Building a Murray River Paddle Steamer

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1 The Murray River

The Murray River System in Australia makes for one of the worlds great river systems rivaling the Nile & Mississipi for the water shed area. Consisting of the Murray, Murrumbidgee, Darling, Edward, Wakool, Goulburn & Rufus all which enter the Murray along its 3200 Klms (2000 Miles) journey from near Mount Kosciusko on the N.S.W - Victorian Border, and exiting to the sea in South Australia. The Darling's headwaters is near the coast on the NSW/Queensland border and traverses the state of NSW joining the Murray near the NSW/Vic/SA borders.

Although the system offers some 5600 Klms (3500 Miles) of navigatable water, the rivers can be very shallow during summer, often less than 750mm (30 inches!), and slow moving, except in flood, and having a very slow fall over largely flat plains, offering many snags, shallow sandbanks, unusual current patterns and rock outcrops for the unwary skipper, also the river meanders some 3 times its actual direct line distance. There's an anecdote about a Skipper who seeing a camper on the shore, ran his boat near the bank to flood the camp site with paddle wash, the angry camper ran across the short headland to await the boat and as it came around the bend and took 'pot shots' at the passing boat with a shotgun!

Early attempts to consistently navigate the rivers great length by boat failed due to the type of boat being quite unsuitable. The English designs were too long and slender and relatively deep of draft. The American Stern Wheelers unwieldly as pushing barges was too difficult in the rather narrow river. Neither type were manouvable enough for the Murray/Darling system as it became known. First navigation took place in 1853, by the 1860's there were 41 paddle steamers and associated towed barges, by the 1870's some 240 units were working the system.

2 A typical Murray River P.S

In a fairly short time a typical Murray River Paddle Steamer was developed, being shorter and wider beam, relative to length, than either of the foreign types, typically some 110ft long, 18 feet wide and 30+ feet over the side paddle boxes, draught from 18 inches to 5 feet, also somewhat blunter in bow and stern lines to allow for greater carrying capacity. In 1930 a record load of some 2000 bales of wool, @200-250 lbs per bale (approx 180 to 230 Ton), was transported by a single boat/barge combination!

The Murray River Paddle Steamer developed into a quite interesting boat due to the nature of its work environment. Often built around a steel frame the lower hull was planked in River Redgum (Eucalyptus) planks of 4 inch thickness which were steamed to assist fitting, the above water line hull was often sheeted in steel to avoid the upper hull leaking when the huge loads forced this section of the hull under water (a fully laden boat often ran at or near the deck line!), and towed a heavily laden barge as well. The above waterline section of the hull was subject to drying out during prolonged periods working lightly loaded in extreme heat experienced in the 'outback'. The deck & superstructure were constructed of timber. An interesting feature of River Redgum timber is that it does not float, is extremely hard and is almost rot proof.

Although somewhat crude by European building standards, Murray River Paddle Steamer's were built by expert craftsmen of the day, and most boats had quite long working lives. Roads, Railways and Time eventually overcame the whole river transport industry and the few boats that remain today are usually based at tourist centers along the Murray River, and operate close to their home ports. By the 1920's the decline of river transport was well advanced but their importance to developing the inland of Australia cannot be underestimated.

3 The model of the P.S.Industry

This model is loosly based around the dimensions and style of the P.S.Industry which was built in 1911 for snagging the lower reaches of the Murray. I have made no attempt to create a scale model , just a model that depicts the general craft. Note that there are no plans of this model, the hull was constructed around dimensions derived from a very poor reproduction of a plan in a book after choosing the overall length. When the problems of motor, battery, paddlewheel location were solved, the deck was installed, then the superstructure designed and built. The boat's running gear was developed and tested using the hollow hull without deck.

After some research and studying many photos of old paddlers I came to the conclusion that full sized ones were developed by the same process! Many sucessful paddlers were simply built from existing barge hulls.

So the process must have been , here's a hull, there's a boiler and motor(s), drop them in , fit some paddles, and now build an appropriate superstructure depending upon the boats function. So feel free to make up your own design that suits your needs, I suggest a visit to the internet or your local library for some example boats.

4 Tools and materials used

Although we are making a model, I don't like using modeling sized tools and materials, so this Murray River Paddle Steamer is constructed using full sized tools & timber.

It is important to note that the measurements used here are guides only, and I refer to 19 x 19mm for eg, just to guide you in what timber I used for what task. It does not matter if you use 20 x 20 or 18 x 18, or what ever, as long as you are consistent for that material usage.

So I used :

1. a 325mm (9.25 in) bench saw (must be true !)
2. a 75mm power hand plane
3. a 100mm power hand sander
4. a 25mm vertical power belt sander
5. a 450mm scroll saw
6. a power table router

The type of glue used in boat building is important and as most hobby glues are not waterproof, they should not be used where contact with water is expected. Note that your typical 5 minute epoxy is not waterproof.

I used four glues in constructing the Murray River Paddle Steamer :

WeldBond is very high quality white glue that dries clear and will bond almost anything,long drying time, waterproof. Manufactured in Canada. Great glue.

West System Epoxy perhaps the worlds most popular epoxy glue for full sized boat building, why not for models? Very versatile, extremely strong and waterproof, long curing time.

PurBond a Polyurethane Waterproof Adhesive which has the nice feature of expanding like foam to gap fill. Fully waterproof and excellent working properties. Manufactured in Australia so may not be available elsewhere. I found this glue after starting the project and would have used this glue for most of the construction. Lovely glue to work with, medium curing time of 2-3 hours.

Hot Glue Gun great to quick assembly of parts, waterproof, very rapid curing time (circa 60 seconds), much cheaper than CA 'super glue' for similar tasks. CA is a better glue however as Hot Glue is not really a structural glue.

The timber used was :

Hull Bottom Pine plank, 19mm thick, 240mm wide and 1270mm long for the hull bottom

Hull Side Planking Oregon 'sticks', 9 x 9 x 200mm long for planking the hull sides,

Bow & Stern Planking Oregon planks 40 x 9 x 200mm for forming the curves in bow and stern.

Deck Planking Straight Grained Pine 7 x 10 x 1270mm planks for deck material. Planed to about 5mm after cleaning up.

Cabins 2mm 2 ply.

5 The rapid building technique

If you are a model builder who likes to spend many a happy hour making beautiful 'true scale' models then this article is not for you! The typical Murray River Paddle Steamer was a working boat, manufactured beside the river using mostly locally sourced materials, but with imported boilers and engines and worked to death from the day of launching. This model is built, not designed, and hopefully emulates the finished product of the day, it is not 'true scale', but scale like. It looks like a Murray River Paddle Steamer but it's is definitely not a scale model.

All the timber was cut using a 235mm power saw and used directly from the saw bench, it was not dressed or sanded before gluing, I assumed that after the saw was set 'square' any joins would fit! Planked (sawn strips glued together) material was later machine planed or sanded before further fitting & finishing, eg the deck.

Some finer fitting of parts was done as necessary, but most parts were machine cut and fitted.

6 Making the Hull

The chosen dimensions of this Murray River Paddle Steamer is similar to a typical 'M' class racing yacht at 1270mm long, deck line 100mm at Bow, 80mm Midships & 90mm at Stern, and approx 210mm Beam, 380mm over the Paddle Boxes, as its a very handy size for transporting and still appears fairly large once on the water, smaller sizes tend to disappear rather quickly after leaving the shore!

Murray River Paddle Steamer's tend to obtain their stability via being short and broad, rather than deep of draught, the same is true of this model as no dummy weighted keel was required to balance the boat.

One of the nice features of a Murray River Paddle Steamer is they usually have flat bottom hulls which makes for easy construction as the baseboard is the hull itself. The hull bottom was constructed of 11 lengths of 19mm square x 1270mm (50in) long sticks glued together with WeldBond (West Expoy or PurBond could also be used), breadboard fashion, to form a very stiff "ironing board", and clamped overnight to ensure full curing.

To achieve a bread board, before cutting your 240+mm wide board draw pencil lines across one surface, cut your 19mm x 1270 length strips, lay them out marked side up then leaving one side plank as is, rotate each other plank 1/4 turn times the position of that plank, ie: count second board as 1, rotate 1/4 turn, third board is 2 , rotate 2 x 1/4 turns (ie: turn over!), etc.

When you have finished turning, pull them together to form a new board, then edge glue them together. The reason for bread boarding is to create a much stiffer board, less likely to warp and split than a natural cut board as you now have many cross grains working against each other.

