BUILDING A STITCH-AND-GLUE SEA KAYAK

by Davide Boschi (Italy)

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Building a stitch-and-glue sea kayak

I) Introduction
Since a long time I wished to build a boat with my hands. I had read a few books and some boatbuilders reports on this matter. In Milan, Italy, there is a Company (BCA – Demco-Kit) which deals exclusively boat plans and materials for self-builders, and I have read its books and consulted its catalogue of self-building boat plans and kits (almost all sailboats).
I never did undertake a construction before for two good reasons:
- Space for the job
- I like sailboats, but I already own a small sail cruiser and to own two would be too much for me.
Now, I usually go biking for fitness purpose, but this is a good exercise only for legs. On the other side, I don’t like to make exercise in closed environments, I like open spaces, nature and water, most of all I like the sea. Paddling on the sea in summer would be the ideal activity, complementary to biking and sailing. Besides, in my area there are lakes and big rivers. So, when the Internet appeared on my desk, I looked for some kayak plans. I found the plans of this kayak at
http://www.guillemot-kayaks.com/Building/Stitch&Glue/StitchAndGluePlans.html
and I choose them for some reasons:
- first of all, these plans are really basic: I have capability for hand-working, but I am also a mechanical engineer and I prefer to handle projects rather than take them ready-made;
- these plans are free, a big advantage for me because at that time I had just started an activity on my own, and at that stage of my job money preferred to leave my hands than to come to my wallet.
I was conscious this was a rather difficult boat for self-builders, especially as a first construction. But I trusted in my manual and creative skills to solve most of the problems.

II) About this report
a) I decided to write this report in English, hoping to see it published on the Internet. Unfortunately, my English wording is not rich. I hope this report will be readable, even if not elegant. Maybe, an Italian version will follow. I also can write in French and Spanish, but please don’t wait for more translations, not by me at least.
Anyway, corrections on this text will be welcomed.
b) This is the building journal of my first construction. It has been written during the job, so even errors and mistakes are described as a part of the construction job.
Naturally, the way to fix the errors is described too, but I think the best way to operate is not to make mistakes at all, whenever possible... So, please read ALL this book before starting. Wisdom is not only to learn from one’s errors, but even from others’.
I made two conceptual errors:
- I did not consider the hull cross-sections, hoping the hull would have shaped automatically when stitching. This is not real. The stitched hull may assume different shapes depending on the way you stress it. Besides, its own weight makes it assume different shapes, depending on the suspension points. Before gluing, it is necessary to check if the shape is right. Check both the keel line (as I did) and the cross sections (as I did not).
- I assembled and glued the deck apart from the hull, to find they did not match perfectly. The best way (I think) is to use the assembled and glued hull as a shape for the deck before assembling the latter.
I could recover these mistakes but with a lot of job for my mind and anxiety for my soul. You may avoid this.
c) This is not a user manual for epoxy products, nor a manual for stitch-and-glue assembling system (although it contains some instructions on it). If you are in doubt about these matters, read a specific book or consult some more experienced people.

III) Special thanks and links
- BCA – Demco-Kit (www.bcademco.it) is located in Milan and, even though I am not a good client, they have inspired me towards boatbuilding with stitch-and-glue system. They sell boat plans of every kind (except kayaks, by now), hold courses, sell materials and books and write books on their own. A unique Company in Italy. Special thanks to Paolo Lodigiani, a real inspirer.
- Nick Shade has built this kayak (not only this, in reality) and written a very interesting journal. I found it online but I don’t remember the URL. I took his journal as a reference.
- More links:
  http://www.guillemot-kayaks.com/ (plans and kits)
  http://www.oneoceanKayaks.com/ (a great deal of links, plus details on building techniques and more))
  http://www.cltboats.com/index.php3 (Chesapeake, plans and kits)
  http://www.fska.org/ (Florida Sea Kayaks)
  http://www.bateau.com/ (mainly sailboats, but also motorboats and kayaks)
  http://instantboats.com/
  http://www.smallboats.com/  
  http://www.boatbuilding.com/ (boatbuilders community - free and pay plans, software & links)
- Special thanks to my Brother Guido, who patiently helped me in some stages of the construction, and to my father Quinzio, who provided me the space for the job and useful suggestions.
- Thanks to mr Belotti, owner of Italiana Resine located in Zingonia (Bergamo, Italy). His Company sells epoxy products (resin, paints and additives) for industrial purposes. He was very interested on my project and supported it by supplying me useful and quality materials at right price.

1) Preliminary considerations
1a) Thickness
Nick Schade used 1/8” thickness plywood, corresponding to 3.175 mm. In Europe, 3 mm and 4 mm are available. I decide to use 4 mm mahogany plywood. This would increase strength (good) and weight (bad).
I also decide to finish the hull only with resin and paint, without clothing. This method is more common in Europe and will recover the weight added with the increased thickness.
1b) Aesthetics
I will try to leave the deck bright, if possible. For this, I will have to put some care in deck assembling. I will try to assemble the two DECK pieces without stitching, and taping the joint only on the internal side.
As a matter of fact, the copper stitching is only for temporary purpose, and I will try to use another assembling method to keep the panels in position.
The absence of the external tape may result in reduced strength and tendency of the panels to open a small gap in the joint point, once assembled and under load. But this is a small boat and I don't believe this will happen. If it does, I will find a solution for this problem, too.
To assemble the deck to the hull, I will use screws and/or glue.
The alternative method of assembling the deck (and the deck to the hull) is described in paragraphs 11 and 18.
2) Units conversion

I imported the panel offsets TXT file on a spreadsheet (Microsoft Excel) and I changed the data into millimeters (1 inch = 25.4 mm), then I formatted the table.

I have some practice with Excel, so the job speeded up quickly. Most of the time was spent in checking and verifying the results, not in data manipulation.

See table 1 for the results.

I point out that the approximation of the original data is 0.001 in. i.e. 0.025 mm. The converted data approximation is 0.1 mm, which is the maximum possible precision when tracing the pieces on the panels.
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### 3) Building a first, gross model

Building a model helps in understanding some things:
- how to trace the lines following the given points;
- the final shape of the boat;
- the behaviour of the panels when you bend and assemble them;
- the influence of unprecise cutting.

I traced the relevant points from the panel offsets table on a sheet of plotting paper, and I traced the lines. The scale was 1:10

I glued a photocopy of this sheet on a light carton and I cut out the pieces (figure 1), then I assembled the model with adhesive tape.

I did not take much care of precision at this stage. I thought that a second model should have to be built anyway. But if you think you don’t need a second model, probably you don’t need precision in building the first one.

See the result in figure 2.
Figure 1 – tracing and cutting the pieces for the first model
Don’t misunderstand: the wooden background belongs to the table. The model is paper-made.

Figure 2 – the first model
4) Nesting the pieces on the plywood sheet
In Europe, the standard dimensions of plywood sheets are 3100 x 1530 millimeters. This would make probably possible to cut all the pieces from two jointed sheets (6200 x 1530 mm).

Table 1 shows a max. offset of 808 mm (BOTTOM piece). If you double this quote, you obtain 1616 mm, which is more than the dimension of the available sheet (1530 mm).

So I had to reposition the pieces on the sheet, approaching them each other. I did this by subtracting a constant quote for each piece from the value given in table 1.

I subtracted:
- 5 mm from the SIDE offset values
- 16 mm from the DECK EDGE offset values
- 41 mm from the DECK offset values
- 46 mm from the BOTTOM offset values

The job was done with Excel. The new offsets table is table 2.

