First timer's guide to setting up a metre boat

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Setting up

Introduction

When I used to race at Swanley Park we tried to race as often as possible during each session of racing. There was no time lost unnecessarily between races and this gave little opportunity for skippers of experience to help newcomers to yachting to make a successful start. Sometimes it was sad to see new skippers, who had no idea how to set up a boat (and it is not easy) and little idea how to make it sail, trying to learn by racing. I wondered whether it was possible to write a guide with suitable photographs that a newcomer might use to set up a metre boat and to attempt to race it. I seldom got involved with helping others simply because everyone else seems to understand it so much better than I do but I can put a guide together and it might help. I have taken photographs of a *Gadget* belonging to Terry Humberstone who kindly lent me the boat. It is fitted with a facility to swing the mast fore and aft with a stop to set its position and I wedged the mast in a fixed position in order to bend it for these photographs.

The International One Metre Class

There are really only three systems to a model yacht. They are the sailing rig, the hull (including the fin, lead and the rudder), and the remote control equipment. The International One Metre Class was intended as an introductory class and each system is restricted in various ways to make for a relatively cheap boat. The class uses a standard Bermuda rig and all the important features of the three permitted sailing rigs are specified so that all boats should carry almost identical rigs. Any variation is in details that are not seen to be important to performance. The length of the hull is limited to one metre and there are upper limits to the draught and the weight of the lead and a lower limit to the all up weight. The design of the hull can to be developed with relatively few restrictions. Restrictions on the materials to be used in construction were laid down but, since the early days of the class, changes have been made to permit fins and rudders to be in carbon fibre whereas they were originally wooden or fibreglass. The remote control system has never been specified beyond restricting it to two channels and one servo and one winch.

Metre boats turned out to be a challenging class for all sailors and to be miniature racing yachts with exciting performance rather than toy yachts with poor performance. The fact that they are easy to carry in ordinary motor-cars gives them a popular appeal and the class now dominates model yacht racing.

Most newcomers are advised to buy a metre boat although it seems to me that in most cases it becomes a baptism of fire compared with learning by racing a Marblehead in a smaller fleet.

I am going to assume that the reader has bought a boat that is new or second hand and that it is supposed to be ready to sail and that he now wants to set it up and sail it as a first boat. The first thing to do is to make sure that the remote control system is doing what it should.

The radio equipment.

The most important element of the radio gear is the transmitter. To a large extent it will determine whether the whole system is, in computer-speak, " user friendly".

The radio control transmitter is most frequently seen as something to be bought as cheaply as possible and some cost so little that some people pay more for petrol every time that they go sailing than the original cost of the transmitter. There are features available on modestly priced transmitters that give food for thought:-

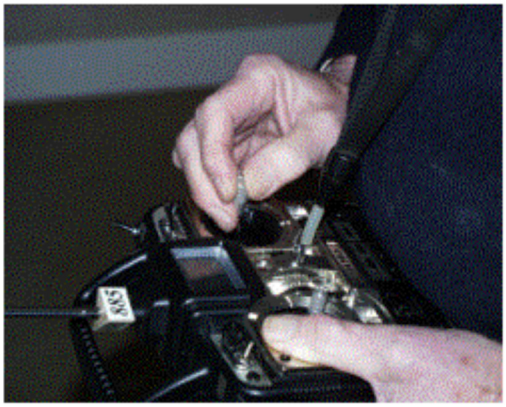
(i) The cheapest transmitters operate on the 27MHz band (megacycles per second). This is the most popular band just because it is cheap. The 40MHz band has many more set frequencies and those who use it have fewer frequency clashes. The most suitable transmitters are the ones that operate on the 2.4 GHz band and find their own frequencies and they are becoming very cheap.

(ii) Low cost transmitters have only two channels and two separate sticks. In the world of model aeroplanes, where the use of four channels is normal, half the pilots fly with their primary controls on one stick and half with them on two sticks. This must mean that one system does not suit all. What is true for pilots should be true for people at large including model yacht racers. Only transmitters with four or more channels permit both options to be tried. I use one sick in my right hand.

(iii) Low cost, two-channel transmitters have short control sticks with no facility to change the length. Presumably skippers will want a sensitive response to control input and this comes from the use of long sticks and not short ones. Most four-channel transmitters have long sticks and the facility to adjust the stick length.

(iv) The low cost transmitters are sold as suitable for use with ordinary dry batteries because they appear to be too expensive at the point of sale if they are fitted with rechargeable battery packs. They have fittings to accommodate 8 AA dry batteries. This is no good for racing and most skippers use rechargeable batteries. Then they have 8 loose batteries to contend with. This is a mixed blessing Frequently the result is that cells of different construction get mixed together and this is not at all desirable but at least the cells can be inspected regularly for corrosion. The higher cost transmitters are sold with ready fitted battery packs and these cause little trouble.[1]

Transmitter held in hands and operated with thumbs. Note short sticks



Single stick operation using penholder grip Transmitter suspended from neck strap and stabilized with left hand. Note long stick

(v) Skippers must decide whether to grip their control sticks as they would a pen or to rest their thumb or thumbs on the tops of the sticks. There is little doubt that the pen grip gives the best control but, in order to use it, a neck strap is needed.