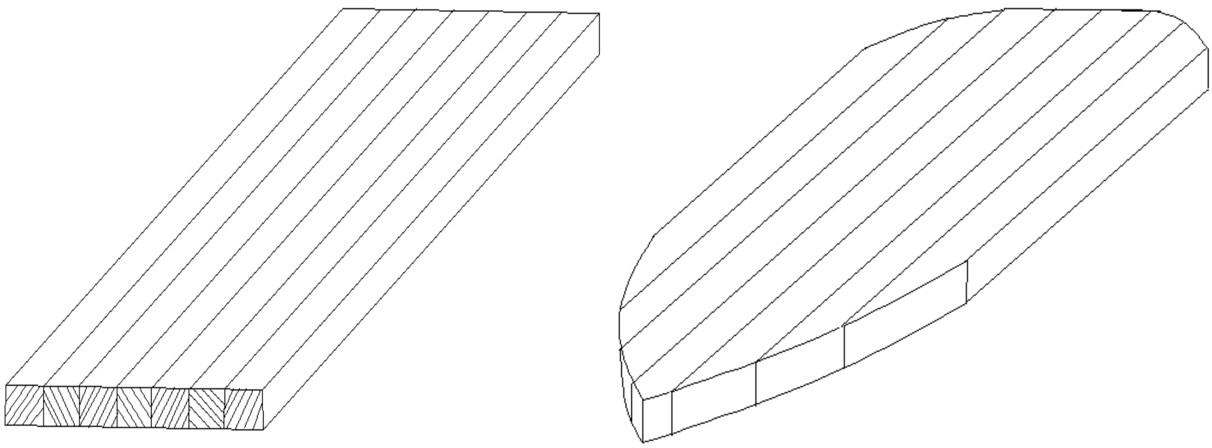


Figure 1: Typical Breadboard (left) and Ironing board (right)

The bow and stern shapes are now formed by trimming with the power saw, giving us the 'ironing board' shape cleaned up using the planer and sander. The curve between the bottom and hull sides is now cut using the router with a 19mm curved edge trimmer cutter with a ball bearing race. The ball race uses the hull shape as its guide.

Before starting the hull sides, I suggested that the Stem Post (the Bow Post) should be fitted vertically onto the hull plate as you will be fitting the hull planking directly to this post as you build. Also the stem post should have a small vertical rabbet cut on both sides to make fitting the bow planks easier. Likewise if a stern post is required in your design.

Now, starting at the center of the hull, the hull sides are simply built by gluing planks up on the hull base board, just like stacking bricks, using the hot glue gun, and without any 'forms' to guide the building process. Perhaps unorthodox, but certainly rapid! (In hindsight I should have used some vertical guide posts spaced along the insides of the hull to ensure correct alignment, but it worked out pretty good anyway). I had to avoid permanent bulkheads as I was unsure of the exact motor/battery placement until after the bare hull was complete. Remember this boat was *built* not designed! Some internal bracing was added after the hull was built and I had some idea just how much room the motors would require, bracing near the paddle drive bearings is also a good idea. Wedges of 12mm multi-ply scrap timber is an excellent material to use for this.

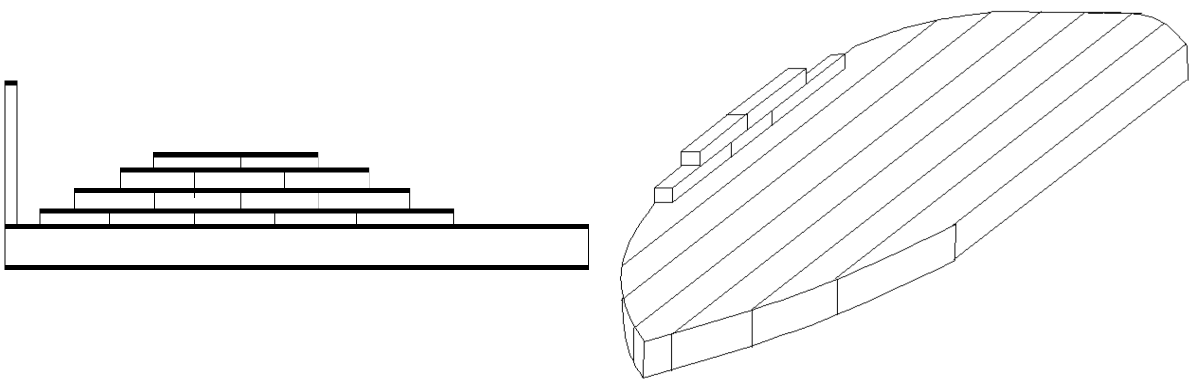


Figure 2: View of Side Planking (left) and on Ironing board (right)

You will soon reach the Bow & Stern end curves thus requiring you to make curved shaped pieces to fit, these are simply the Bow & Stern Planks mentioned above which are placed upon the hull bottom in such a manner to offer the greatest curve covering and the external hull curve is traced with a pencil, the curve cut on the scroll saw , excess material cut off the 'inside' of the curve (the piece now looks like a segment of an orange), the ends are trimmed to fit the space and hot glued on, building the next row commences. You could cut out more of the inside material if you wish, but its not necessary in the bow, I did rough cut the inside of the stern pieces as the curve is much rounder than the bow curves so these was more excess material to remove. Note that there is no need to clean up the inside of the hull.

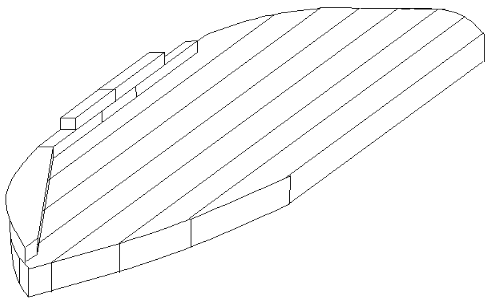


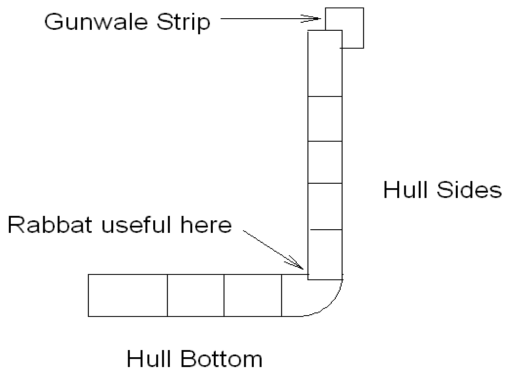
Figure 3: View of Bow Planking

It is important to ensure that all the pieces overlap at the joints and no joins lay exactly above each other to avoid a weak join. Continue laying the planks until you have reached approx 100mm height at Bow, 80mm Midships & 90mm at Stern.

Boats usually a have a slight curve in the deck line from Bow to Stern, through the mid section of the hull as it gives the boat a pleasant visual effect when seen on the water. However, its easier to shape this ‘curve’ by straight line from Bow to in front of the paddlebox , level midships, then straight from aft of paddleboxes to stern. Makes fitting deck beams, paddle bearings, paddle boxes and planking easier as you are working with straight timber.

After the hull sides are built, leave aside overnight to ensure full glue strength is attained. Then clean up the outside surfaces using the planer and sander (I start with 40 grade paper and work down to 200). Dont worry about minor misalignment of your planks, small indents add character to your model, just like full sized Murray River Paddle Steamer's ! We are not trying to achieve a really smooth surface.

Along the hull sides a gunwales, or capping strips, were formed from a piece of long grained hardwood by tracing the hull profile direct from the hull and cutting the groove with a router. These only needs to cover from the Bow to forward of the paddleboxes , and from Stern to the rear of the paddleboxes, missing the mid section completely. By being a single length of timber they add strength to the hull edges and help lock the hull walls together. The small inside ledge is a natural support for the deck planks.



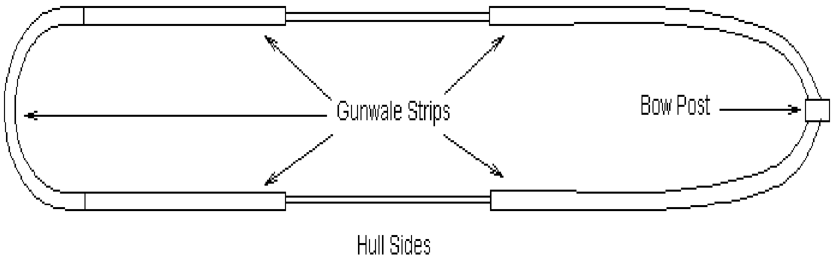


Figure 4: Section view showing Gunwale fitted

The inside was finished with West System Epoxy and 50mm wide strips of fibreglass, especially along the side to bottom join to ensure waterproofness and add strength.

7 The Engine Room

7.1 First Design

Full sized Murray River Paddle Steamer's used wood fired steam engines as their motive power, however I have opted for a easier power source, a 12Volt battery and electric motors.

After some research, I discovered that 50RPM is about right for effective paddle wheels *on full sized paddle boats*, and that Car Window Screen Wiper Motors operate at just these revs, and as they are already fitted with a right angle drive gearbox are ready made for our purposes as they are easily fitted into the hull. The motors are a little heavy at 1Kg each but as such this is not a problem, we are not building light weight here! and this weight is quite low, instability is not a consideration. As there is plenty of room in the hull,I fitted two motors, placed back to back with their output drive shafts aligned to directly drive the paddle wheels, powered by one 12 Volt,7.2Ah sealed lead acid battery wired through micro switches mounted onto a standard servo giving stop, forward & reverse. This simple arrangement does not offer variable speed and note that a typical model car speed controller will not be suitable due to 12volts.

