

Construction of International Canoe USA-244 “Mayhem”

John Kells 2007

Like all projects, the build of IC USA-244 “Mayhem” began innocently enough. I have been sailing IC’s for sixteen years, and it had been 10 years since I had built USA-201. I had never been a big fan of racing boat for boat against Lust Puppet (a National Canoe that has been terrorizing the Chesapeake since the late 1980’s) as she was built to a different rule but the idea of racing boat for boat against other IC’s designed to the same rule, that is a new ball game, and I wanted to play!. I had always been interested in designing boats so the proposed new IC rule was irresistible. To promote the new rule, and with luck see the new rule adopted as the IC Class Rule, I decided to design & build a boat to the proposed rule, and to bring it to McCrae for the 2008 World Championships. .

In December of 2006, the construction started with the seat. Steve Clark has always been generous with his seat mould, but the need to build & replace several seats for himself and the other members of the “Farm Team” in the spring meant that the seat mould would only be available in December. My garage, aka “The Little Shop of Horrors” can not be used between November 1st and April 1st for boat building as I need to park my car in the garage during the winter months, and it is just too %^&%*^cold, Steve invited me down to the “Lab of Luxury” in Warren RI. Two Saturdays produced the top & bottom panels that I brought home before X-Mass. I set the seat aside until the thaw in April after returning from Sarasota & the Midwinters.

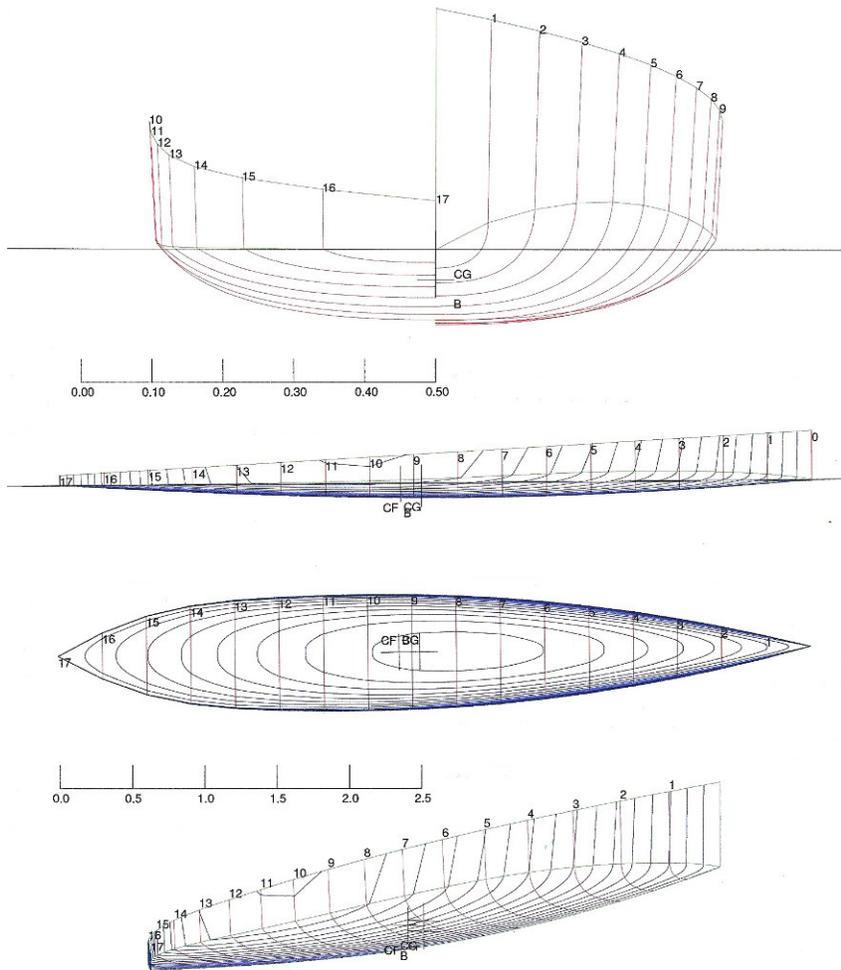
The hull was designed with Hull Form Software by Blue Peter Marine

Out of necessity (a lack of room for anything else once I started the construction of the hull mould), I started the construction with all of the sub assemblies first. Seat, seat carriage, & blades all being substantially complete before the construction of the hull began. The basic parameters of the hull had been established during the winter months of early 2007

The original schedule was as follows:

April	Complete the seat
May	Seat Carriage
June	Blades
July	Build Hull Plug
August	Build Hull
September	Rig Mast & Hull
October	Sail as much as possible before shipping

Emergency surgery to remove my appendix laid waist the month of July, so the shop name “Dire Straights” seemed appropriate. No one was taking bets that this project would be finished before the container was packed for OZ but I succeeded (with two days to spare) and what follows are photos & captions that illustrate most of the key steps along the way. To date this boat has won the National Championship in both 2008 & 2009.