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The gaps between the pieces result to be:
- 3 mm between the edge of the sheet and the BOTTOM piece
- 5 mm between the BOTTOM piece and the DECK piece
- 8 mm between the DECK piece and the DECK EDGE piece
- 5 mm between the DECK EDGE piece and the SIDE piece
- 3 mm between the SIDE piece and the edge of the sheet.

These values are rather small (about equal to the ply thickness) but I hope they will be enough.

I decided to leave more gap to the deck because I think that the method of assembling to the hull (described in paragraph 18) will need some adjustments more.

5) Building a second model
I wanted to build a second model with heavier carton. The purposes were:
- to be more precise than I was with the first one
- to check the tracing method I aimed to use with the construction.

To trace the pieces I will use the following method:
I will mark the points with nails in the plywood. Then I will fix (with some nails more) a 1 cm side square cross section wooden batten, following the nails. Then I will trace the line with a pencil.

I used this method for the second model (see figures 3 and 4) but the results on the model were not so satisfactory, and I spent a lot of time without achieving the precision I hoped to. I even did not assemble the deck, because it was not precise enough.

Anyway, some considerations I made on the first model were confirmed with the second one.

a) The SIDE pieces resulted too short to match the BOTTOM and DECK SIDE pieces at stern. It is unprobable that the plans contained such an error, but I will cut the pieces a little longer, just in case... I will lave the stern unstitched and fix the final shape after all the pieces are assembled.

b) The keel shows an irregular line, i.e. two negative bubbles, one bow-wise and the other one stern-wise. See the keel line (as results from the FORMS OFFSETS table) in figure 5. I have never seen this on any boat project, so I am in doubt. The only reason I can imagine for this is that the designer wanted to create more volume where the kayak is loaded with the weight of the paddler. I even asked some people in a Kayak Club located in my area, but they could’n give me any explanation more about this. Well, by the time I decide I will cut the pieces as they result from the project (and with the help of God), leaving my doubts apart.

c) The joint line between the two ply sheets will be located some cm bow-wise the cockpit, resulting to be visible. This is in contrast with my aim of leaving the deck bright, giving the deck an indecent look. So I decided to displace the pieces, to place the joint line in correspondence with the cockpit hole, resulting almost invisible.

To shift all the pieces, I added a constant quantity (654 mm) to the POSITION values in the PANEL OFFSETS table. The resulting table is table 3, and this is the one I will definitively use.

The line in **bold** font is approximately where the joint line will be.
Table 3 – Panel Offsets (final version)

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figure 3 – tracing the model lines with a small rod fixed with pins.
Figure 4 – The second model (detail)

Figure 5 – The keel line resulting from the FORM OFFSETS data. (The scale is compressed in the longitudinal axis). See the two negative bubbles in the keel lines. They appeared in the models as well.
6) Jointing the two plywood sheets
I jointed the two sheets with a plywood strip overlapped to them. See figure 6. The strip was cut from one of the sheets. I chose a width of 50 mm, this means an overlap of 25 mm to each sheet, i.e. 6 times the thickness. The joint was glued with resin plus additives.

7) Tracing the lines.
I marked with nails the points given in table 3 without marking with pencil before. I checked twice the position of each nail (I was very careful, but I made four or five mistakes, recovered immediately), then I started to trace the lines with the method explained afore. See figure 7. The method seemed to be good: the lines appeared to be morbid and elegant.
8) Building a blade for my jigsaw

My hand-held electric jigsaw has a 1.25 mm thick blade for wood cutting, with big teeth. This blade snatches many splinters from the plywood surface, leaving it unacceptable for fine cuts. Besides, it is too thick and aggressive to allow to follow a small line traced with a pencil on a thin sheet of wood.

I decided to build a blade by myself from the blade of a manual saw for metals.

I used a SANDVIK blade, 0.6 mm thick, with small teeth. I shaped it with a grindstone. I made three blades for my jigsaw (the original SANDVIK was destroyed, so why not to have some spares?). The cutting test I made was satisfactory. The cut was slower than with the original blade, but left an absolutely perfect edge, without splinters.

See figure 8.
9) Cutting, at last

I cut the ply sheet (they were two, now they are one) longitudinally into two halves and I put them one on the other one, fastening each other with a congruous number of staples.

Then I cut out the pieces, obtaining two identical pieces at a time. I put attention in leaving the joint inside the hull both on the right and on the left pieces. This causes more anxiety for your heart than job for your mind.

I was very, VEEEEERY careful when cutting the centerline of the deck, and simply careful with the other pieces.

10) Assembling by stitching

Yes, assembling by stitching... but where can you buy bare copper wire, 1 mm diameter? Well, I found it in a do-it-yourself megastore, in the gardening section. I wondered why a gardener should need such a thing, but... why should I care? I bought it.

a) BOTTOM pieces

I filed down to 45 degrees the BOTTOM pieces at the centerline edge for about 50 cm at bow and stern, to have them facing properly once assembled. I also filed down to about 45° the side edge of the BOTTOM pieces in the central area, where they meet the SIDE pieces with an about 90° angle.

As a matter of fact, this job is unessential, since the ply thickness is small. But I did it anyway.

I put the BOTTOM pieces face to face and I drilled the holes (about 20 cm spaced) for stitching, both near the centerline and near the side line (why not at the side, Nick?). I left about 0.5 – 1 cm from the edge.

I stiched loosely the BOTTOM pieces along the centerline, while they were still face to face, then I opened them like a book. I tightened the copper stitches, leaving a small air gap between the pieces. The bottom assumed a fair shape.

b) SIDE pieces
I filed down the bow and stern straight end edges to an angle sharper than 45°, and the central area of the edge meeting the BOTTOM pieces to 45°.

I stitched the pieces at bow and stern, and put them on the bottom, such a way that they match perfectly at bow. Then I stitched the pieces at the bow and proceeded towards the stern, drilling holes in correspondence with the already existing holes in the bottom edge and stitching.

Oops! The stern I cut longer than in the project is really too long. Well, I will leave the stern unstitched in the last 30 cm and fix the differences later, as planned.

c) DECK SIDE pieces

The job was fairly the same as for the SIDE pieces, except for sharping the edges, because they meet the SIDE pieces with a wide angle. I left the stern unstitched, waiting for the deck assembled.

The result of this session is shown in figures 9, 10 and 11.

The hull assumed a superb shape, with sweet, morbid and elegant lines. I am going to fall in love with this boat.

Now it’s time to deal with the deck, i.e. the most delicate job.
Figure 10 – OH OH ...the stem doesn't match. I wil fix and stitch it later.
11) Assembling the deck
As I said above, I don’t want to stitch the deck because I want to keep it bright. I have conceived a method for this (I don’t know if this method is new, but I didn’t read it anywhere, so it is new for me).
First, I processed the data in the FORMS OFFSETS file, to calculate, for each given cross section:
- the width of the pieces
- the angles between the pieces
- the width of the boat at each edge between pieces.
See table 4. The job was done with Excel and some knowledge of geometry (Pitagora’s Theorem and Cartesian geometry).
Then I built some frames having the same width of the boat at the deck edge.
Table 4 – Measures of the cross sections (millimeters)

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<th>At sheer</th>
<th>At chine</th>
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With the help of the device shown in figure 13, I assembled the deck. The job was done without gluing, because I wanted to check if the deck matches with the hull.