That neck strap can be a transmitter cover to keep rain off and fingers warm. Thumb control permits a free transmitter because the hands can be used to hold the transmitter.

(vi) It is very desirable to be able to adjust the throw of the rudder and the travel of the winch through the transmitter. What is not desirable is some sort of gate fitted to the front of the transmitter to restrict the movement of the stick. If you have to do this something is wrong. Lots of four-channel transmitters have an ATV facility that is just a screw (actually a potentiometer) to turn to change the throw. Most transmitters have servo reverse.

(vii) All transmitters have trim adjustment (see later photograph) which moves both endpoints together unless a computer transmitter is used when the end points can be adjusted separately.

(viii) Computer controlled transmitters give the extra facility of storing the data for each model and a lot more besides. The most common problem that confronts the model yachtsman is to find that the mechanical arrangement of the sheeting, the dimensions of the winch drum and the throws produced by the transmitter do not all match and some further adjustment is needed. The computer-controlled transmitter solves this problem completely.

The above permits a choice of radio transmitter[2].

The on-board radio equipment for a metre boat will be a receiver, a battery, a servo for the rudder and a winch for the sailing rig. The receiver and the battery will probably be housed in a waterproof pot with a screw lid and the servo and winch will be inside the hull, probably under a patch. Inevitably with an internal winch water enters the hull through the fairleads.[3] Wet conditions do not suit electronic equipment. Any suitable receiver can be used. If the inside of the hull is dry the aerial can be inside the hull.

Batteries must last through about 2 hours of racing and a capacity in excess of 500 mAhr is required. Most run on 6 volts or 7.2 volts depending on the winch. Receivers may run on 4.8 volts or 6 volts but not normally higher.

Normally servos do not have electronic throw adjustment. Throws are adjusted mechanically by changing the length of the servo arm or the length of the rudder arm. Skippers find electronic throw adjustment of the winch to be very useful and it is often provided as a small screw in the case. Drums of different diameters are usually available for winches. The size that gives about the required throw with full transmitter throw and middle winch travel is what is required. Metre boats usually need the smallest size available.

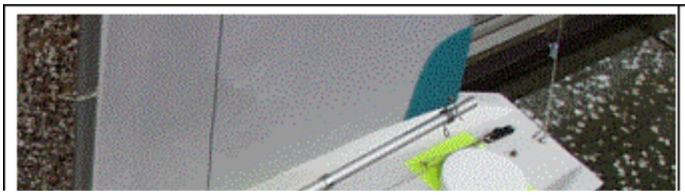
Rudder movement

A rudder should move by no more than 30° either way. Some skippers provide 45° or even more. It does no good and they have to use two push rods to avoid going over centre. With 30° only one push rod is needed and this takes strain off the servo.

Sail movement

All the designs of sheeting equipment are set up for the largest suit of sails[4] and make token adjustments for the other rigs. If you buy a boat the three positions of the swivel for the jib booms and the mainsail sheeting post will be fixed for you as will the position of the sheeting post and therefore the arm of the sheeting on the main sail.

There is still much disagreement about how the sails of a yacht actually work, but it is evident that, for beating, the main boom must come in to be almost in line with the centreline of the hull as shown in the figure 1 where the boom is sheeted in almost to the top of the sheeting post. To go with this, the jib boom must come in to make about 15° to the centre line as shown in figure 2. Then the two sails can interact.