The photo above illustrates the second laminate of the second rail in the vacuum bag. Blocks were secured to the jig to provide surfaces for unidirectional carbon to bond the rails to the carriage sides



Carriage rail showing unidirectional carbon tabs for secondary bonding to carriage sides



Carriage rail showing inside bearing surface. All excess material was removed with a router using a vacuum attachment.



Carriage rails, track guides & pan. An old Nethercott carriage was used as a mould for the pan. Simple plywood jigs were used to mould the angled flanges for the tracks



I have always been a fan of large diagonal braces on the seat carriage. The braces are 1/8" foam with uni-carbon at the bottom edge, and a layer of 300 gsm carbon over all.



Aft sheeting rules!
Right: the underside is very clean. There are substantial reinforcements at the corners. The carriage pan only has a carbon lap joint on the top.





Carriage completed and the mould for the daggerboard & rudder is being prepped.



Half a blade in bag



The mould was painted before the lay up.



A simple jig was built to remove the excess foam from the part



The table shown was built to be the strong back for the hull mould. Before building the mould, polished plastic laminate was applied to one side to lay up the flat stock for the internal structure & the deck.



The daggerboard is complete, and the rudder is being prepared for the 2 halves to be bonded around the rudder shaft.



The frames were laser cut by Precision Laser. The frames on the left are for the female foredeck mould.



$\frac{3}{4}$ " Spruce strips were scarfed into 18'-0" lengths, and used to support and define the chine. $\frac{1}{4}$ " holes were drilled in the frames to allow the inside of the mould to "breathe"



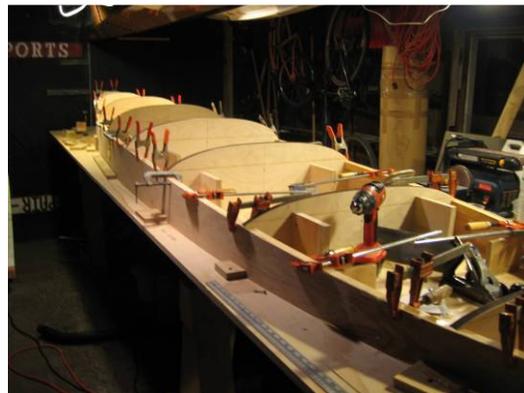
Frame spacing is 1'-0" at the ends & 2'-0" in the middle. This was a mistake. 1'-0" spacing should have been used throughout as the cedar strip sagged where only supported 2'-0" O.C.



Frames were angled 3° to be perpendicular to the design waterline. Precision Laser scored center and water lines in the frames that were useful in aligning the parts.



$\frac{1}{4}$ " plywood was used for the sides of the hull where the hull is essentially flat. Adding $\frac{3}{4}$ " spruce at the deck as originally intended would have been a good idea. Fairing the deck line required a little persuasion.



You can NEVER own too many clamps.



The compound surfaces of the mould were fabricated with 1/4" cedar strip.



It is incredibly gratifying to see the hull that was once just 3D images in the computer come to life.



Polished Formica was used as a mould surface for the foredeck. It was difficult to work with, being very stiff, and the epoxy used to bond it to the frames shrank, telegraphing the frames to the mould surface



Prior to the layup of the fore deck, the recesses for the jib tracks were placed into the mould. This required some careful calculations to determine the correct placement.