The position of the frames was defined by the corresponding width of the DECK piece and not by the corresponding POSITION value in the table. So, many frames resulted in a slightly different position. The frame in pos. 2540 resulted much more sternwise than the table said. Don’t ask me why.

Figure 13 – deck assembling (scheme)
1) deck
2) rope
3) frame
4) In Italy we call this the “Spanish winch”. What is its name in English?
5) Wooden blocks (where the deck is too flat to press it direct with the rope)

The method worked good. The deck resulted fairly locked and rigid. See figures 14, 15 and 16.
Although not glued, the deck is rigid and may be lifted and transported (with some care, of course).
12) Glass and resin for gluing and taping

I had about 1 kg of epoxy resin of an almost unknown manufacturer located in my area (Italiana Resine, see para. III). This resin was a free sample I intended to use to solve a problem in my job, but it gave no results so it remained unused. Now it is time to make it useful.

In my area there are also some fiberglass boat manufacturers. I bought from them some fiberglass sheets. The lightest type they use is about 1 kg per square meter, i.e. about four times the weight to be used for a small stitch and glue boat (0.25 kg/m²). But it was very very cheap and I decided to use it as well for the internal taping, putting one layer instead of two. For the external one I will use a standard 0.25 kg/m² tape.

As an additive, I took from a joiner some wood powder (joiners have sacks of it, and it goes direct to trash). The advantage of this additive is that it absorbs the resin very much, so it is very effective as an addensant. The resin-manufacturer who gave me the resin gave me also some quartz-powder additive for a symbolic price. Well, I could get all the most expensive materials to start my job without traumas for my wallet.
13) Gluing and taping the deck

I tried to check if the deck matches the hull properly, but it was a very difficult task because the hull and the sternwise deck moved too much. So I could check them only with approximation. I had to start gluing and taping something without having carefully checked the shapes. I believed that the hull gave more possibilities of adjustment, so I decided to start with the deck. This was a mistake, probably.

First of all, I sealed externally the deck centerline with adhesive tape, to avoid pouring of resin. I varnished with pure resin the plywood at the centerline sides for a width of 7 cm approx. to prepare it to receive the glue. Then I put the deck reverse side and I bonded the inner corner with the glue (a mix of resin and wood powder), providing an acceptable internal radius. Then I taped inside, using pure resin and fiberglass stripes. I put two tape layers because there will be no tape outside. I let from 8 to 12 hours between an application of resin and the further one. To apply new resin when the previous is “young” avoids the job of sanding the surface, giving a very good adhesion.

Since I bought fiberglass sheets instead of tapes, I had to cut them into stripes (about 10 cm wide), and during this job they released many, long fiber threads. I put them apart. They will be useful to give strength to some points or to fill corners requiring big strength (like bow or stern ends).

Obviously, I did not tape in the central section, where the cockpit hole would have place.

14) Gluing and taping the keel

Let’s operate on the hull now.

First of all, I had to give the keel an acceptable shape. I tightened the copper stitches (breaking some wires) to shape the keel properly. The two negative bubbles (see figure 5) were too evident and I decided to smooth them by loosing the stitches in that area.

The job was done with the keel downside and the hull horizontal, laying on wooden supports, because I didn’t want the weight to influence the shape while gluing.

I checked many times the position of the wooden supports, comparing the actual keel line with the quotes given in the plans. This is a very delicate job, as a fair keel line is essential for aesthetics and hydrodynamics.

To help the hull to take the right cross section shape, I nailed some transversal temporary rods to the DECK SIDE pieces. I was about to nail rods to the SIDE pieces too, but the keel assumed a good shape as well so I thought it was unnecessary. The hull was rigid enough to proceed.

I proceeded as I did for the deck, but with only one layer of those heavy glass fiber stripes. Before taping, however, I had to remove the copper stitches from inside. So, I taped some small fiberglass pieces between one stitch and the other, so I could safely cut the stitches without danger of disassembling the hull. This job doubles the taping time and is unnecessary: the further corners were glued leaving the copper stitches in position, then the copper threads removed (where possible) and then the joint was taped.

Then I fully taped inside.

15) Gluing and taping the chine

Before taping the chine, I wanted to be sure the hull was symmetrical. I built an instrument by means of which I could compare corners each other, and even reproduce corners on paper. (see figure 17) I had never seen this instrument before, so I thought I was in the position of giving it a name, and I called it “the gonioscope”.

Building a Stitch And Glue Sea Kayak – by Davide Boschi - Italy - version sep 2002
Using the gonioscope, I compared the corners between the bottom and the sides at right and left. The construction was precise and I needed to correct the angles in two points only. In one I installed a rope to approach the sides, and in the other one a wooden spreader, to space them.
Then I proceeded as for the keel.
The same job was done for the DECK SIDE pieces.

16) Giving shape to the cockpit hole
The drawings on the Internet did not show anything for the cockpit hole. So I went to the Kayak Club and took some measurements on existing kayaks. They were approximate but sufficient. However, I had time between one resin job and the other, so I tried to obtain the same shape by maths. I succeeded and the result is given in figure 18. The quotes are in table 5. The graph shows the profile as seen from above. On the contrary, the quotes in the last column of the table are referred to the hole to be cut in the deck, in other terms they already take into account the increase in cutting width due to the deck angle. The deck inclination causes the real hole to be narrower than the cutout.
The hole shape made me perplexed. I thought that a traditional-looking kayak should have an oval hole, not an anatomically-shaped one. To be sure of my choice, I cut out a false hole on a light black carton and I put it bended on the deck. Examined in semi-darkness, it seemed a real hole! The look was not bad, so I decided that was the definitive shape. Besides, an oval hole would have been longer, causing rigidity loss.
From a thick carton I cut a half-shape for the cockpit cutout.
Figure 18 - The cockpit hole shape, as calculated by maths

### Table 5

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Φ is the deck angle and is supposed to vary linearly along X.

Y is the quote (half-width) of the hole as “seen from above”.

Y/cos Φ is the quote of the cutout hole.

An Excel spreadsheet is available if you want to change length, width and curvature.

The row having X=0 is the max. width section. Negative X is stern-wise this section, positive X is bow-wise.
17) What to do when the deck and the hull don’t match

Now it’s time to deal with the biggest problem. When trying to install the deck on the hull, I found they didn’t match each other:

a) First of all, a gap appeared at bow for a length of about 1 metre. The max. gap was 11 mm. See figure 19

b) A big bubble appeared stern-wise the cockpit. Trying to force the deck was resultless: the bubble appeared in another position. Another smaller bubble appeared bow-wise the cockpit.

This would probably be avoided if I left the deck disassembled, using the assembled hull as a shape for assembling the deck. But now they are too rigid to be matched together. This is a lesson for the next construction.

To increase flexibility on the deck, I cut out a pre-hole for the cockpit, smaller than the final one. But the bubbles remained.

So, I decided to cut the deck along the transversal joint line, obtaining two pieces: one stern deck and one bow deck.

It worked: the bubbles disappeared and only the gap at bow remained. I decided I will take care of it later: the method of assembling the deck to the hull will fix the problem almost automatically.

Figure 19 - The maximum gap between deck and hull was about 11 mm
18) Hull-to-deck assembling method

I decided not to stitch the deck to the hull for two reasons:

a) drilling holes in the deck will make it bad-looking

b) it will be difficult to apply the glass tape inside. Even impossible, if you create sound compartments in the kayak, as I planned to do.