For

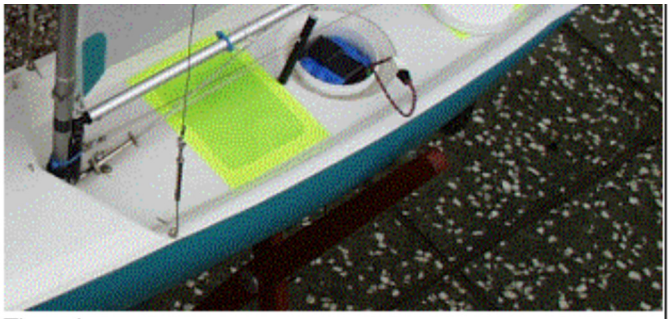


Figure 1

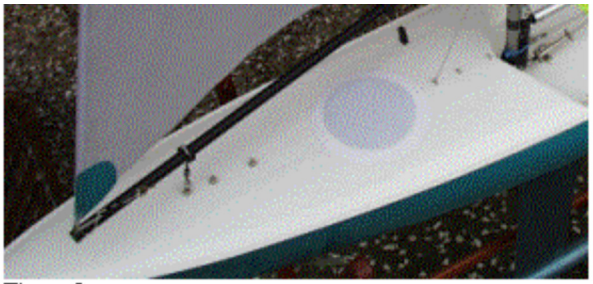


Figure 2

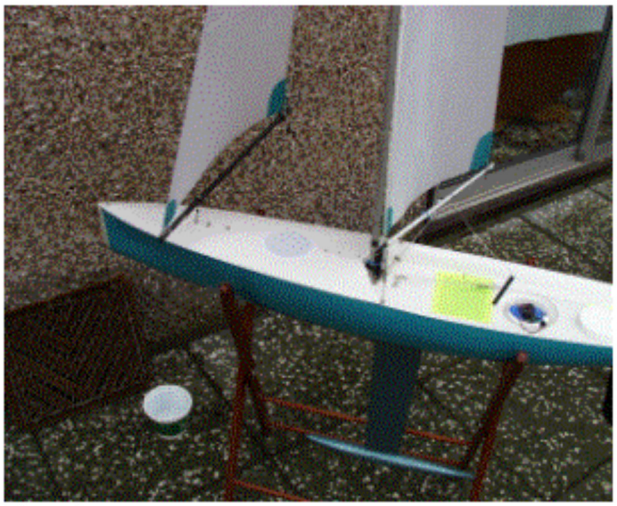


Figure 3

sailing down wind the two sails no longer interact in the same way as for beating and the two booms can be more or less parallel at about 80° as shown in figure 3. Some may say that the jib is out too far and that they might be parallel to advantage.

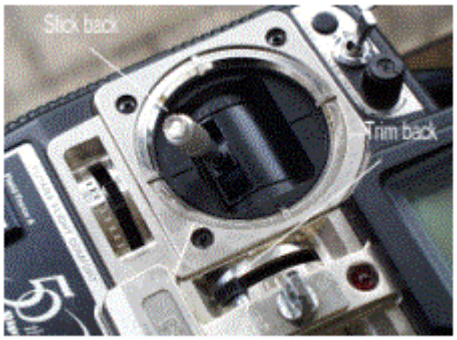


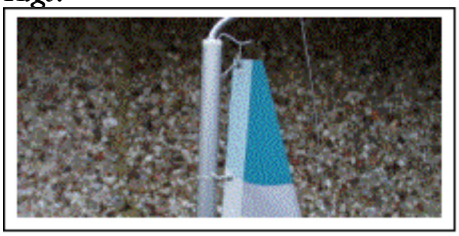
Figure 4

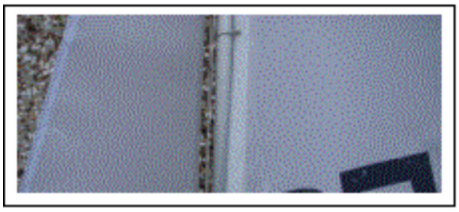
This means that what is required of the sheeting system is for the full throw of the transmitter stick to make the main boom travel through about 80° and the jib through about 65°. The best starting point is to pull the stick and the trim right back (see figure 4 of an out-of date transmitter) to sheet in as much as the set up will allow. The sheeting cord comes from the winch, through the sheeting eye at the top of the sheeting post and is then tied to the boom attachment so that the boom is as close as possible to lining up with the centre line of the deck. This avoids the possibility of overloading the sheeting by trying to sheet in beyond the physical limits of the sheeting arrangement. The boom must pass only just above the sheeting eye. If it is too high the boom will be pulled down at the end of the travel and flatten the sail. With this arrangement the boom can be sheeted in to the mid position by using the full travel of the stick and the full travel of the trim but the position of the boom can be adjusted, i.e. let out a little to fine-tune for beating if needed, by adjusting the trim. This gives one very important position of the rig that can be found consistently.

The arrangements above settle the main boom. As the jib boom has to operate with the same travel as the main boom, the position of the boom attachment for the sheeting must be selected to suit. It follows that, as the jib moves through a smaller angle, the distance between the swivel on the jib and the sheeting attachment on the jib boom is greater than that for the main boom. It should be set up for the jib boom to be at about 15° when the main is sheeted in and the trim in mid position. Provision should be made to alter the effective length of the jib sheeting cord and to alter the position of the sheeting attachment to the jib boom. These two will permit fine-tuning of the jib.

If these arrangements are in place it is possible to set up the rig for sailing.

Rigs.





Composite figure 5

People who race model yachts try to get their yachts balanced. What they would like and cannot have, is a yacht that, with the rudder set in its middle position, follows a straight course for every sail setting and every point of sailing. Unfortunately there are forces exerted on the hull from the water acting directly on the hull, from the fin and rudder and from the air acting on the sails and these forces cannot be balanced out for every point of sailing. However, if the fin is in the right position on the hull and the mast in the right place relative to the fin, the balancing action of the rudder can be minimised. Of course this is not easily achieved and arrangements may be made to permit the adjustment of the mast either fore and aft or by raking the mast, normally, the maker of the boat will have experimented to find the best position for the fin and the mast and then the mast will go into a fixed socket.

Setting up the rig.

As this is supposed to be about a new or a second-hand boat that presumably has been sailed the top rig can be fitted leaving all the lines slack. First the shrouds should be tightened but not to be over-tight. Model yachts can heel in response to changes in wind speed and having some give in the rig can help in squalls. Assuming that your mast starts off straight[5] make sure that the mast is still straight when viewed from the front and that it is upright.

These days the sail will almost certainly be made from mono-film. Mono-film does not deform in the same way as cloth and getting "belly" (as distinct from camber) into the sails is difficult. In order to try, most mainsails are cut with a curved luff and the initially straight mast to allow some overlap of the luff over the mast as shown in the composite figure 5 to produce, hopefully, some belly if the wind is strong enough.