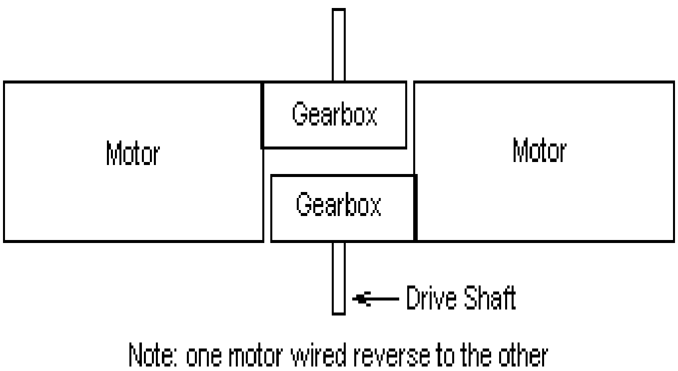


Figure 5: First layout of installed motors

I decided upon two motors as I wished to experiment with using the paddles as a steering aide by switching port-starboard motor on-off via the rudder servo as required when maneuvering should the rudder prove insufficient.[1] Full sized Murray River Paddle Steamer's often had one motor per paddle, powered from one boiler and often steered via paddle wheel control rather than relying upon rudder only. Especially when going downstream!

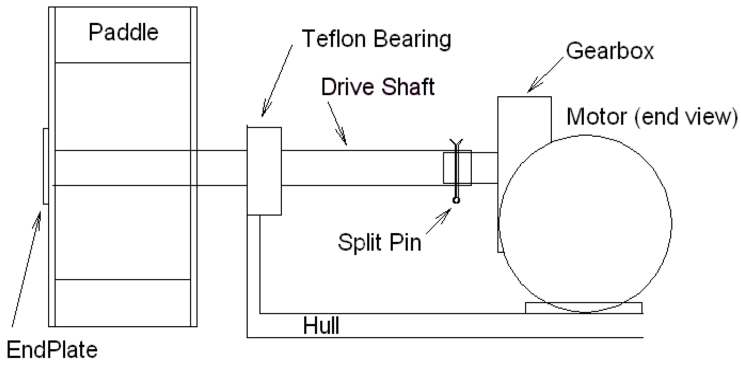


Figure 6: First Paddle Drive System

This design worked quite well, but, 50 RPM was definitely not enough revs, the boat moved OK, but I could see that there was not enough wake and wave motion from the paddles that would allow the boat to make any headway against a current or breeze, especialy when the superstructure was in place offering greater wind resistance. Coincidently, I had this observation confirmed by a posting in the Yahoo! WebSite Paddleducks Newsgroup that same day. Paddleduckers must be clairvoinant. Thanks Derek. Refer to section 7.5 for drive layouts tested.

After some testing I discovered that the wiper motors I used were actually doing 30 RPM, not 50 as first thought.

[1]It was'nt !!

7.2 Second Design

So back to the workshop. I needed a extra 'gear' to get the final drive shaft revs up to around 200 RPM. This time I tried a rubber drive wheel fitted to the motor shaft and then aligned the end of the Paddle shaft with a 'stub axle shaft' that was silver soldered to a fixed position on the motor mount bracket, this system had merit, but, I discovered that the amount of rubber pressure against the paddle drive shaft was critical to its efficiency. ie: a 1 mm misalignment between motor drive and stub shaft centers would cause the final drive to either work or not! Once working it performed quite well but it was a major problem to change final drive speeds; the stub shaft would need shifting! Refer to section 7.5 for drive layouts tested.

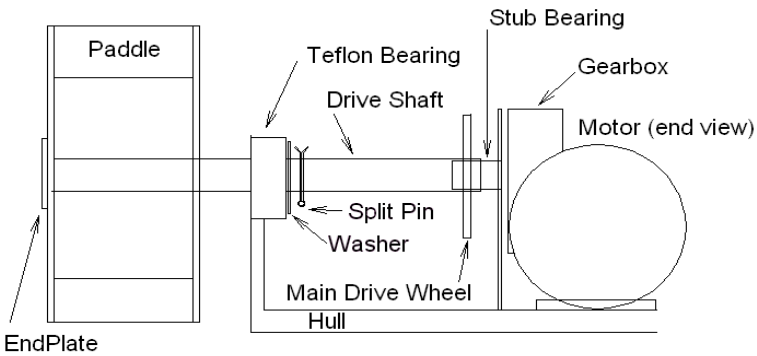


Figure 7: Second Paddle Drive System

7.3 Final Design

So back to the workshop. I had tried to avoid using a belt and pulley drive system because by having two motors meant the pulley drive shaft would need a stronger bearing system as the pulley end would be 'floating' and be harder to ensure the pulley tension did not side load the bearings too firmly. So I removed the single teflon bearing from the hull side, and built a simple wooden bearing box with two teflon bearing at each end, fixed this to the hull side with appropriate reinforcements. I then fixed each motor onto a sliding tray with screw adjustment to enable correct belt tension to be set. I then made two pulleys and obtained a suitable 'O' ring as the drive belt. This system has a number of advantages :

1. the drive ratio and final paddle speed can be readily changed by selecting pulleys of the required size. I wrote a simple computer progam which allows me to enter different pulley sizes, main drive speed and compute the final paddle speed in rpm.
2. minor misalignment of the pulleys does not stop the system working. More direct drive systems had proven problematic.
3. the sliding tray tensioner system allows very fine adjustment of the belt tension. I used a slide tray boot binding mechanism off a pair of discarded childrens downhill snow ski's , works great.

Refer to section 7.5 for drive layouts tested.