The assembling method I wanted to use at the beginning is more similar to a conventional construction: it is based on screws fastened on wooden brackets, and a longitudinal, continuous corner-rod as a joint reinforcement. See figure 20.

![Figure 20 – deck-to hull assembling method](image)

Obviously, all the joints must be glued. The screws work as fastening elements while the glue hardens. But I was in doubt whether to use screws or wooden pins (about 6 mm dia.). The pins are better-looking, but the screws are safer. It is also possible to combine the two methods, as follows:

- use screws to have the pieces assembled while the glue hardens
- remove the screws after the glue is cured
- redrill the holes to a larger diameter
- force wooden pins (the same wood essence of the plywood) into the holes and sand to obtain a flush wooden surface, with the pins almost invisible.

This method allows to save the weight of the screws, and is better-looking. To keep aesthetics if leaving the screws in place, you may hide the screws heads with round wooden caps.

If some gap opens somewhere while gluing, keep the pieces in contact with some additional Spanish winch.

But these are only hypothesis: at last, I decided to use only glue and Spanish winches, without anything else.

a) I decided to cut the wooden brackets (is this the right term?) from a square wooden rod, 30 mm side. First of all, I positioned the deck on the hull with adhesive tape and some temporary Spanish winch. I marked the
positions for the wooden brackets: the first 30 cm from bow, the second 25 cm from the first, then one each 20 cm. The same I did starting from stern. In the middle, where the two deck pieces meet, there will be two close brackets: one for the bow deck and one for the stern deck.

I measured the angles between deck and hull with the gonioscope and reproduced them on paper. Finally, I cut out the brackets, following the lines traced on the paper sheet.

b) I glued the brackets to the hull. To recover the gap at bow, the relevant brackets were cut longer than the others and were installed in a suitably lifted position.

c) I measured the distance between each bracket and I cut a series of sticks from a 20 x 10 mm rod. To recover the gap at bow, the relevant sticks were cut from a 40 x 10 mm rod, so that I could install them in a lifted position, as I did for the brackets.

I shaped every stick with an approximate angle to fit the hull – deck angle, then I glued them to the hull. Finally, I paper-sanded along the hull edge to create a continuous edge, following the angle given by the brackets. See figures from 21 to 28.

Figure 21 – the bow deck temporarily positioned on the hull. The stern deck is present but still to be positioned.
Figure 22 – marking the positions for the brackets

Figure 23 – Copying the angles between the hull and the deck

Each angle was copied on paper, using the gonioscope which has a locking screw.
Figure 24 – The brackets were cut after tracing each angle on a paper sheet. To recover the gap at bow, brackets from n° 2 to 5 were cut longer, to install them in a lifted position.

Figure 25 - The brackets installed.
Figure 26 - The brackets were temporarily kept in position with some staples. The thread is to allow removing the staples once the glue is hardened.

Figure 27 – The final look of the joint line between the hull and the deck edges. A series of short sticks, each shaped with a proper angle, was glued between the brackets to create a continuous gluing surface. The angle for each stick was taken directly from the two adjacent brackets.
Note the special shape given to the stick installed in correspondence of the panel joints.
Note also that two brackets, facing each other, were provided in the section where the bow deck and stern deck pieces meet.
19) Reinforcing the hull and creating the sound compartments.

a) Bulkheads

Even after installing the continuous joint line for the deck, the hull seemed to be too flexible, except at bow and stern, where it was as strong as a battleship.

So, I decided to build some bulkheads to make the hull more rigid. Even more, the bulkheads will create sound compartments in the hull. The sound compartment just stern-wise the cockpit, on the contrary, will have a watertight door so that it can be used as a boot to transport things like safety equipment, food or even a camping tent.

To shape the bulkheads correctly, I did not find any other method than to build them in carton with an approximate shape, then cutting out them from the plywood, and adjusting them with paper-sanding to the final shape to fit the hull cross-section.

I made four bulkheads, numbered from stern to bow:
- n° 3, just after the cockpit, to be fitted with a loading door.
- n° 4, stern-wise the n°3, at 60 cm approx. from it. Between these two there will be the boot.
- n° 2, just bow-wise the paddler’s feet. The kayak will be suitable even for my brother, who is 1.90 metres tall.

So, this bulkhead was placed at 140 cm from n° 3.
- n°1, at 60 cm bow-wise the third. I was in doubt whether to create this bulkhead or not. But this is my first construction, and I have no experience of the final rigidity of the kayak. Besides, the compartment will be sound and it will be difficult to install new pieces once assembled. So, I decided to put myself on the safe side.

I planned to glue the bulkheads to the wooden brackets previously glued to the hull, and to tape them to the hull with fiberglass tape.
b) The floors for the central hull

A long section of the hull, where the paddler takes place, can not be fitted with bulkheads. Unfortunately, in this section there are the biggest dimensions (which increases flexibility) and there will be the biggest load.

As a reinforcement for the central section of the hull, I built three floors (is this the right term in English?), two of them to serve also as seat supports.

All the floors were made from a 30 x 30 mm square wooden rod.

Where the seat has to take place, the floor is made of three pieces, one horizontal and two almost vertical. One of these floors was placed 6.5 cm bow-wise bulkhead 3, the other one 32 cm bow-wise the first, to match the position of the nearest wooden bracket.

Two wooden wedges were placed below each floor to increase strength, while in the middle I left a gap for free water circulation. At each corner I placed two reinforcements (I think they are called "knees" in boat building), taking care to leave the suitable gap (390 mm) to fit the seat between them (or, even better, to use them as a guide for a removable seat).
The third floor is located just below the paddler’s knees. To avoid to disturb the paddler, the transversal rod follows the hull angle and is made of two pieces. A half-circular hole allows inner water circulation and makes drying inside easier. No care must be taken for the dimensions of the knees.
See figures 30 and 31

Figure 30 – The two floors, serving also as seat supports. A suitable gap for the seat must be left between the knees.

Figure 31 – The third floor. The knees are not shown in this figure.
Figure 32 - The floors and bulkheads installed, before gluing. This view is from bow to stern.

The two horiz. floors will work as seat supports. The bulkhead just behind them (n°3) will have a door (still to be cut) to give access to the inner boot.

The bulkheads were placed in such positions to be glued to the brackets.

The bulkhead n°1, the nearest to the bow, is not visible in this picture.

c) The beams for the remaining hull
To give rigidity to the hull, I decided to install some additional beams (I hope this is the right term in English), i.e. pieces connecting the two sides of the hull with strengthening purpose. These pieces were cut from a 10x30 mm rod, and shaped so that they could be glued to the brackets, connecting them from right to left side.

One of these beams came in the middle of the boot. All the other came in the sound compartments.