Now we must set up the main sail. The first thing to realise is that the luff of the main is likely to have a small curvature although, sadly, it could be straight. In composite figure 5 the luff is clear of the mast at the head, overlapping the mast over all of the middle length and clear of the mast again at the foot. Whilst the sail might shift round the mast when the boat is made to change tack in a good wind it is certain that in very light winds the sail would not swing round the mast. It follows that, if the luff is curved and the wind is light, that the mast must be bent backwards to make it match the luff of the main. For this we must tighten the backstay to bend the mast via the mast-head crane. If the luff is straight the best that we can do is to remove the slack in the back-stay.

The back-stay is attached to an eye at the stern of the boat and to a crane at the masthead. Tightening it pulls the mast backwards and consequently bends it. In addition it does give the mast some pre-tension ready to resist the force in the fore stay when it is tightened. The mast-head crane is generally seen just as a way to keep the backstay clear of the sail but if the length of the crane is altered the shape of the curved mast can be altered if it proves to be necessary. So tighten the backstay until the shape of the mast matches that of the luff as shown in figures 6 and 7. Now tighten the uphaul and the downhaul of the main to get the sail in the correct vertical position relative to the main boom. The sail should now swing freely on the mast. Check particularly at the foot of the luff. The basic arrangement of the downhaul is not really satisfactory


Figure 6

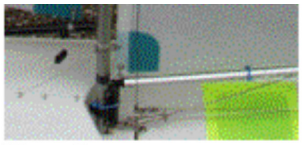


Figure 7

but no one seems to have found a better way of attaching the downhaul.

The rig shown in these photographs uses mast rings made from knotted cord and there is a significant gap between the mast and the luff. Having a gap is not really desirable because it lets air leak from the windward side to the leeward side but it does permit some freedom to let the mast straighten until it touches the luff and, as I have said, with sufficient wind this might well produce some belly in the sail and perhaps a crease without impairing the freedom to swing round the mast in light air.

Now we can adjust the jib.

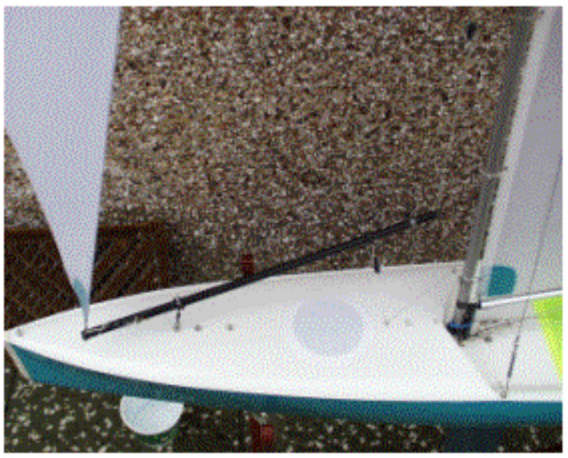


Figure 8

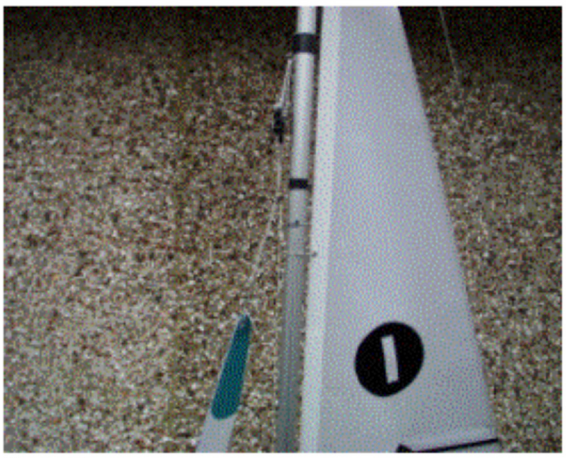


Figure 9

The jib sail is fixed to the forestay and to the boom at its clew. If the sail were to be removed as shown in figure 8 we would see that the boom is fixed to the deck through the swivel and its angle is determined by the fore stay that is attached to the forward end and the leech line that is attached to the aft end (the leech line is just visible as a white line). The fore stay and the leech line are attached near the mast-head as shown in figure 9. Tightening the forestay produces tension in both the forestay and the leech line but, because the swivel is near to the forestay, the tension in the forestay is about four times that in the leech line. If the leech line is to remain tight in moderate winds the tension in the forestay must be quite considerable. When it is applied it may alter the tension in the backstay and possibly move the mast-head but not by much. This arrangement means that the aft end of the boom can be raised or lowered by shortening or lengthening the leech line.