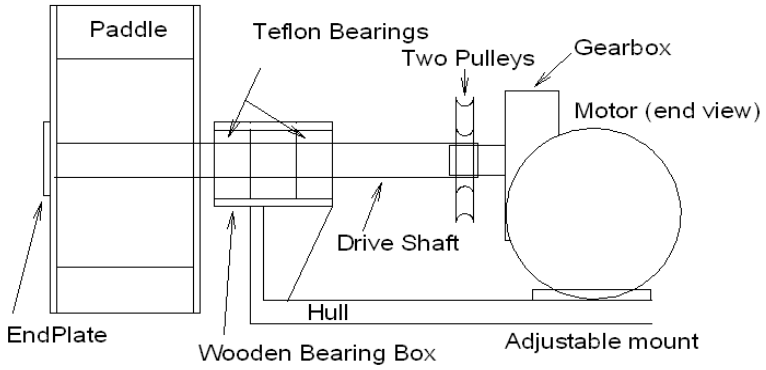


Figure 8: Final Paddle Drive System

7.4 Revised Motor Layout

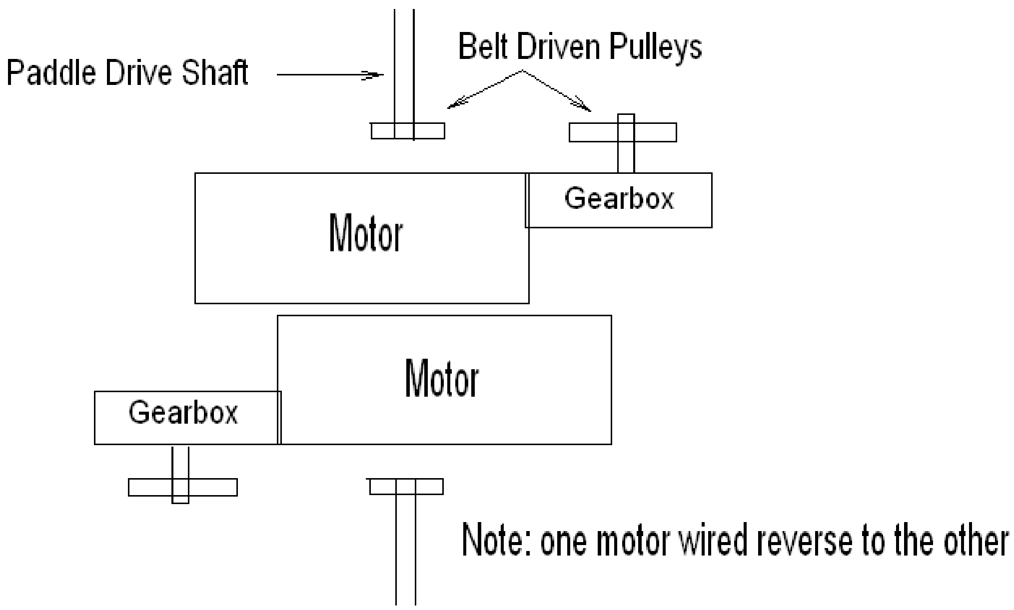


Figure 9: Final layout of installed motors

7.5 Final Drive Arrangements Tested

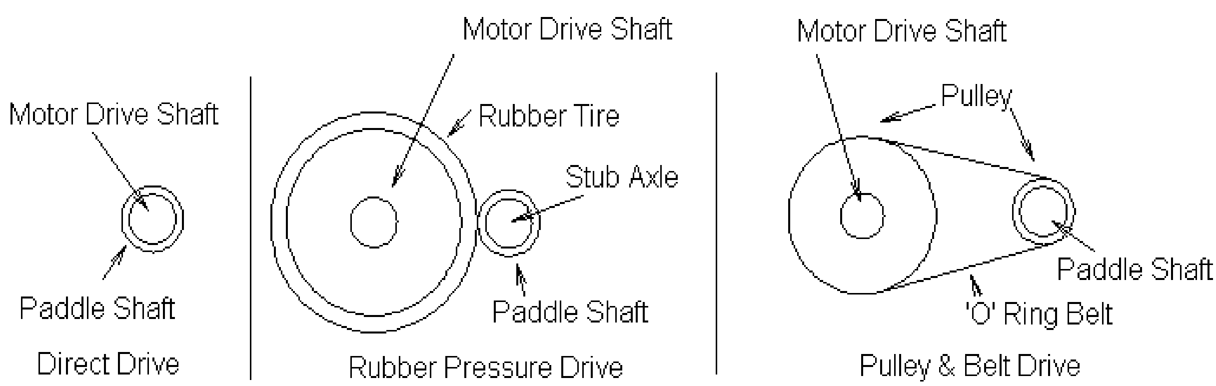


Figure 10: Paddle Drive Systems Side Views

8 Revised Bearing Boxes

Observe the bearing box layout show in figure 8, which used two bearings in a small wooden box. This worked quite well , however, I noted excessive wear on one of the inside bearings which sometimes caused lockup of that paddle shaft when rapidly going forward/reverse. It turns out that teflon is not really impervious to water and swells slightly, this probably caused some tightness in the affected bearing, which the powerful motors overcame by wearing out the bearing! This was solved by replacing the complete unit with a solid brass unit of 22mm square x 40mm with a 12.5mm hole bored lengthwise using a lathe for accuracy, this hole was reamed out to the correct size to allow easy, but not sloppy, fit of the drive shaft. A small transverse oil hole of 1mm was drilled into the top side thru to the 12.5mm hole, with a 1/8in drill, form a small 'cup' above the 1mm oil hole to hold a few drops of oil. These bearings were simply 'U' bolted, made from 1/8in brass welding rod and treaded by hand, into position onto two small 12mm ply support plates glued to the hull. These work really well, are cheap to make, but access to a lathe does ensure accuracy of the bored hole and a good fit of the shaft. Using standard drills would probably not achieve this result. In hindsight I should have selected a drive shaft / bearing system that matched each other from off the shelf components and built the paddles / drive system around those components.

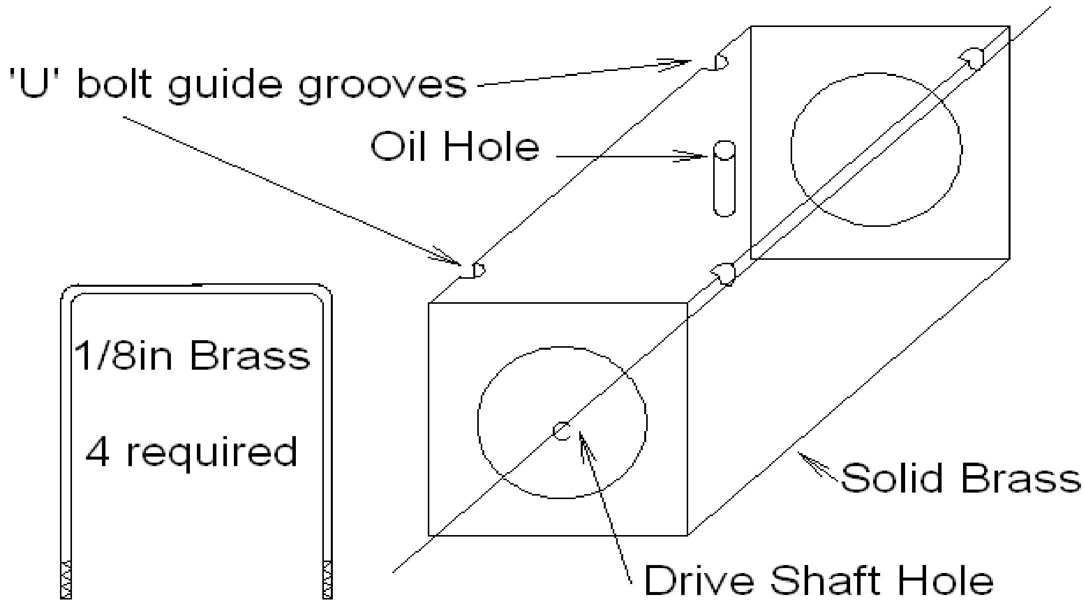


Figure 11: Revised Bearing System

9 The Pulleys

One of the major problems I encountered was sourceing suitable pulleys, in the end I decided to make my own, well almost, I did get a mate to turn up the pulleys for the final paddle drive shafts. But I did fabricate the pulleys fitted to the motor drive shaft. These are simply large discs of plastic , turned up from discs cut from a typical household chopping board of about 8mm thickness, using a drill press on high speed as a lathe.

Once you have the two discs, cut 4 discs of thin metal 10mm diameter larger than your plastic ones, stiff plastic sheet could be used, and make a sandwich of one thin disk, one plastic thick disc, and one more thin disk. Keep them in alignment on a bolt through their center hole. Then drill two or three small holes through the sandwich and bolt the parts together with very small bolts, voila! a pulley.

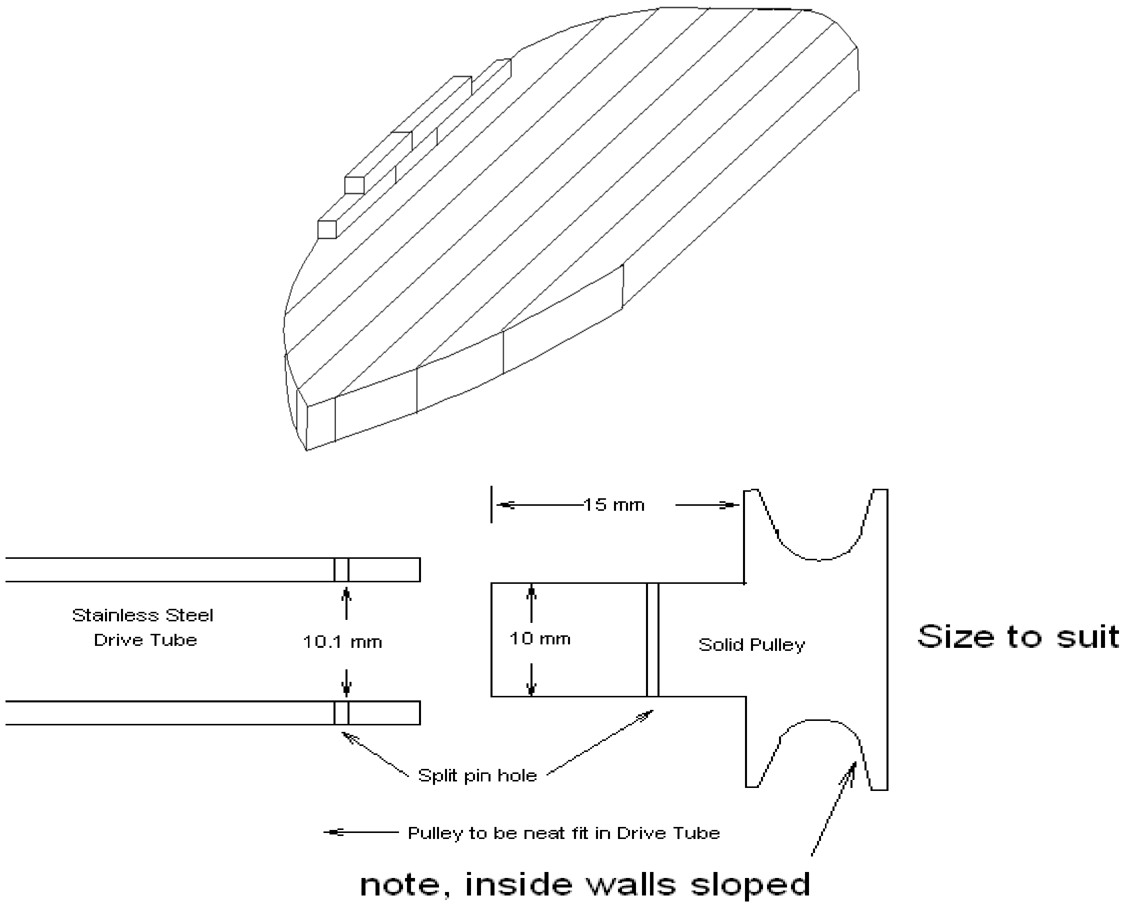


Figure 12: Fabricated Pulley & Small Turned Pulley

I also discovered that quite nice pulleys could be made from 12mm thick plastic sheet by cutting the belt groove with a rat-tail file once the disk had been shaped on the drill press. No need for the two side plates if this technique is used. As the gearbox drive shafts had two 'flat' surfaces to act as a keyway, I shaped pieces of flat tin plate to match the key and screwed this plate onto the pulley side to locate the pulley to the shaft.