No beams were fitted in the cockpit, where the paddler takes place.

d) Reinforcements for the bottom
From the same 10x30 mm rod used for the previous job, I cut some pieces to be glued to the bottom, with diagonal orientation.

e) Creating the hole and the door for the peak.
Before gluing all the reinforcement pieces, I had to cut the loading door in bulkhead n°3.
I traced a pentagonal shape on the piece, trying to leave enough material around, but the hole appeared too small to allow loading big objects (like a small camping tent, for instance). So I decided to cut a reasonably big hole, and to reinforce the bulkhead with a frame all around the hole itself. This frame will serve also as a flange to rest the door.
The hole resulted to be pentagonal, 350 mm wide, 210 mm high in the middle and 170 mm high at sides. At the corners I traced a suitable radius. This radius was too small to be cut with my self-made cutting blade, and I had to make a narrower one.
It was my aim to use the same cutout, resulting from the hole, to make the door, in order to maintain continuous wood textures between the two pieces. So I had to find a method to create a point to start cutting, without making holes in the inner piece or damaging the external one.
With my hand-made cutting blade, I engraved by hand a slot along the cutting line. I had to be very careful and patient, but the plywood is thin and the job was done in 10 minutes. Starting from this slot, I cut the hole in the bulkhead, leaving intact both the inner cutout and the outer frame.
As I foresaw, the bulkhead resulted very weak with such a big hole. So, I built a reinforcing frame all around the hole. The pieces were cut from the 10x30 mm rod (already used for other reinforcement pieces.) See the frame in figure 34 (left). The reinforcements to the lower and upper sides of the hole run from side to side of the hull, working as beams and then giving big strength. The reinforcement of the upper edge is also destined to be glued to the inner side of the deck.
The frame pieces were sized and shaped to create an inner rest frame to the door about 9 mm wide, enough for a plane gasket (eventually).
Four reinforcements were glued to the door, to complete the job. See figure 39.

f) Frames for the bulkheads, to glue the deck
The bulkheads will be glued to the hull by fillet-bonding with resin plus addensing additives, and eventually a glass tape.
But this method can not be used for the inner side of the deck, because it is impossible to reach the bulkheads to glue them to it. On the other hand, the sound compartments have to be sound (otherwise, why to call them like this?).
So, a frame for the bulkheads must be provided, to increase the gluing surface and to support a suitable amount of glue destined to receive the deck (as it was done between the hull and the deck edges). This joint line will provide enough gluing surface, the bulkheads being too thin for this.
From a 10x30 mm rod I cut and shaped the pieces to create the joint line for bulkheads 1, 2 and 4. The bulkhead n° 3 is already provided with it (see previous paragraph).

Now, we have all the pieces we need to reinforce the hull: bulkheads, floors, beams, floor reinforcements: we just have to glue them to it.

See figures from 32 to 34 showing the result and the final layout of all the reinforcements.
The internal hull is now almost complete: it still lacks only the footbraces, the seat and the final sanding and resining job. I will probably fit some accessories more, but I have still to think about this. Now let's take care of the external hull.

**20) Resining and taping the external hull**

For this job, I turned the hull upside down.

First of all, I sanded the external corners of the hull in order to create a suitable radius to rest the glass tape. I also sanded the bow and stern to a straight line. Then I fixed all the unprecise matching and the gaps between

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**Figure 33 – Layout of the hull reinforcements and compartments**

1 – Transversal rods (beams)
2 – Blind bulkheads
3 – Bulkhead with door
4 – Horizontal floors (seat supports)
5 – Floor
6 – Diagonal bottom reinforcements

**Figure 34 – details of the hull reinforcements**

The frame for the door - fitted bulkhead (stern side, i.e. this view is from inside the peak)
The same frame, seen from bow (it works as a door rest) and transversal beams.
Upper frames for the bulkheads (to glue the deck) and transversal beams. This is the bow.
the plywood edges with epoxy filler (resin plus quartz powder as an additive). The biggest unprecisions were near the bow and stern, but this was not a very difficult job.

Then I taped all the corners with light (240 g/m²) glass tape. I decided to use only one layer. The glass tape was so wide that the SIDE pieces were almost completely covered. At bow and stern I had to cut the tape longitudinally into narrower stripes, to avoid overriding.

The method was the usual one:
- first, light wetting with pure resin to penetrate the wood fibers
- second, heavy wetting of the plywood
- third, applying the glass tape onto the wet resin
- fourth, final wetting of the glass tape to full penetration of the resin into the glass fibers.

All these phases were carried out with pure resin, without any additives.

The tape I used came from a roll, so I used only one tape cutout for any corner.

I used a special attention for the bow and stern lines: a short tape piece doubled around them to give strength to these delicate sections of the hull, often subjected to accidental shocks.

The job required some days, because it had to be done in horizontal, and I had each corner to be hardened before taping the further one. I tried to use just the quantity of resin required, to avoid unaesthetical dropping along the hull, hard to be fixed once hardened.

After this job was completed, the hull didn’t look very well: the steps along the tape edges were evident, as well as the canvas-looking surface of the glass tape. The further job will be to use filler on the external hull, to obtain a plain surface.

21) Filling the external hull to a plain surface.

I can’t teach very much about this job, unless it is very tedious, dirty, dusty and slow.

First, I sanded the surface to remove the excess of resin, and to make the surface defects sweeter especially on the glass tape edges. Then I prepared some filler by adding very thin additive powder to the resin, and I applied the filler with a wide spatula.

Unfortunately, it is almost impossible to obtain a plain surface with the spatula, because fillets of filler remain aside while applying, so when you try to remove defects from one area you will probably create some elsewhere.

It is a job requiring big patience. The most delicate points are:
- the steps at the sides of the glass layer, to be blend with a decreasing thickness of filler to the wood surface
- the hull corners, to be filled with filler providing the same radius all corners

(If somebody can show me a better method, I will be grateful to him for life).

After applying the filler, a complete surface sanding is required.

22) Sanding the external hull

When working on the internal hull, I experimented how hard the resin is when you decide to sand it. I used an electrostatic-coated paper (it is red colour) sold in tapes, having the same width of my orbital sander (this is an advantage, of course). This paper was good for wooden surfaces, even dropped with some resin. But it was in crisis when sanding on a completely resined surface: it caused local heating on the resin reliefs (like hardened drops, for instance), melting of the resin and adhesion of the melted resin to the sanding surface, which became irregular and unusable.

So, I decided to use such paper for gross sanding and to finish the surface with waterproof paper and water.
The advantage of waterproof paper is that it lasts more, the water washes the dust away keeping the surface free for sanding, and cold so that the resin does'n melt. Besides, you don’t produce dust (not in the air, at least), and your lumbs will thank you for this.

23) Building two frames for road transport

Winter has come and I have got to take note that I have no heating in my garage. Differently from Nick Shade, building a kayak is not a winter project for me. Besides, in Italy energy is expensive... different conditions from U.S., Nick!

So I must stop working on the hull and concentrate my job on smaller parts. Loading frames for road transport are among them.

I planned to build two frames to be fixed onto my car’s top loading bars.

I have a WW Golf (Rabbit in U.S.) with a small roof. Besides I sometimes transport my bycicle and I usually install the top rods about 82 cm spaced, which is less than ideal but enough.

The frames construction scheme is shown in figure 35. The angles between pieces were taken on two sections of the hull, 82 cm spaced.

I used 25 x 45 mm wooden rods recovered from some used shipping pallets (light type), destined to rubbish. I have a lot of such wood, to be used for temporary jobs on the kayak. I had to choose some in good conditions, which was not difficult. An environmental-friendly and definitively cheap solution. Two shaped metal plates (conceived for self-made furniture) served as reinforcement and mounting fittings. See figure 36.

To fasten the frames to the car’s bars, I used four pieces cut from a metal rod and screws. Eight winged nuts will make mounting easier (but you may use hexagonal ones, if you want).

The pieces were glued with epoxy, which could seem a waste but, you know, they must be strong and safe... epoxy paint was used for painting.