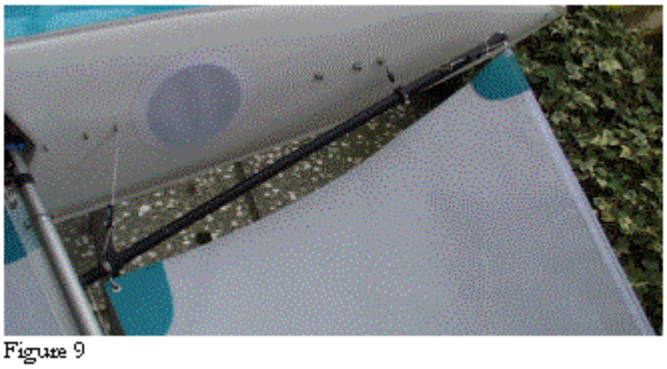


Figure 9

If we now reattach the jib sail it must be set to the correct camber. The camber is the curve of the foot of the sail. It is adjusted by moving the clew attachment on the boom. When it is correct it will look like figure 9. Skippers talk of reducing the camber for heavy weather and increasing it in light weather. I could never find this effect because it was masked by the swirling wind at Swanley Park

Now we can look at the use of the leech line. The three photographs in figures 10, 11 and 12 show how the shortening of the leech line increases the curvature of the leech. Most

would sail with the leech curved as in the middle picture where the jib at mid-height makes an angle, when sheeted in, of about 20° to the centre line of the hull.

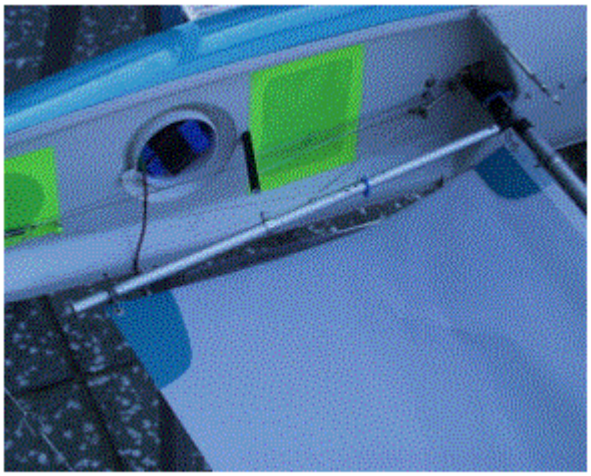


Figure 13

Now the main sail must be set up and we start with the camber. The camber should be set to give the same shape to the foot of the main as that of the jib (not the same offset) as in the picture on right. Hopefully the sail will be free from creases or wrinkles.

Finally the sail will require some twist and we need to know why. A yacht when it is sailing is subjected to a variety of forces. The sails each produce what can be regarded as a single force. These two forces are of different magnitudes and directions. They act on the hull through the mast and the swivels and the sheeting post and so on. The hull produces a force and perhaps a pair of forces trying to rotate the hull as it moves through the water and the fin and the rudder produce more forces. The rudder is adjusted continuously to keep these forces balanced and a well-developed yacht will not need a very great force from the rudder. If it does, it just adds to the drag and slows the boat. On a full sized boat the helmsman, if he is up to his job, can sense the variations of force on the rudder and interpret these changes in terms of wind changes. The skippers of model racing yachts do not have this flow of information and they must either be very good at sensing wind shifts or they must set up their yachts to go well despite continual variation of the wind direction. They allow their main sail to have a twist.

This twist is controlled by the kicking strap and about 10° of twist is usually enough. In figures 14 the kicking strap been tightened to make the sail almost flat and in figure 18 it has been adjusted to give a large loop in the leech. In order to see the sail, look at figure 18 and in the middle find the mast-head crane. There is a small green triangle that is the reinforcement of the head of the sail. The leech can be seen to sweep downwards from this triangle and then up to the boom. Then find the curve in the others. For most purposes the curve in the figure 15 will be about right with a little more when the wind is swirling from passing obstructions.

When all this is done the rig is set up ready for sailing.

