear flap be of the same section shape? If not, which section has proven most effective in that role? Is it a standard NACA section? If so, # please?**
*The trailing edge flap is not the same section. I have used NACA 630A10 and NACA0009 sections. Tom Spear makes an argument for NACA 0012 sections. There are quite a few practical compromises in the flaps and I think any of these sections is fine. The thinner sections will provide a smooth leeward side at a lower flap angle.*

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3) **Should the main wing and rear flap be 50/50 area wise? Or should it favor greater area in the main wing? If so, what percentage would be the optimal split?**
*Current wings are pretty much 60-40 splits. We have the #2 at about 20% of #1 as well. The placement of the pivots along the fore and aft axis of the wing determines the lateral displacement of the flaps at various flap angles. This is a fairly complex compromise.*

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4) **Is there an accepted method for the control systems? If so, are there articles/drawings/photos on the web detailing the principals and execution there of (links please)?**
*I have DXF or PDF file of what has become the standard control system. This was invented by Dave Hubbard 490 years ago and developed over 10 wings or so by the Patient Lady Team. I believe thay wings are only as satisfactory as their control systems. This is the only one I can say is dead nuts reliable. Send me PM and I will send you the file. Specify format please.[SEE PATIENT LADY CONTROL SYSTEM PDF in first postDL]*

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5) **Since rigid wings are more efficient, can the total sail area be reduced to achieve equal or greater performance over a soft sail on all points of sail? If so by what percentage can it be reduced?**
*In theory, but most of the design work has been done to provide more power for equal area. I actually look at it the othr way: since wings can be so much cleaner and can be depowered more effectively than soft rigs and sails, how much could their area be increased? Can this increase make light sails unnecessary? My current best guess is about 25%.*

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5) **What is the optimum aspect ratio?**
*Wings are not subject to the same constraints that sails are. They can be taller and narrower, however the vertical CG of the vessel and thus the stability of the vessel is effected by the rig height. You have the competing values of center of effort height and aspect ratio at play as well, so this is a hard answer to give. C Class wings have been about 40' tall for 300 square feet.*

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6) **How low can the aspect ratio be pushed before there is an appreciable drop off in performance?.**
*In catamaran sailing there is a big performance increase associated with flying a hull. So being short doesn't pay until it is blowing pretty hard.*

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7) **Is there a proven optimum side profile shape?**
*Some variation of quasi-eliptical. What we have done is some form of taper. It is usually simplified for ease of construction.*

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8) **What has proven to be the best method of inducing twist into a rigid wing sail? BMW Orical AC tri appear to have 9 seperate adjustable sections on the rear flap, Is there a way to mimic this on a smaller scale and be mechanically controled for twist?**
*The Oracle wing controls were losely based on the Patient Lady system.[SEE BELOW-DL] PM and get the drawing.*
SHC

from"us772" on SA:

*Another question would be were to locate the pivot point for the flap hinge on a two element wing. In practice we have found for our application/landsailing of wings that a pivot point that produces too large of a gap makes the overall wing a bit gutless . To make the gap larger place the pivot point further forward on the main element. To make the gap smaller place the pivot point further back. With my own wind tunnel testing I found the pivot point to be placed at 87.5% of the main wing worked best overall. My flap is 15% thick. A thinner flap section would probable want to pivot a little further back than 87.5%. Tom Spear has more info here*

[RCsailingForum](http://www.rcsailing.net/forum1/showthread.php?5641-WingSail-Design/page3)

More Tom Speer

http://www.boatdesign.net/forums/design-software/reynolds-number-javafoil-31832.html

The combination of flap deflection and angle of attack that keeps the stagnation point just to windward of the leading edge is a pretty good guide to trimming the wing. It also has the virtue that it is something that can be observed and measured while sailing.

When you're dealing with variable geometry, like a flap that can be deflected, it's a good idea to overlay polars for different flap deflections and then look at the envelope of the polars to see how the flap should be operated in conjunction with the angle of attack.