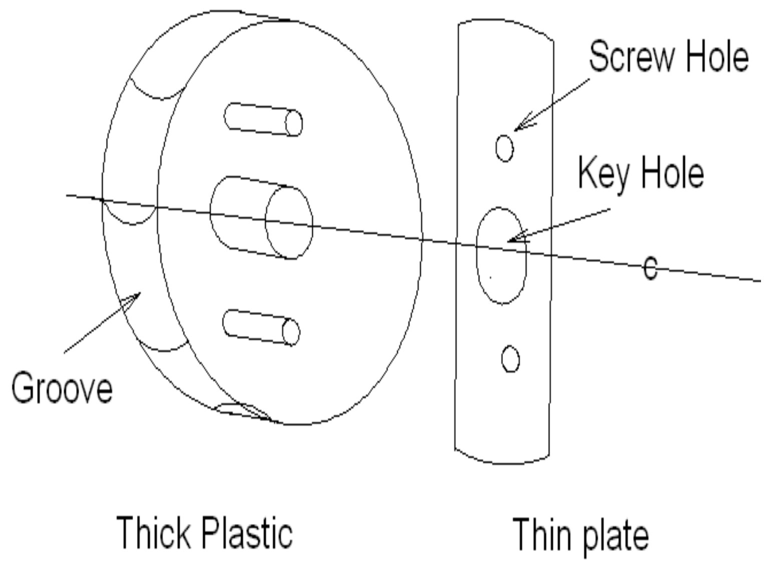


Figure 13: Another Fabricated Pulley

10 The Paddles

The paddles are professionally cut laser discs of 155 diameter, cut from 1.5mm thick stainless steel and joined together by the paddles formed from channel section of .75mm, 'pop' riveted at the rims (see diagram below). and fixed to a stainless steel drive shaft, 12.5mm s.s tube was used, which runs through the bearing block, fitted to the top edge of the hull, drilled with a hole for the drive shaft which is then connected to the gearbox output shaft via a pulley arrangement as detailed previously. Again not scale, but quite good looking and easy to assemble. Note that you must be very sure of your design needs with laser cutting, what you ask for is what you get! Be very aware of the pop rivet hole sizes required, if you under specify you will have to drill them all out yourself. On my wheel design over 80 holes are required.By the way good quality Stainless Steel is no more difficult to work with than mild steel.[2]

The Paddle Blades are 68mm across, 20mm deep, with end flanges of 8mm and 2x3.2mm holes suitable for pop rivets at each end. There are 10 Paddle Blades per wheel required. The Endplate is a flat 'washer' center drilled to be silver soldered[3] or welded to the drive shaft, its three pop rivet holes line up to the outside wheel rim and pop riveted together.

I decided upon 10 paddles as I felt that the power of the motors used can well handle the extra paddles surface area. Articulated paddles, while common in UK and Europe were not popular on Murray River Paddle Steamer's as their very complexity made them impossible to repair on the river should they be damaged, and your boat maybe 1000 Klms from help!. Of interest is that most Murray River Paddle Steamer's had their 'running gear', including the paddle drive shafts, steering cables/chains exposed for easy access for maintenance and repair work.

The paddle drive shaft might appear to be over engineered, but the 12.5mm s.s. tube is light, strong and easy to work with.

[2]An aquaintence made this mistake by specifying, 'just a guide hole would be fine', thats what he got!, and lots of extra drilling to do, and he had poor quality s.s, broke lots of drills.

[3]There are a number of suitable low temperature silver solder products available that only need a 80 watt hobby soldering iron

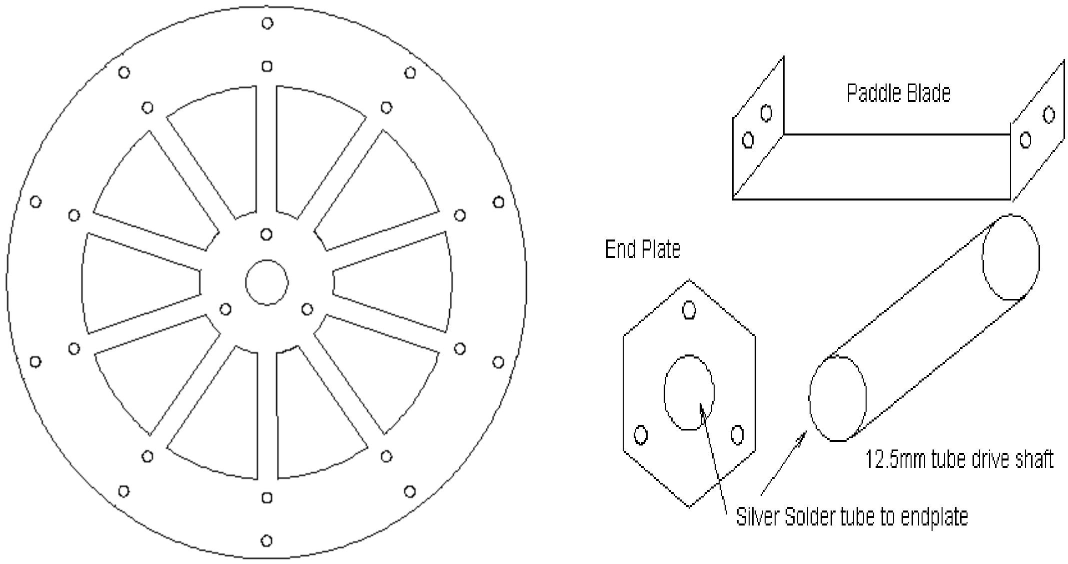


Figure 14: A Paddlewheel Rim & One Paddle Blade & Endplate

10.1 The 'rule' of thirds

I was directed to an article in a engineering magazine regarding setting up a new full sized paddle steamer's paddles. And after much research they came up with the *rule of thirds* as a good starting point.

- choose a wheel *diameter*.
- the paddle *width* should be at least 1/3 of the *diameter*
- the paddle *height* should be 1/3 of the *width*.

This is a simple rule of thumb, my paddles are a little larger than this, but I offer the rule as a sensible starting point. Obviously, if you have plans use the information supplied, especially if your building scale.

11 The Paddle Boxes

Most Paddle Steamers have a 'box' enclosure covering the paddlewheel from the deck line up, consisting of a side wall on the boat side, a roof over the paddlewheel and two walls front and back, the water side is either open or slated (a bit like garden trellis), some boats had very fancy designs on the outside. The function of the paddle box is simply to stop the water getting into the boat! It has little or no effect on the efficiency of the paddlewheel themselves. The early Murray River Paddle Steamer's paddleboxes had a curved arch , but later designs favoured the simple square or slanted staight lines style as they are much easier to build. Also by building the access stairs onto the paddlebox resulted in more useable space on the boat, the paddleboxes being off the boat.

However on our model the simplest paddlebox is a timber side wall attached to the hull and a roof of bent thin tin shaped to your prefered style.

Another technique is to use perforated tin (with lots of predrilled holes) bent to the desired shape and then planked over the top with thin timber planks glued on. This looks like a proper timber paddle box but without all the internal framing required to support a timber fabricated version.

The simplist supports for any paddle box is two 9x9mm planks fitted completely across the hull to the outside of the paddleboxs, if the motor clearance allows, and build the paddlebox directly onto those. I originally thought to make removeable boxes but figured the extra complexity was unnecessary.

A 825gms fruit tin (empty !), makes an easy to shape paddlebox, just cut out both ends, including the folded ridge, then cut along the seam and gently pull apart to make a simple curved paddlebox.