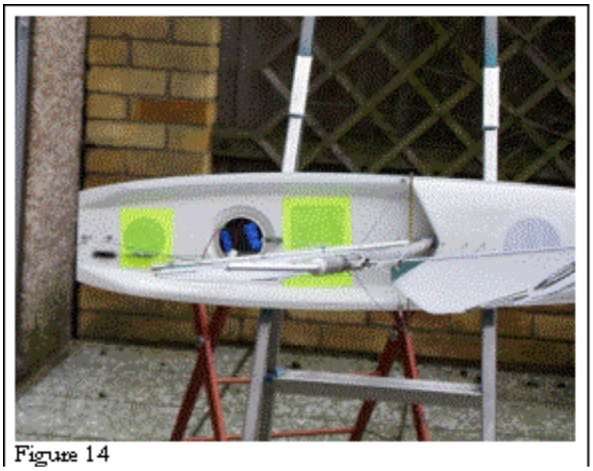


Figure 14

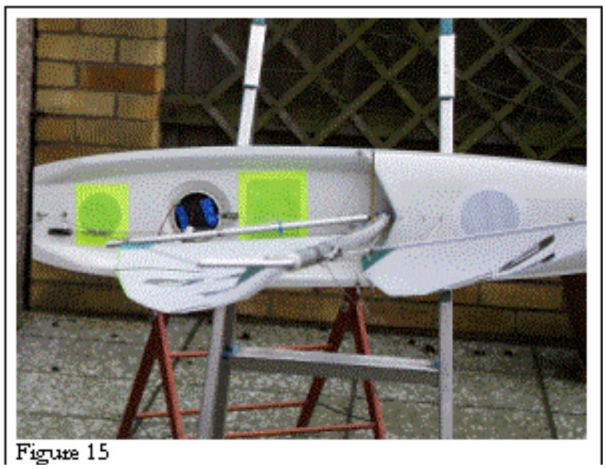


Figure 15

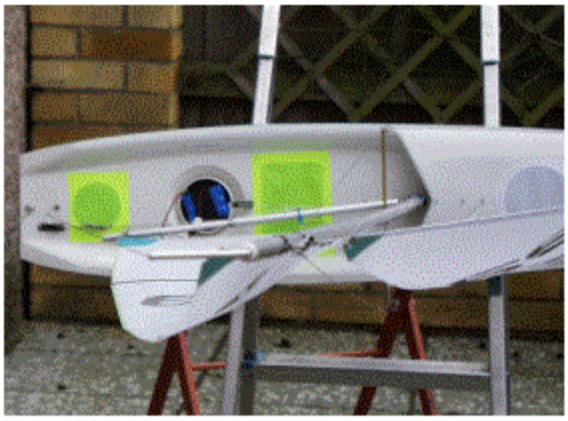


Figure 16

Sailing

Beating

The most important point of sailing is beating, i.e. sailing upwind. This is done zig-zag fashion. The sheeting system must be set up for this. Start by sheeting in fully and letting the boat sail freely with the rudder on centre. It may take a short time to settle down. What we would like is for the yacht to swing to one side and for the sails to fill and the boat to set off upwind at about 45° to the wind with a tendency to swing gently towards the wind. If it does it will go on turning into wind until probably the jib starts to flutter and then collapses. The boat will quickly lose way and fall away from the wind until the jib fills again and the boat repeats the sequence. If the rudder stick is used to apply a very small amount of rudder to keep the boat sailing with the jib just not fluttering we have real progress. The boat will beat if we stop it luffing into wind by this application of a very small amount of rudder and holding it on.

Of course we are unlikely to be so lucky. The most likely change that will be needed is to let the main boom out by a small amount using the sheeting trim. If this is an improvement then we need to watch the jib again. If it collapses too soon the jib may have to be brought in by the amount that the main was sheeted out.

Now the setting up process has to be continued until the yacht is set up well enough to race. Do not expect to be able to set up properly from the start. There is a lot to learn. An important point to accept is that yachts do not beat without rudder application albeit a small amount. When the yacht changes tack the same amount of opposite hand rudder is needed. It follows that yachts cannot be set up to sail a straight course on both tacks and therefore centring the rudder is not enough. The skipper must alter the rudder position with each change in tack. In fact the skipper has continually to correct for the ever-changing want of balance between the forces on the yacht. Correcting using lots of dabs of rudder is not really an option because the boat is impeded much more than it would be if a small amount of rudder were to be held on. Hence the need for the minimum total throw and long transmitter sticks.

Now one must learn to sail in order to observe the behaviour of the yacht well enough to tune it.

It is quite possible to sail a yacht by setting the main sail boom at about 35° and leaving it alone whilst using only the rudder to give control. Try going upwind. The yacht will make headway upwind but only at a large angle to the wind and attempting to sail closer to the wind will just cause the sails to collapse and the boat to stop. If the sails are now sheeted in a little the boat will make better progress against the wind but the sails will still collapse if the boat is turned too far into the wind. Skippers call turning too far into the wind "pinching". The best we can do against the wind is to go to the position for beating. We would then be looking to sail as close to the wind as possible with the jib just showing the first signs of collapsing which will appear as a flutter just behind the luff and at the leech. Pinching from this position is pointless. The boat is sailing as close to the wind as it can and pinching will cause the drive to decay and the boat to slow or stop. It will be found that in order to do all this properly only very small rudder movements are needed.

Getting out of irons

It is most likely that at some point the yacht will go into irons. It will end up with its bow pointing somewhere upwind and both sails collapsed and flapping in the wind. Obviously we need a way to recover from this position. There is only one way and that is to sheet in fully, centre the rudder and wait. You may

wish to come out of irons on a specific tack but you do not have that option because the rudder cannot possibly influence events except to stop the boat recovering, especially if it has a large rudder throw. You must wait. The wind will blow the yacht on to one or other tack and eventually the sails will fill and the boat will start to move. If it is on the desired tack OK but if it is not then you must change it to the other tack and to do this it must pass through head to wind during which there cannot be any drive. For this to be achieved the boat must have sufficient speed to carry it through head to wind before the change of course is attempted. If it has insufficient speed and an attempt is made to steer the yacht to the new tack the boat will stop and go into irons again. There is a balance to be struck here. If full rudder is applied too soon the boat will turn sharply and stop. If a small amount of rudder is applied it will turn more slowly but the rudder drag is much less and the boat might just complete the change of tack. Experience is needed to master this essential manoeuvre.[6]

Reaching

For beating and getting out of irons the rig has been sheeted in fully with perhaps a little sheeting trim. Only the rudder has been used. When the boat has to sail across the wind we have to let the sails out and try to find the position for them that gives the best boat speed. At the same time we have to control the course using the rudder. We have two controls to worry about and, indeed, good skippers work one with the other all the time. Hence the use of one stick. In full sized sailing the crew can observe the sails at close quarters but with models we are short of cues to tell us what is going on. Probably the best guide is how much the boat is heeling as evident from the mast. The yacht heels in response to the transverse force and that force changes more or less proportionally with the driving force. If the boat heels there is a good drive. But, if it heels too much, it may be better to sheet out just a little and reduce the angle of heel of the mast and improve the rudder authority. If the boat is near enough it may be possible to see the sails and watch for flutter in either or both sails. Sheet out slightly if they flutter. Another cue is the sail position of other yachts racing in the same area of the lake. This involves looking away from your boat and it is devastating to see how quickly your boat goes off course to your disadvantage when you look away. The work-load on model yacht racers is quite high.