Bondo was used to fair the hull mould. It is cheap, & cures quickly



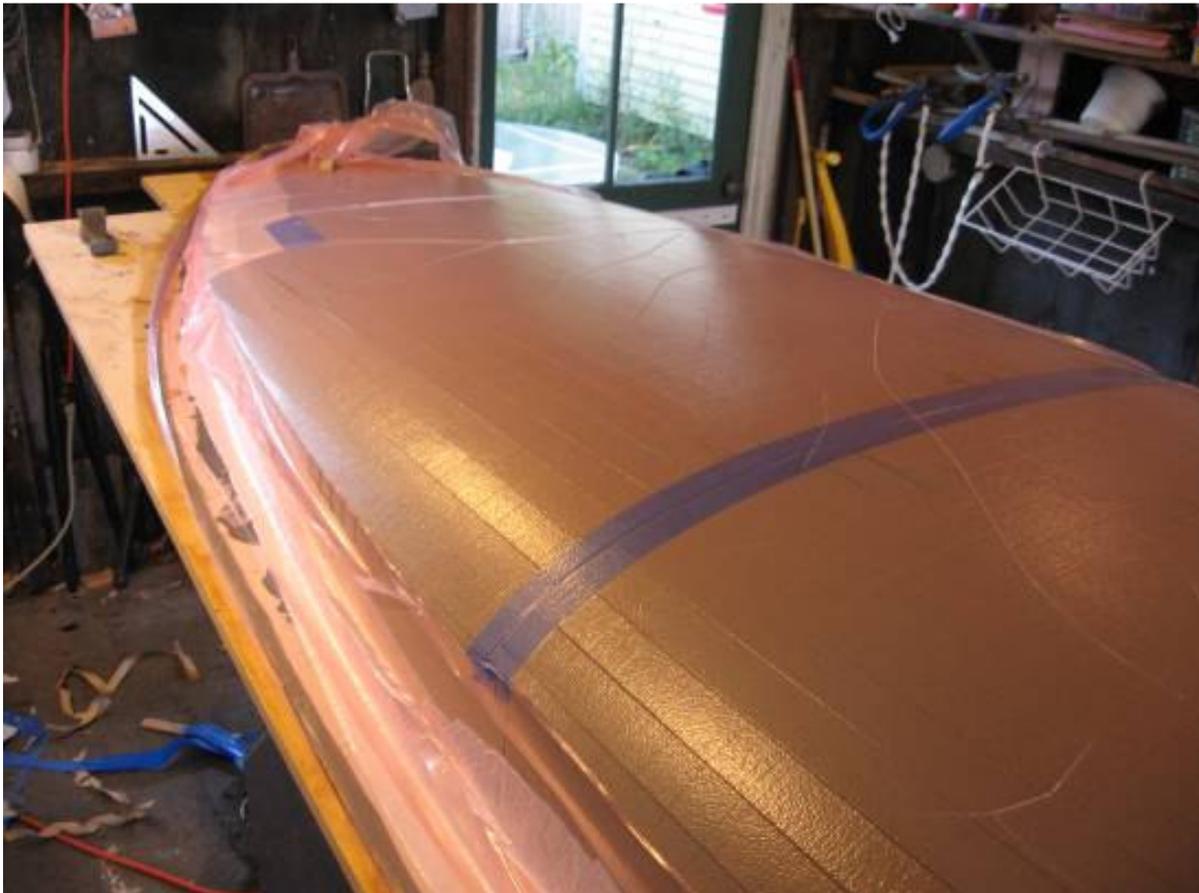
The fairing process was complicated by the need to fair in the sags between frames in the mould, as much as 6mm in the flat mid sections. This added two weeks to the build!



August 27th - The inside carbon skin and the core were laid up together. Steve Clark drove up to assist with the lay up. This is a task that should not be attempted solo. A knowledgeable assistant is a must



Prior to the layup, the mould was bagged and checked for air tight integrity. The holes drilled into the frames earlier would prevent the collapse of the mould in the event of a failure of the air tight integrity.



The entire core was carefully dry fit on the mould prior to the lay up. Masking tape was used to prevent the core from shifting as the vacuum pressure is applied.

The scores of the foam core are readily visible in this view. Prepping the hull for the outside skin involved long boarding the foam core to knock off the high spots before applying epoxy & fairing compound.



Filling and fairing the foam core prior to laying up the outside skin is a critical step



It is important to establish a consistent mix of epoxy & filler that can be duplicated for each application of epoxy & filler



The foam was faired with a 30" long-board of 3/4 "AC Plywood with 3" wide 80 Grit Belt Sandpaper applied with 3M Spray Adhesive



One week later the outside skin was laid up with the assistance of a neighbor. In the photo above, the peel ply is still on the hull.



Another view of the completed hull laminate on the mould. Prior to laminating the hull, the mould surface was covered with 3M packing tape in long strips, wax & PVA



The hull shell off the mould. The blue masking tape helps improve the visibility of the marks & reference lines used to locate the centerline of the hull & the location of the daggerboard & the rudder trunk.