Finally, some pieces of foam tube for thermal insulation will provide a soft rest for my creature.
Figure 35 - Scheme for the transport frames and final look

Figure 36 - Two metal fittings (originally T-shaped plates and carefully bent) provide reinforcement and (with the help of metal counterplates and bolts) mounting pieces on the car's loading bars, without drilling big holes in the wooden rods.

1) Metal fittings  
2) Counterplates  
3) Rubber cushions

24) Preparing some bent pieces for the combing
The combing will be made of a bent wooden rod, with a “L” shaped cross section obtained by stripping some plywood layers. See figure 37. I tried many methods to make it. Nich Shade’s method seems to be effective, but... I didn’t understand it very well. Would you like to make your description a little bit clearer, Nick?
After trying to bend (with hot water, vapour, ammonia...) plywood stripes, mahogany stripes, and some other
madnesses, I decided for the only working madness, i.e. to bend plywood after boiling it in water for a couple of
hours.

![Diagram of combing cross-section](image)

Since I hadn’t such a pot, I had to boil and bend only short pieces (about 22 cm) to form the bent sectors of the
combing. The sectors with small curvature were bent without boiling.
The plywood, just taken out of the boiling water, can be bent quite easily (even though I almost cooked out my
fingers). I clamped the hot pieces onto the inner side of a bucket having approximately the same curvature I
wished, and I left them in position for a couple of weeks (maybe two or three days would have done as well,
who knows?), then I removed them. They kept the curvature perfectly, with no elastic return.
The cross section I planned required one strip 22 mm in height, and one 30 mm, plus some 10 mm in height to
build the cockpit edge. A reinforcement on the internal side of the deck will make the whole assembly stronger.

25) The boot door
The cutout of the hole in bulkhead 3 was used to make the door, as explained above.
An inner frame was built with a 15x10 mm cross-section rod. Two plywood stripes were glued to the lower
frame to nest it to the bulkhead frame. The door is intended to be removable. To rest it and allow opening and
closing I built an handle with a small mahogany rod, fitted with a screw. The inner locker was built with another
wooden rod, and fitted with a nut. A second nut was used to fasten the locker to the screw, which worked as a
small shaft.
To fit the screw and the nut I made a partial hole a little smaller than the hexagonal shape of the screw (nut) so that they could be strongly embedded into the wood. Some resin completed the job. People who looked at this method suspiciously may be quiet: it is effective. I tested it on my sail cruiser, as a mounting system for the removable support of the tiller autopilot, and it is still in place after many years of trouble-free service. Resin is only for sealing the hole in the wood, the nut remaining in position with no further help, provided the hole is well sized.

Obviously, the system is good only for axial loads or torque, it is not for buckling loads.

To hide the screw head inside the handle I fitted a thin, round wooden cap into the hole after gluing the screw, then I sanded to a flush surface.

See figures 37 to 40.
26) The seat frame

The seat frame is made of a double plywood (8 mm) thickness, dimensions mm 330x390, reinforced with two longitudinal square rods (30x30 mm). See figure 41. When gluing the rods to the frame, beware they do not interfere with the bottom hull or with the bottom reinforcements. The longitudinal square rods match perfectly the space between the seat supports in the hull, so that the seat is longitudinally stable. In the transversal direction, it rests between the knees, so that it may be nested into the hull, and may be removed vertically.

As a matter of fact, this piece is intended to be removable from the hull, to allow hull accessibility. So, I didn’t glue it. A good cushioning (still to be invented) will give my butt comfort and pleasure.

27) The footbraces

As far as I had heard about, the best toeclip type is made in ladder-style, with different steps to match any paddler’s tallness and pushing force. See figure 42.

I had to decide whether to make wooden footbraces or to buy ready-made plastic ones. I decided for the second solution. As a matter of fact, the plastic ones appeared much more comfortable, due to their round shapes and their hollow inner space, than I could have obtained from massive wood.

However, a method to mount the toeclip had to be fitted to the hull.

This was obtained by gluing two 20 x 40 mm mahogany rods fixed along the hull to the wooden brackets. The dimensions of this pieces are quite massive, but I couldn’t find smaller ones, and I discounted the idea of stripping them from smaller ones.

I embedded two 6 mm stainless steel nuts (I forgot to advise: all metal fittings have to be stainless steel at least) in the rods using the same method as shown in right figure 38, to provide fastening points for the footbraces. See figures 43.
The so installed frames will also reinforce the hull, since they are fitted in a section in which the hull is poor in reinforcements. Of course, the so fitted toeclip will be removable and replaceable just by removing the two screws each, the supporting frames remaining in place.

28) Two holes for the lifting ropes
All the kayaks I have seen have got one hole at each end. Two small ring-knotted ropes, passing inside, allow the boat to be lifted by two people. The holes serve also to fasten the kayak to the car top, to moor, and for many other purposes, so I decided my kayak should have such holes.
I drilled two holes, 10 mm diameter, and I put inside one small length of 10 mm diameter copper tube, after filling with resin inside the holes and varnishing the tubes. I used a plumber tube for water and gas (a plumber who did a small job in my house gave me enough for one hundred kayaks, I think). Copper is corrosion resistant and will not suffer damage. Besides is easy to shape and to sand. Resin does not adhere to metals very well, but the piece is so small that I think it will stay in place in spite of temperature changes and stresses.

See figure 44

Figure 44 - Two holes, with a copper tube resined inside, at bow and stern.

The bow and deck ends of the hull had been abundantly filled with glass fibers and resin (each time I had some resin left after the day’s job, I poured it into the bow or stern), so the holes and tubes run from side to side of the hull on a completely resin-wounded path.
29) Before continuing... a floating test
I thought that a floating test would have made me sure that the boat balancing was OK, mainly in the longitudinal direction. As a matter of fact, I built the seat a little more bow-wise than it was shown on the (poor) drawings I found on the Internet, because it seemed me too backwards, but in spite of this, it still seemed me to be too much. So I painted the hull with just one layer of resin and I loaded it onto my car’s top to take it to the lakeside some kilometers far.

With the help of my brother (thanks Guido) I put the hull into water and we got on board (leaving apart that this was just a test, it was very exciting... WOW!). I couldn’t paddle, anyway, because... I had not yet a paddle.

As a matter of fact, the stern was a little bit more submerged than the bow. I don’t know whether this was in the designer’s aim or not. Trying to compensate by displacing my butt ahead or behind gave an almost negligible effect, so I decided I will cut the definitive cockpit hole ahead as planned.

See figure 45 and enjoy.

30) Gluing the deck
Now it’s time to glue the deck. Since it is divided into two parts, the job will be done in two stages. I decided to start with the stern.
First of all, I sanded the wooden brackets and the hull edges to be glued to the deck (corner joint line and bulkheads), and I varnished them with pure resin. Then I varnished with pure resin the internal side of the deck to make it waterproof. Finally I placed the deck onto the hull.

To install the deck in the right position, I fixed it with adhesive tape at the extreme stern, keeping it lifted with a wooden rod at the opposite side (like a car hood).

Then I put an abundant quantity of glue (resin added with wooden dust to reach the consistence of jam) on the gluing surfaces of the hull (not on the deck, the deck was just wetted with resin). Finally I lowered the deck onto the hull and I fastened it firmly to the hull with a big number of Spanish winches. There was one Spanisk winch each 20 cm about, but to distribute the pressure along the line I put a lot of small longitudinal wooden rods under the rope. Besides, some vertical spreaders were placed to press where adhesion to the bulkheads was required. See figure 46

Figure 46
Spanish winches to keep the deck in position while gluing to the hull.
Note the sticks to make the contact pressure uniform.
Note also the vertical sprags to press against the bulkheads upper edges.