Running

Running is the name for sailing down wind. This is quite a difficult point of sailing. The sails are let out, often to their physical limit, and the both sails appear to be simply obstructing the wind. As the metre boat has only one servo and one winch it is more or less a matter of chance whether both sails will go out to the same side or whether they will go to opposite sides (goose-winged). Given the dominance of the swing rig over the simple Burmuda rig for Marbleheads when running there can be no doubt that the goose-winged boat runs best. It is said that the main sail "blankets" the jib but that might be too simple. Whatever may be the case, running is not the fastest point of sailing because the difference between the wind speed and the boat speed, and therefore the drive, drops as the boat speed increases. In full sized racing, where legs can be very long, skippers often sail downwind and get extra boat speed at the expense of sailing further. This is probably not an option for model yachts because the legs are usually very short. However it pays in model yacht racing to try various sail settings to see which is best.

Regardless, the running yacht has a severe imbalance because the main sail is out to one side. This tends to turn the boat and the rudder must be used to keep the boat on course. If the yacht is really sailing close to the limit for the size of rig fitted it may be desirable to sheet in and reduce the effective sail area and reduce the load on the rudder to give something in hand to cope with gusts.

Tuning and racing

These two go together because there is only one way to get the best out of a yacht and that is to compare its performance with that of other similar boats. This means racing.

Now it is one thing to be able to control a yacht and quite another to race it. The first requirement is to know the rules of racing. Basically these are simple. What is not simple is applying these rules almost instantly when racing. The simple rules have to be applied in many situations and it takes time just to learn how the rules apply in the commonly-met situations such as rounding marks and meeting other boats. You must be patient whilst you build up a familiarity with the rules and how thay are applied.

Model yacht racers vary in their response to racing mishaps, some just shrug and get on with their sailing but others get aggressive and shout and grumble and behave in an intimidating way. As a novice you will make mistakes and have to cope with all sorts of responses to these errors. It is a crucial stage of learning to race a yacht and somehow you must survive. The OOD should protect you from the loudmouth but he has to take the brunt of the comments if he does. But, to some extent, you can help yourself by racing at the back of the fleet. This keeps you away from the front-runners for whom a boat in the wrong place, either at the start or on the course, can make the difference between winning and losing. There will always be back markers that you can race with. As you get your boat up to speed and become more familiar with the racing rules you will move up the fleet and eventually compete on level terms. **It takes time.**

Even if learning to race takes time there is no reason to delay tuning the boat. If you go to an open meeting you will see skippers holding the yacht resting on the front bumper and the lead and eyeing the sails with great concentration. If we assume that it is not a charade put on for the benefit of the opposition they must be doing something that they think is useful. What they are trying to do is to set their boats up so that from race one they are very nearly as good as they can be for the prevailing conditions. Only experience makes this possible and some skippers race the same boat twice a week throughout the year. They each have a mental picture of what their rig should look like for every condition. You must have the same goal even if you do not intend to enter the world championships. So get used to looking at the two cambers and at the twist of the main and the curvature of the leech of the jib etc.

Tuning involves means making changes to the rig and the golden rule is to make only one change at a time. If there is such a thing as a silver rule then it is have a good reason for making the change. You will start with the boat set up as outlined in this pamphlet and tuned to beat etc.

It is this second rule that is difficult to implement. The trouble is that you have to separate the behaviour of the boat from the effects of your control actions. If you continually move the sails in and out and thrash the rudder from side to side you will never know what the boat does when it is sailing steadily. Get your boat behind a boat that is being sailed without fuss on a reach or a beat. Set your rig to look like the one in front and then try to steer a matching course by finding a rudder position that needs little subsequent movement. If your boat is noticeably slower try again in a later race to confirm the outcome. Your view of the same sail setting might be wrong. If it is slower a change is needed.

Now you have to choose a change. The best bet is to concentrate on the jib. There are three possible things to change, the angle of the boom when sheeted in, the curve in the leech and the camber. We have already set up the angle of the boom so it is the camber or the curve in the leech. Try making a small change in the camber (by small, less than ¼² movement of the clew). Test your boat again. If it is better make another small change. And so on. When you are satisfied try changing the curve of the leech. Do not imagine that you are setting up the boat once and for all. What you are trying to do is find out what affects what so that, in the fullness of time, you can alter the rig to suit the weather before you sail. The snag is that in one series of perhaps 8 races there will be only a very few chances for a rig adjustment so you must make other opportunities during social sailing as well.