A single mould fabricated from $\frac{3}{4}$ " AC Plywood was constructed for both the port & starboard halves of the mast step hog & daggerboard trunk. 3M packing tape, Wax & PVA is used for the mould prep.



The rudder cassette was used as a mould for the two halves of the rudder trunk



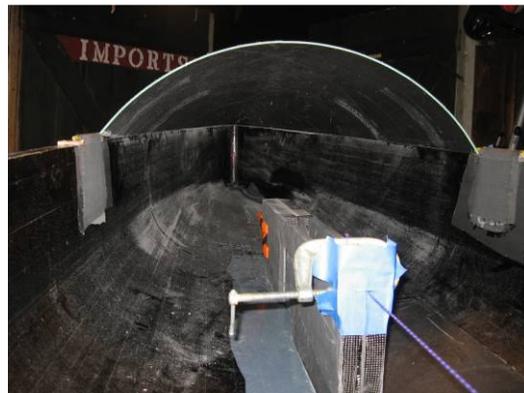
The photo above shows the two halves of the mast step hog / daggerboard trunk. Additional unidirectional carbon was placed under the mast step when the two halves were bonded together.



The mast step hog / daggerboard trunk are dry fit to the hull. Pell-ply was placed on the hull mould where internal structure would be bonded to the hull.



The fore deck is dry fit as well



A fair amount of time & effort goes into checking the alignment of the various components.



The male plug for the hull can not make the stem a fine as I wanted. Solid foam with a carbon rod at the stem were shaped and bonded to the hull. A layer of carbon was added after the fore deck was bonded.



The rudder trunk bonded to the hull. Carbon 90° angles are added to provide additional gluing surface for the deck. Carbon tape at $\pm 45^\circ$ will be bonded around the rudder trunk hull joint to provide additional strength.



The mast step hog & Daggerboard trunk bonded to the hull. Carbon tape at $\pm 45^\circ$ will be bonded around the hull joint to provide additional strength. The centerline stringer is seen beyond.



The internal structure bonded in place. Note the shelves bonded to the hull at the deck edge for the seat carriage tracks.



A detail of the composite chain plate. A step was provided in the hull mould at this location allowing the outside hull skin to have double the laminate as the rest of the hull



Nick arrived to lend a hand as Newton Clamps help secure the deck to the hull.



The deck skins, laid up flat prior to the construction of the hull required a little more persuasion to twist into shape than I had anticipated.



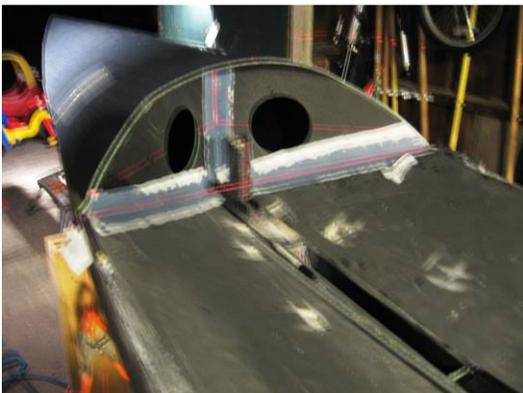
Dry fitting everything and rehearsing placing the deck, so that it could be placed in one step on the first try is critical to getting a good bond with the minimal amount of glue.



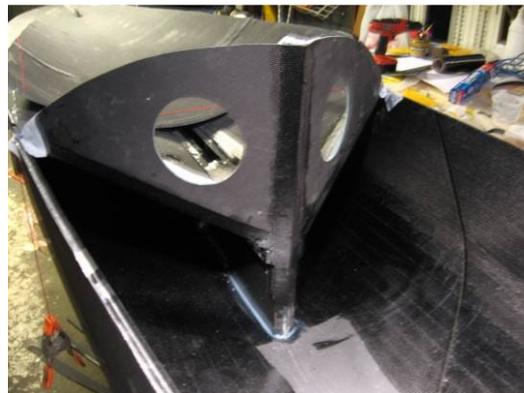
Progress is being made. 6 weeks until the container gets packed!



There is not much to the internal structure of the hull. Note the bead of epoxy & colloidal silica at the hull deck joint.