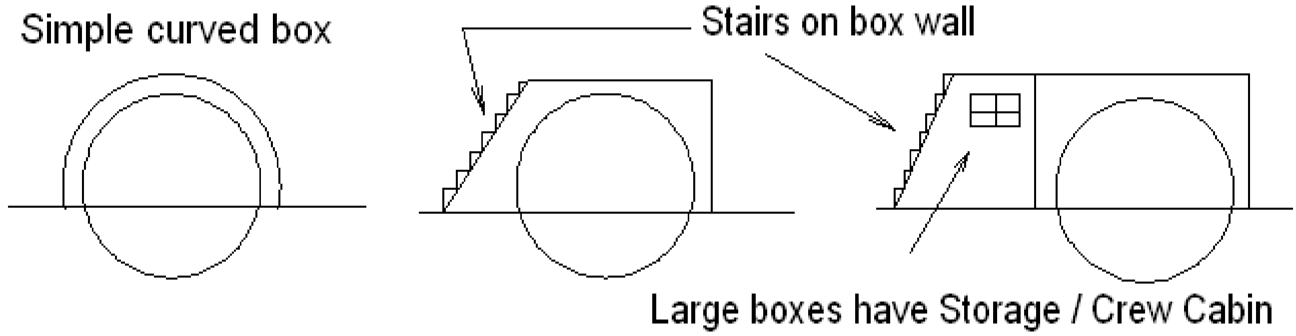


Figure 15: Sketch showing typical Paddle Boxes

12 The Rudder

On a full sized Murray River Paddle Steamer the rudder was a large and very heavy unit controlled from the wheel house using chains and/or cables which usually ran exposed along the main deck. The rudder did not protrude below the bottom of the hull line and are often not very efficient depending upon the hulls aft shape.

On the model, a heavy rudder is also used, in fact it is constructed by laminating sheet lead between 3mm marine ply. The extra weight of the lead helping to balance the boat by having some weight as far aft as possible to counteract the weight of the heavy battery which had to be placed forward of the motors.

Due to the length of the rudder the servo cable attachment points are much further from the hinge point than a typical servo setup. Therefore, an extension arm must be made and bolted to the standard servo arm to achieve sufficient rudder movement. There will be loss of effective servo power because of this extension. The distance from the servo arm center to the extension arm cable attach point will need to be similar to the distance from the hinge center to the cable attachment point.

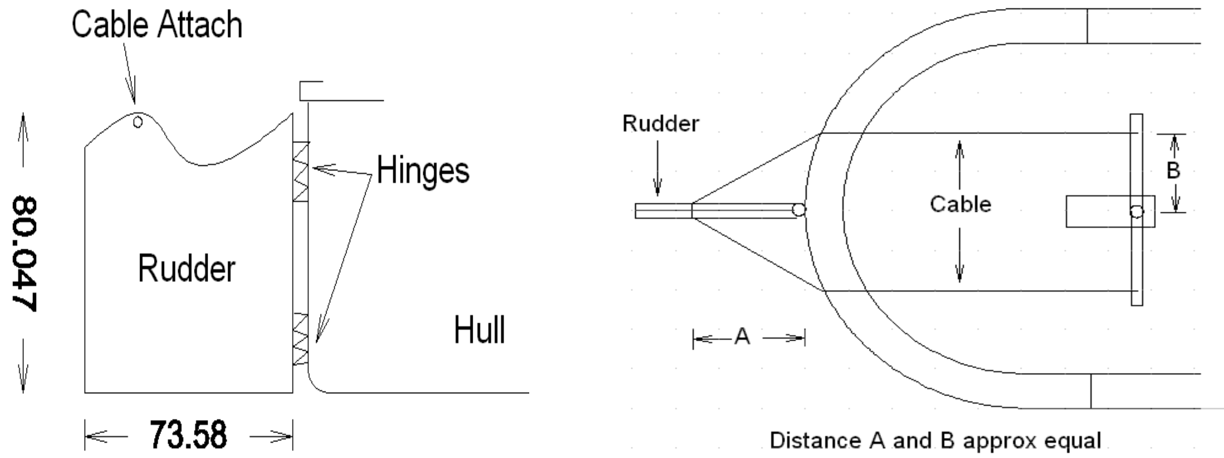


Figure 16: Typical Rudder Installation

(In hindsight I should have used two smaller 6volt batteries wired together so I would have more freedom in weight distribution).

13 Deck & Superstructure

This Murray River Paddle Steamer is loosely based upon the "P.S Industry" which was designed as a "snagger" in 1910, built in 1911 at Goowa, South Australia, and spent it's working life removing fallen trees, etc, from the river system. Reputed to have removed some 3 million snags before retiring in the 1970's. Somewhat more refined than the typical river trade boat as its decks and accommodation were for the crew as they were working away from home for extended periods of time, and no cargo space was allowed for in the design, whereas trade boats had smaller cabin space and far more cargo space. It even offered seperate Officers & Crew Dining rooms! It is a truly unique design as only one of this design was ever built, she is currently resident at Renmark, South Australia, as a working tourist & museum, after complete restoration in 1970.

The model hull has minimal cross beams (6), and therefore deck was made from 5 x 10 x 1270 mm planks of pine , edged glued and shaped to fit into the step formed by the gunwales. This forms a very strong deck.

The sponson's, smallish triangular deck extensions, fore and aft of each paddlebox are built from deck material after an appropriately strong length of timber is fixed from the outer of the paddlebox cross beams to reach the gunwale somewhere along the hull. Depending upon upon the sponsons size, extra bracing may be necessary underneath. The sponsons acted as bumper bars for the paddlebox, and therefore protect the paddles themselves, as well as additional deck space for lighter cargo and wood for the boilers. They are not really necessary , but they may stop you from tearing off your paddle boxes one day!

The superstructure, wheelhouse, cabins, etc are made of inexpensive 2 ply sheets obtained from a D.I.Y shop, lite ply could be used. I was going to plank up my own wall sheets to give the true weather-board effect, then I figured it was not worth the effort on a non scale craft.

Observe on the side sketch of the P.S Industry how there is a 'gap' in the cabins near the center of the boat where the boiler & engines are fully exposed to the elements. The gap in the upper cabins is simply where the Funnel comes through from the boiler and a exit point for the stairs. This layout opens up different possibilities for the building of the cabins. After some consideration I opted to build the main deck cabins as two seperate units , without roof. Both cabins are removable from the deck. The upper cabins are also build a two units, but fixed to the floor, which of course is the roof of the lower deck. This allows easy access to the inner workings of the boat. A roof was then fixed to the top cabins. The top cabins are more or less sealed boxes , so offer some extra floatation should the boat capsize.

Making the cabins is quite straight forward. I simply cut lengths of the ply sheets into 80mm wide strips (the height of the cabins), then cross cut enough cabin ends from those strips at 125mm (the width of every cabin), 8 lengths were then cut to the required size (length of each cabin) of the individual cabins.

Each corner will be reinforced with short offcuts lengths of the 9x9 material used to build the hull. You should glue one piece flush to the wall corner edge before joining the next wall piece to it.

Using two house bricks set at right angles to form a 'inside' corner to press the cabin corners into, then using the hot glue gun place some glue along a wall height edge and the exposed piece of offcut and then press two sheets together into the brick corner, hold for a few seconds to allow the glue to set, repeat for the other three corners.

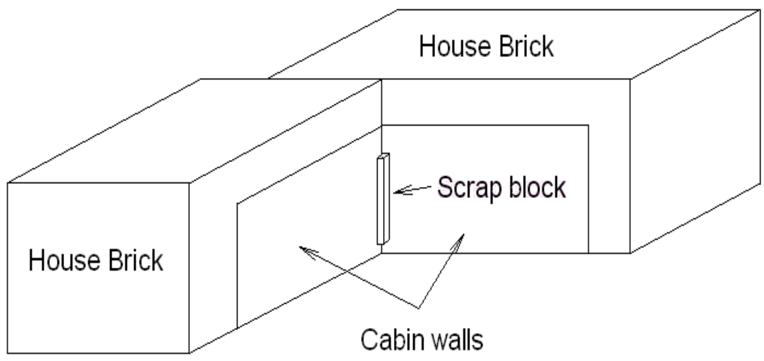


Figure 17: Building walls using house bricks

This adds considerable strength to the box. The only tricky part of the operation is being quick! and getting the corners lined up before the glue sets. Using the sold brick corner to push the pieces into helps the building process considerably.

Once you have completed your cabins and deck, its a good idea to give them a quick coat of white exterior undercoat paint. This will show up all our bad workmanship - as it did on mine. Afer drying, rub the pieces back using the power sander with, say 100 grit, then fill the obvious cracks, etc with a good exterior filler, the cabin corners tend to be the most problematic if the glue joint was not quite a flush fit. But thats what fillers are for. After sanding the fillers, give another coat of undercoat. Its totaly up to you just how much effort you wish to expend on the painting process, but dont forget paint and fillers can add considerable weight if you use too many layers to get that 'perfect' finish. An airbrush is a good option if you have one available, much less paint required to get that good finish.

I airbrushed some dummy doors and windows, in red and black, to breakup the rather large expanses of plain slab sides. Not exactly a professional spray job, but it does add to the overall effect without much effort. If you decide on some feature painting, I can recommend 3M 'Scotch' brand masking tape No.2070 as an excellent tape as it has a very light stick and will not remove previous paint work. Be warned, its quite expensive, it cost more than the paint!