This is the stern deck.

I glued the bow deck after the stern one was ready and the Spanish winches removed. Gluing the bow was a likely similar job, except it required a bigger number of Spanish winches because it was harder to match it to the hull. They were definitively incredibly strong! Besides, to position the deck I had to take care of the final position of the joint line with the stern deck, where I wanted to leave as a small gap as possible.
Where the gap between deck and hull had been fixed (see chapter 18), I had to put some filler. I used the glue coming out of the joints for the gross job, plus some more for the finer one. The job required about 12 metres of thread (curtains type, with no elasticity) and about 60 wooden rods of various lengths, cut from old shipping pallets. After the job, I sanded (first with a 90° disc sander, then by hand and with my orbital sander) the angle between deck and hull. The deck was cut a little bit abundant so that there were no vacations. I tried to obtain a quite sharp angle, because I aimed to paint the hull and to leave the deck bright wood, so a sharp edge would have helped me in establishing the boundary between the two colours.

31) Building the cockpit combing

Now only the combing is left. I cut the final hole in the deck (a little bit ahead than planned, see chapter 29) using my carton shape. The cut was a little smaller than the final one (three millimeters about). I glued some plywood stripes below, to double the edge thickness (see figure 37) and finally I cut the hole to the final size. Now I have a perfect hole, with enough edge thickness to glue the combing stripes. First I glued the external layer, starting with the pre-bent pieces I prepared in chapter 24. The layout of each layer is shown in figure 47. For the sections with smaller curvature I used flat stripes and I bent them when gluing in position.

![Figure 47 – layout of the combing, divided into pre-bent pieces and flat pieces, bent when gluing](image)

The job was quite long because I had to divide it into steps:
1) the four pre-bent pieces, external layer
2) The flat pieces, external layer
3) The pre-bent pieces, internal layer
4) The flat pieces, internal layer.
5) The edge (only one layer, not three as shown in figure 37)

I had to wait the resin to be hardened between each step and the further one, to obtain the precision I aimed. To keep pieces in position I used clamps and staples. Obviously, the curvature of the pre-bent pieces was quite approximate and I had to fasten them in position to fit them to the final shape.

The final look of the combing was quite satisfactory. See figures 49 and 50. The construction resulted to be extremely rigid and strong.
32) Painting

Painting was carried out in various steps:
- I sanded definitively the hull, fixing the small defects left with some filler. Then I painted it with two layers of pure resin.
- I sanded the deck (which was still at the state of bare wood) and I painted it with two layers of pure resin.
- I painted the hull with a blue, epoxy paint. For this job I chose a paint from my resin supplier: In practice it was the same epoxy resin used for gluing, added with pigments. This choice gave me many important advantages:
  - complete chemical compatibility with the underlaying resin
  - absolute impermeabilization
  - surface hardness and strength.

Unfortunately, to obtain an aesthetically acceptable result was a very painful job. This is due to the nature of this paint. As a matter of fact, most paints reduce their volume when hardening, creating a “flat skin” effect which automatically fixes brush stripes and small irregularities and provides a glossy surface. This is not the case of epoxy resin, which keeps its shape and volume after hardened. So I had to be very careful when applying this paint, and dilution with a small quantity of alcohol was necessary to avoid brush stripes. Nevertheless, to obtain an absolutely regular surface was impossible. Anyway, I think a strong finishing is always better than an aesthetical one, so I kept this result as satisfactory. When this boat needs to be repainted, (in many years, I hope) I will try do do better, probably with a polyurethanic paint.
- To finish the deck, I applied three layers of bi-component, poliurethanic, transparent, UV protected paint. UV protection is essential because sun rays damage and destroy the unprotected resin, and make the impermeabilization inefficient after some time of exposure. While the underlaying resin provides water resistance, this paint does provide a “flat skin” surface and gives natural wood a bright, glossy and spectacular look, without the problems I experienced with the hull.

33) Final look

Let’s have a look at the final results (figures 48 to 50). The boat looks elegant and distinctive, although I had preferred a brighter look of the blue hull. She is even very slender and much longer than any industrial kayak I could find in my country.
Figure 48 – laying on the path to the garage she was born in

Figure 49 - The combing look. The peak door, the floors and the brackets are also visible in this picture.
34) Technical data

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35) Nautical test results.
Paddling on this kayak was my second paddling experience in my life. You say, new the kayak, new the builder, new the paddler... some friends of a kayak club in my neighborhood gave me their impressions, too.
Remarkable things:

a) The first thing I remarked when sitting on board was the high baricenter. I think this was due to two separate causes:
- low draught due to the high volume of the boat: this keeps your seat high on the water surface
- high position of the seat.
It is possible to correct a little the second item, not the first one.
Although your baricenter is high, this does not disturb the stability because...
b) Lateral stability: the boat is as stable as the others I tested the same day (thank you friends!). The same feedback came from friends who tried my kayak to compare it with their own ones.
c) Longitudinal baricenter: Really should I better place the seat about 30 cm ahead? As a matter of fact, most of the kayaks I have seen are kind of trimmed down by the stern. From an hydrodynamical point of view, this should be disadvantageous, shouldn’t it? Anyway, my kayak is not more trimmed down by the stern than the other ones. But my personal opinion is that she should be less. I’ll take note of this for the next construction.
d) Hydrodynamically she is spectacular: I paddled for about 1/2 kilometer together with a friend on a 3.50 meters kayak aside. His boat produced waves at bow and a turbulent wake, and some noise, too. My kayak, at the same speed, gave rise to a very small wave at bow, leaving an almost flat wake. She really proceeds light and silent, like a fairy on the water!

I suppose this is due to length: as it is for sailboats, the longer is the boat, the faster she is.

Why do I point out on things like wake and noise? Well, water turbulence and noise are some sort of waste energy...the smaller they are, the more efficient is your boat.

On the other side, she is very hard to tack, due to her length and to the angle-keel. I estimated she takes about five times her length to make a 180° turn, paddling on one side only. If you paddle on one side ahead and on the other one back, you may turn on a smaller radius, of course. But it is hard anyway.

For the same reason, my friends estimated (but I couldn’t test yet) that this kayak is very stream-sensitive, this is, in case you find a transversal or obliquous water stream, she will easily follow it, loosing her course and forcing you to correct it. Actually, this is not a kayak for streamy waters (she was declared to be a “sea kayak”), so this is not a surprise for me.

I did not test her yet on the sea, with waves and wind and so on. If you want to know how she does, please contact me later or wait for a further edition of this book (if any).

e) I tried to capsize as a trial for me and for the boat too. All was OK, but the inner boot boarded a lot of water, and everything inside was wetted. I will have to fit a neoprene gasket to the door, to make it sound.

Definitively, from the tests I made, this should be a boat for long trips, thanks to:
- low running resistance
- good static stability
- very good course stability
- sound compartments
- big boot volume
- strong construction

and this was the result I was looking for.