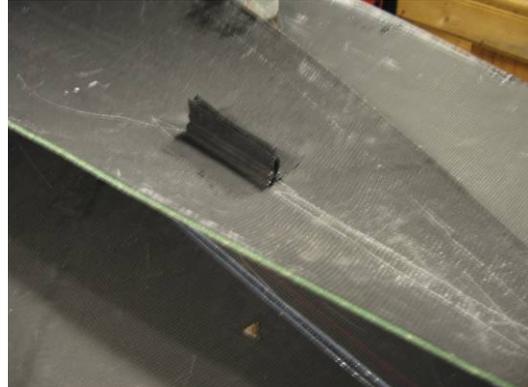
I used an inexpensive laser level to align components throughout the build. Carbon tape at $\pm 45^\circ$ with peel ply is used to reinforce the all joints on the outside surface



Carbon tape at $\pm 45^\circ$ with out peel ply is used to reinforce the all joints at the V-bulkhead



An internal strut to transfer the forestay loads to the hull was bonded to the hull before the fore deck was installed



A block of G10 replaces the foam core at the forestay attachment. A slot was fabricated to allow the internal strut to fit neatly in place as this area is inaccessible once the foredeck is installed.



Just as when installing the aft deck, the installation of the fore deck was rehearsed allowing the minimum amount of epoxy to be used.



September 27th, one month after the inside skin and core was laid up, the hull was moved to a conveniently located spray booth. Bill Beaver was flown in to assist with paint.



Primed & sanded awaiting the final coat of paint



At this stage, the hull could have used another pass with fairing compound & wet sanding. Bill's insistence that we use only the best materials (Awlgrip) is one of the reasons the paint came out so well.



Just off the scale at Composite Engineering at 50 lbs. (<23 kg.) with paint



The hull looks stunning in this photo

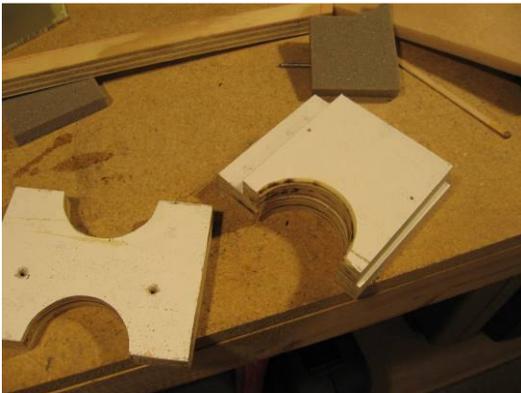




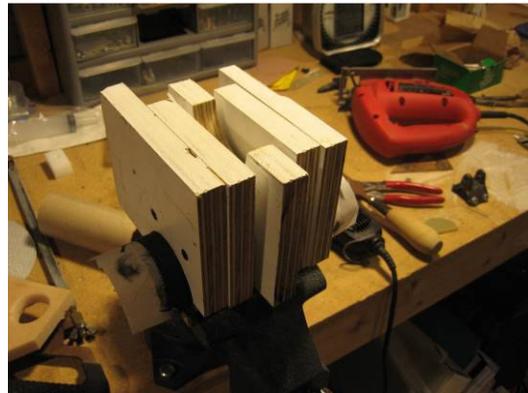
Securing the cast aluminum gooseneck proved to be a nightmare. After having it pop off at two consecutive events (Ottawa Skiff Grand Prix & Nationals) I replaced it with a bonded composite mast mount.



3/16" G10 was used to accept the 1/4" bolt from the cast aluminum universal joint that was cannibalized from the original part.



Simple plywood blocks were built to allow the assembly to be clamped as the carbon was laminated.



Everything was mocked up prior to the lay up.



Every clamp that could fit on the jig was used. There are times when a vacuum bag is just not the correct option.



The part after the clamps and peel ply are removed, but not trimmed. This was later bonded to the mast.



I try VERY hard to get the pin for the mast head sheave to pass through the mast tube. Once and a while I succeed.



The bolt for the lower shrouds also secures the dead end for the Cunningham that is internal in the mast.



A detail of the spreader bracket



Most new IC's have more spreader sweep than was common on Nethercotts.



The mast exits are reinforced with additional unidirectional carbon on each side of the exits. Note the new gooseneck bonded to the mast.



Detail of the Mast Heel



2:00 AM on October 27th 12 hours before launching! And two months after the hull laminate was started



There is never enough time to sort out all the little details.

This project could not have been completed without the help and assistance from:

- Steve Clark
- Bill Beaver
- Tony Arends
- Ted VanDusen
- Bud Selig
- Sol Marini
- Scott Hopkins