The dummy funnel of 22mm plastic tube is fitted thru the roof to the top deck floor.

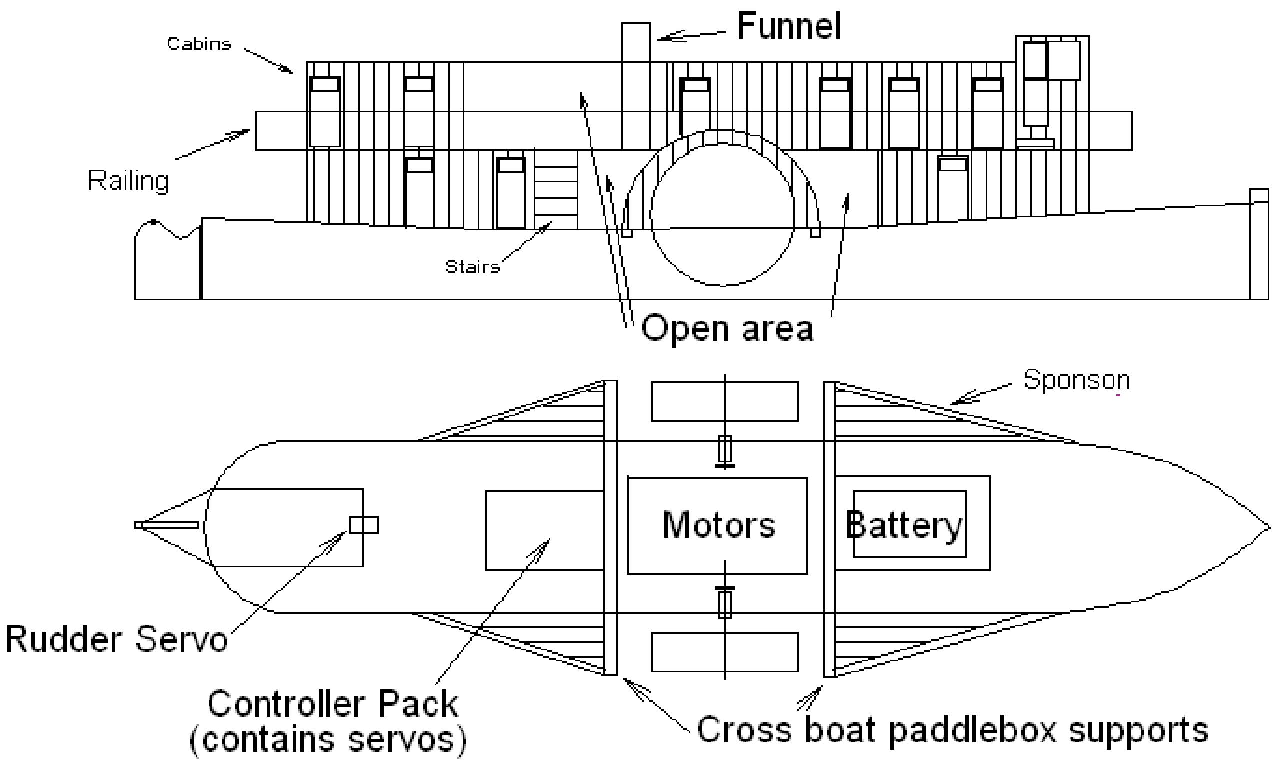


Figure 18: Sketch showing side view and layout of inner workings

Keeping in mind information I've read about C of G problems with model paddle boats where people have had to resort to using very thin card for superstructure, I deliberately used quite heavy materials for the hull itself up to the deck, and of course I have used very heavy battery and motor gear compared to typical modelers more refined (and possibly better quality) running gear, however my method does have the advantage of placing weight where it belongs, very low, and the aspect ratio of length to beam is also low thus offering inherent hull stability.

And also remember, I'm not trying to create a scale model , just a paddle boat that looks the right scale, true scale material dimensions was not even a consideration! My model weighs in at 12Kg , of which the complete superstructure only weighs 800grms and its made of 3mm 2 ply.

14 Installing the Radio Gear

After, building the cabins and placing them on the hull, I realised that the receiver battery and radio on/off switch would be better placed inside the rear lower cabin, I therefore fitted a small ply floor to place the receiver battery , the on/off switch was fitted to the rear cabin wall allowing ready access once the boat is assembled.

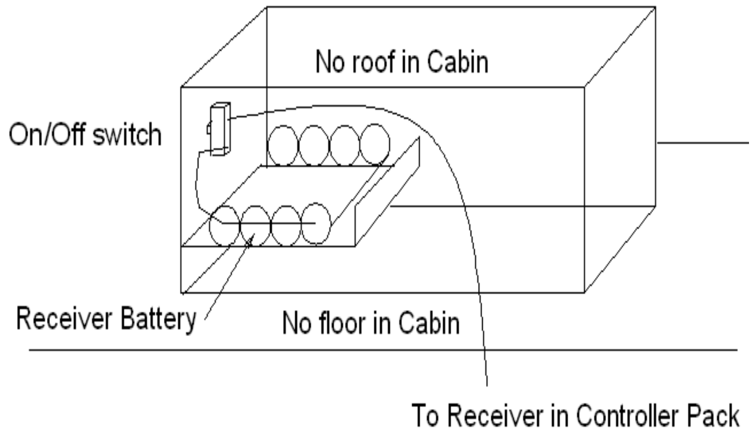
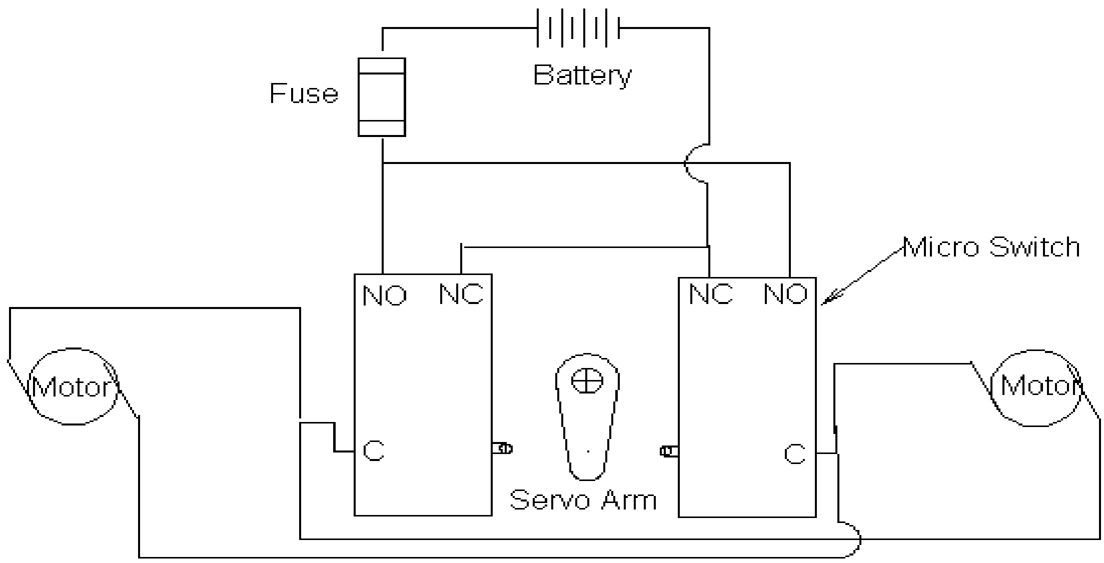


Figure 19: Location of on/off switch and receiver battery

Only a two channel radio system is required to operate the boat, but this will depend upon any extra functions you wish to add to the base design.

One channel for the rudder, the 2nd channel is set up for motor control[4] via 2 micro switches set either side of the servo arm. When the motor control channel stick is in the center neither micro switch is used, motors stopped, move full down one micro switch is engaged allowing motor reverse, full up the other micro switch engages full forward. This system works for either single or multiple motors with the advantage of no battery power loss. I have heard about a set up where two 6 volt batteries are connected in both series and parallel (not simultaneously!) via multiple micro switches giving stop, slow (6 volts) and full (12 volts) speeds which might make for an interesting option. Also the two separate batteries will offer better weight distribution for minimal extra wiring. The only consideration with this system is that you must ensure that only ONE microswitch at a time can be ON, otherwise a short circuit through both motors will occur! A inline fuse is recommended as sealed lead acid batteries should not be shorted.

14.1 Motor Control



[4]A real speed controller does not appear to be advantageous, and Stop, Forward & Reverse seem to be sufficient control

Figure 20: Simple Speed (Stop, Forward & Reverse) Controller Circuit

The above simple circuit works well and is very easy to built using off the shelf components from your local electronics shop, eg Tandy, Dick Smith, etc.