36) Lessons for the next construction (and for yours)
a) It was a big error to assemble the deck and the hull independently. Once glued, they were too rigid to fit each other, and I experienced troubles (the biggest one was the gap between hull and deck at bow). I think the best way should have been to use the assembled hull as a shape for the deck. The next time I think I will try as follows:
- First, assembling and gluing the hull (taking care of the cross-sections given in the plans, not ignoring them as I did).
- Then temporarily positioning the deck pieces (with adhesive tape and Spanish Winches) and gluing them each other at centerline, obtaining two deck pieces (bow and stern). Gluing shall be done in two stages: first a preliminary gluing with the deck pieces temporarily in position, then completing the gluing and taping (only internally) after removing them from the hull.
Maybe this method will bring to gaps between hull and deck, maybe not, depending on the precision of the job. But if this happens, you know how to fix them.

Anyway, if you think you have a better method, do not hesitate to use it, and to advise it to me.

b) I had planned many methods to assemble the deck to the hull without stitching: glue with screws or pins, etc. The one I choose (only glue) is very strong, aesthetically good and relatively quick, so I will use the other ones only for much bigger boats, if I ever build.

I even believe that the brackets along the deck sides are redundant. The joint corner rods running all along the hull sides give big strength and enough gluing surface by themselves. A job that could be avoided, with extra weight saving.

c) I used big weight glass fiber for the internal taping and light weight for the external one. This was because the big weight tape is less expensive but unaesthetical. This is correct, in principle, but I forgot that there are some sections of the internal hull that are visible when the boat is complete, namely from the cockpit hole. So, I should have taped with light tape also in some internal areas. To be remembered next time.

d) The hull is really strong. I think that a 3 mm plywood would have done as well, with weight saving, provided all the reinforcements I described are installed.

e) I have already written about the seat position. I think that to place it about 30 – 40 cm ahead would have been better, regardless of the way most commercial kayaks are built.

Of course, from a theoretical point of view, displacing the seat involves to displace the sound and boot bulkheads and (remember!) the cockpit hole and the joint line between the bow and stern deck. Definitively, the panel offsets table should be changed, displacing all pieces ahead. This is not the case, because the joint line come ahead compared to the position I planned, so when repositioning the cockpit hole you will have probably the deck joint in the right position.

f) I didn’t test the cockpit combing by installing a sparyskirt. I am afraid that the external lip is too small (4 mm) to fasten it: on all kayaks I have seen, it is 10 to 15 mm. I think it would be too long and difficult to strip 3 or 4 mm layers to reach 15 mm thickness all around the combing, so I think the best way is to glue some round-shaped pieces, laying horizontally. See figure 51 for a foreseen cross-section. But my kayak remains as it is, by now: I will do this job later.
f) Finally, I have some doubt that the external glass tape is really necessary, for such a small construction. As a matter of fact, my deck centerline, which was not taped outside, seems to be strong enough. Not to tape the external hull would have saved not only money to me and weight to the boat, but also a lot of time, both for installing the tape and, above all, for filling and sanding. I think I will try the next construction without taping outside.

Considering the weight saving provided by thinner plywood and the elimination of tacks and external taping, I believe that I could save 3 kilograms at least.

g) A suggestion: if you want your wooden boat (whichever she is) to last long, do not try to save money on material quality, especially on paints. Painting is not a finishing stage: it is as important as the whole construction. And, when you have to choose between aesthetics and protection, choose the second one. Aesthetics can be improved when doing maintenance, but a rotten piece of wood is a much bigger problem.

h) About tools: to build this boat, I have used the following tools:
- electric hand-held jigsaw
- disc electric sander
- orbital sander
- electric drill
- a sandmill, used only to shape cutting blades (but the disc sander would have done as well)
- 12 screw clamps (some more have would been better)
- a stapler

Figure 51 – A probably better way to build the cockpit combing. 
- standard hand tools (hammers, screwdrivers, etc)
- a lot of recovered wooden rods for temporary purposes (the best way to find this important resource is from used shipping pallets)
- brushes, cans, spatulas, syringes to handle resin and paints.
I think I have used the nearly minimum tool set. If you have a bigger one, this is good for you. If not, you know that this job may be done as well.

i) I wrote that this is a rather difficult boat for a first construction. Strictly speaking, it isn’t. Naturally, it is made of eight pieces instead of four or five like a sailboat or a bent-deck kayak. But you have just to be careful in cutting the pieces and in giving the right shape before gluing, everything else being a matter of time, patience and method.

37) Important notes to keep always in mind when handling resin and bi-component paints
a) Even though it could seem redundant, I advice you to wear rubber gloves when handling resin, and dust masks when sanding. When you sand wooden and especially resined surfaces, do not carry tobacco or cigarettes with you, unless you want to taste the flavour of wood or epoxy dust.

When some liquid resin dropped on my skin, I used water, soap and a strong brush. It might seem masochistic to use the brush (it’s not pleasant, believe me), but I prefer it rather to solvents, which allow chemicals to penetrate under the skin, and in your lumbs, too.

b) Always mix small resin quantities. Resin hardens in less than 24 hours but has a short pot life, this means that it remains fluid for a short time, about half an hour. After this time, it is still good for filling or gluing, but not for wood impregnation, because it does not penetrate well into the wooden fibers. Remember always to impregnate wood with pure fresh resin, for complete penetration.

c) Before gluing, always impregnate wood. The resin penetrates into the wood fibers anchoring strongly to it, providing an ideal priming for the further gluing. This should follow the priming shortly: always try to glue on incompletely hardened resin. As a matter of fact, new resin attaches well on young uncured resin without sanding, which is necessary if you want to glue on completely cured resin.

d) At the engineering University I learned that, when a material breaks (metal, wood, plastic, etc.), the rupture crack ALWAYS starts from the surface. So, if you harden the surface, the strength of the piece increases dramatically. It might seem crazy that the strength of a wooden piece may be increased just by painting it with resin, but it is true. If you don’t believe it, ask an engineer for confirmation.

This is applicable to wood too: when the resin penetrates the wood, it hardens the surface and a small thickness below it, so that the mechanical strength of the piece is increased.

For his reason, ALL wooden surfaces have to be impregnated with at least two layers of resin. This is not just for protection against humidity, but also for a structural reason. Even if you plan to paint a surface (let’s say the deck, for instance), always varnish it with resin before. It will gain big strength with a small increase in weight.

e) To measure exact quantities of resin and hardener, I used big (about 50 cc) one-shot plastic syringes for medical purpose. Sometimes I had to prepare multiple quantities, but the method is very precise, and very cheap. I always used two syringes, one for the resin and one for the hardener, and I mixed them in a small tunfish can. After using the syringes, I extracted the pistons to end of stroke so that if they glued to the cylinders it would have been easy to push them back and detach them (on the contrary, it would be impossible to pull back the piston after it was glued at top of stroke). With this method, the syringes were usable for about ten - twenty times.
f) Never use the same tools for resin, hardener and mixture. Tools used for the mixture shall never come into contact with the pure resin or the pure hardener, and vice versa in all combinations. If you want a drastic suggestion, keep them one meter far from each other. Resin is expensive and any care should be taken to avoid to damage it.

g) Do not try to use resin with low room temperatures: I tried but it was a disaster: the resin couldn’t cure enough. I didn’t take measurements, but I estimated that 13°C is the minimum acceptable to have the resin cured. The manufacturer will give you all the information you need on this point.

h) Brushes used for resin can be washed in nitro diluent or (better) in acetone, but if the resin is not fresh you won’t be able to clean them completely. After, wash them with water and soap, and put them in sunlight to have them dried off. They will last for three or four times, exceptionally more, before becoming as hard as golf clubs. So, don’t waste your money in buying quality brushes.

I say bye bye to you with a picture of myself enjoying a summer cruise.

Good job!