14.2 Improved Motor Control

However with the addition of another servo, 'Y' leaded to the rudder servo channel and two, three position switches (on(1),off(2),on(3)) set up so that on(1) is forward motor, off(2) is stop that motor, on(3) is reverse that motor. This is in *addition* to the above micro switch circuit. This servo's arms are placed so the movement of the rudder stick will knock the appropriate switch lever from forward, to off, to reverse on that motor only, leaving the other motor alone. The switch levers are 'spring loaded' with rubber bands to return the switch to off(2) then on(1) as the rudder stick is returned to center. In operation, half stick movement stops the motor on 'that' side, full movement reverses that motor.

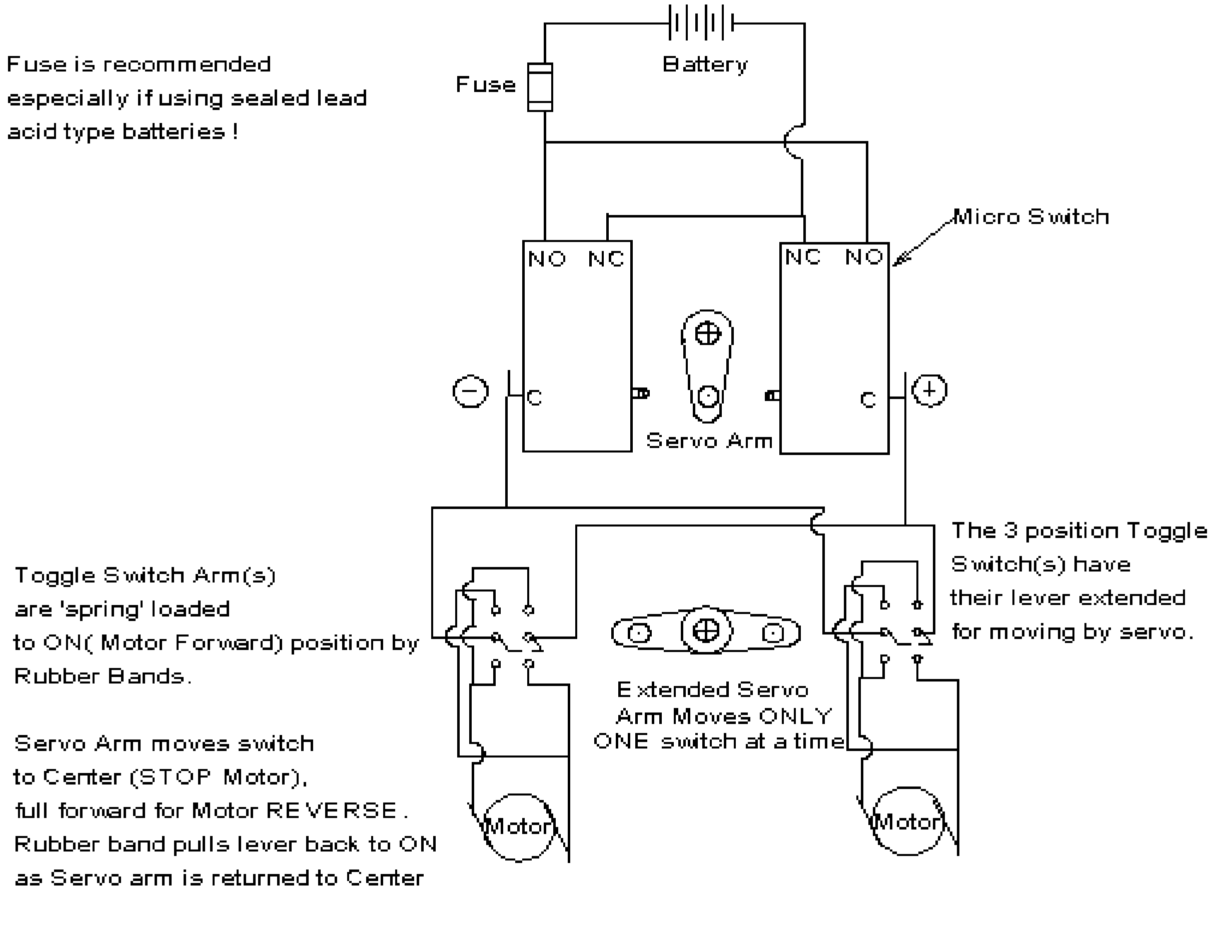


Figure 21: Simple Speed with Separate Motor Controller Circuit

This control center is fitted onto a metal plate that is inserted into a simple plastic container without the lid. External plugs are fitted to the walls of the container for convienance of plugging in motor power, battery power. The control center houses two servoes, two micro switches, two toggle switches, all the wiring and the RC reciever. Its not meant to be waterproof.

15 River Trials

The half completed boat was tested on a friends swimming pool for ease of salvage should the need arise. No problems were encountered, the hull is very stable, show no tendency to excessive heel in tight turns, and these can be very tight with motors running in reverse to each other. The paddles are very effective causing some cavitation from dead start, but this effect soon disappears once the hull is moving and nice 'paddle' waves are formed. Throwing the throttle into reverse from full ahead brings the hull rapidly to a smooth stop. This is true also from the push-start test, ie: give the boat a really good shove and throw the motors into reverse.

Hull stability is very good, one can rapidly rock the hull from side to side and the hull resumes normal position without hesitation, trials on a windy day with the cabin superstructure will be the next major test.

The twin motors are proving very sucessful, lots of power, smooth operation and no fuss when switching from forward to reverse rapidly. There is no need for any 'speed controller' system.

Once the superstructure was finally painted, I then started proper trials. On the day in question, the wind was blowing 10-15 knots, squalls of higher wind force were experienced, small waves of 50mm, we are not talking ocean trails here !, were formed on the lake which gave a very good test for the overall ability of the boat. P.S.Industry handled the conditions without any problems, and remained a dry boat even with the odd wave coming over the windward bow, driving directly into the wind without hesitation, coming about on either tack , and doing 'U' turns easily. All in all a most satisfactory test.

A few days later in much calmer weather , I was testing various higher paddlewheel speeds, by changing the drive pulleys, and discovered that I had a mismatch in final paddlewheel speed as the motors were not running at the same speed. This should not have surprised me considering the type of motors being used, however, I was surprised at the effect slightly different paddlewheel speeds had upon the handling, as the final paddle speed increased. Under certain turns the slower paddle caused the boat to 'dig in' as the faster wheel lifted the hull on that side. Most alarming as I thought that I was taking water and the changing ballast was upsetting the balance of the boat. However there was very little water in the hull so the problem had to be paddlespeed. After I measured the exact motor speeds, and found that they were a few RPM different. I then computed new motor drive pulleys of different diameters for the different speed motors which then gave me exact final paddlewheel speeds. Handling problem solved.

16 Summary

Paddle Boats are an interesting variation on the typical model power boat. There is little information available for the average modeler to draw upon when entering this facit of boat modeling.

In summary :

- make your first design choice a large as is sensible for your transport! I have chosen the popular 'M' class yacht dimensions as a good starting size (1270mm or 50inch long). Big enough to see on the water, small enough to carry.

- Designs were many and varied and most were built on a ad-hoc basis and no production line boat designs appear to exist, so any variation you may come up with is quite legitimate. Check out your local library, search the internet, chose a type and style from the photos and start building!

  Plans for some models are available, mostly of PS Adelaide, PS Pevensey & PS Alexander Abuthnot, to name are few.

- In general, a larger boat allows large dimensioned materials to be used, much easier to work with. If you like true scale then get as fiddly as you like.

- Make a Sidepaddler first, much easier to build and certainly easier to control. This is not to say that a Sternwheeler should not be a later project!

- If possible, use electric power, simpler to set up and maintain than steam. If, as in my case, 12 volts are used, select a suitable sealed lead acid battery rather than nicads, as they will give longer running times.

- Use twin power sources, one motor per paddle, as this offers better steering control especially as some paddlewheeler designs have very poor rudder control, no matter how big the rudder is. believe me increasing the rudder size will have little effect on steering! Full sized paddlers had the same problem, so it's not just model scale effect.

- The facility to stop & reverse power on a selected motor during a turn manouver is essential on side paddlers for sensible craft control. eg: to turn slowly to port the rudder might be sufficient, a tighter turn stop the port motor, in a very tight turn the port motor should reverse! In fact a boat can turn in its own length in the forward/reverse power combination.

- Full sized Paddles rotate at around 50 RPM, however a model boats paddles should turn somewhere between 100 to 200 RPM depending upon wheel diameter. In my design 100 - 150RPM on a 155mm diameter wheel works well. The larger the wheel the slower the RPM required.

  My chosen motors are slow reving (30 RPM) and need *gearing up* to achieve the desired RPM, most model boats use fast reving motors that need gearing down.

- Full Speed control, from stop thru full speed, is NOT really necessary for a sucessful paddlewheeler. My paddles turn at full revs from start, a bit of paddle cavitation occurs from dead start, but soon settles down as the hull makes way.