There are of course other things to change like the twist in the mainsail and its camber. Do not forget the possibility of changing the travel of the jib relative to the main to alter the relative positions of jib and main when reaching. The sails still interact. Be patient you will get there.

Miscellany

Counterweights

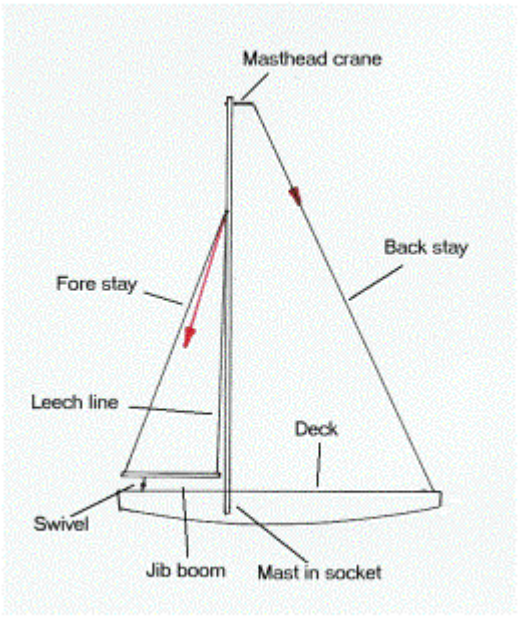
Metre boats should be fitted with a counterbalance weight on the jib. It may not be necessary in heavy weather but you cannot manage without it in light winds and SMYC members try to sail in almost no wind. It is needed because the swivel is set as far back as it can be consistent with the jib generating sufficient force to switch from tack to tack automatically. In light weather this is a very small force indeed. The physical arrangement of the jib means that when it swings out its centre of gravity without a counterbalance has to swing upwards. This may not be possible with the small force generated in light airs and the fitting of the counterbalance solves the problem.

Rough or smooth?

Novice skippers receive all sorts of advice. Among this advice may be the statement that the lead should be rough for minimum drag. This is very suspect. If it were to be true we would have interesting situation at the junction between the lead and the fin where, of the two adjacent surfaces, one is smooth and one is rough. It seems to be most likely that they should be the same. If you genuinely think that a rough surface is best take fine sandpaper to your hull and fin in circular motion and make them rough. Before you do, take on board the fact that the very top class gliders are polished all over by hand before they are sold, not polished like you would a car but like an optician would polish a lens. The best we can manage is to fill and paint our leads and wax the hull, the fin and the lead and pay very special attention to the front third of the fin. Do not scrub your lead on the bottom of the lake.

Curvature of the luff of the main sail

In order to understand the need for curvature we must look at the mechanics of the rig. In the next diagram I have drawn the rig without its sails. The mast is initially straight as drawn but if the back-stay were to be tightened a force would be exerted directly on the mast-head crane in the direction of the red arrowhead on the back-stay. It will tend to bend the mast backwards and push the mast downwards into its socket. If instead we left the backstay slack and tightened both the forestay and the leech line the mast would be bent forwards and again pushed downwards into its socket by a force in the direction of the red arrow. These actions are only possible because the mast is in a socket. If we tightened the fore stay and leech line first it would bend forwards and if then we tightened the backstay the top of the mast would bend backwards. The mast would have an "S" shape. This does not lend itself to cutting sails. If we reversed the sequence the mast would end up with a smooth curve. This is much better for designing sails to have a curved luff especially as it holds out the possibility of giving the sail some "belly". Some skippers put a set in the mast so that, when the rig is tensioned, the mast takes up some desired shape for which, presumably, they cut sails.



Figure

When a rig is set up we need to pay special attention to the leech line. Its function is to control the curvature in the leech of the jib. Unfortunately when the jib is under load, as it might be in a strong wind, the leech of the jib tends to billow out and lift the aft end of the jib boom. We want the tension in the leech line to be enough to prevent this. The location of the swivel near to the forward end of the jib boom means that the force in the forestay is 3 or 4 times that in the leech line. So the force in the fore stay is really quite large. This means that the force in the back-stay must also be large and in turn it means that we simply cannot get an adequate force in the leech line of a metre boat without bending the top portion of the mast. So if one were to make a main sail with a straight luff it would be impossible to get sufficient force in the leech line and simultaneously have the correct shape for the main sail. Hence the curve.

This inherent problem is more easily managed if the fore stay and the backstay are made of wire that will not stretch significantly under the sort of load applied to them. Typically 26 SWG stainless steel wire would be used with short lengths of Dacron cord for the bowsies.

Location of sheeting post

Where the sails are controlled by one winch, as in a metre boat, the sheeting travel must be the same for both sails. We know that the mainsail will be required to sheet out by about 85° and that the jib must sheet out by about 70°. So the distance from the swivel to the sheeting eye on the jib will be greater than the distance from the goose neck axis to the sheeting eye on the main sail boom.

The actual distance that the winch sheets in or out depends on the rotation of the winch shaft and for full movement of the stick and the effective diameter of the drum fitted to the winch. Some winches have the facility to adjust the travel corresponding to a given movement of the stick but the manufacturers of the winch will say that they intend that you should buy a drum of a size to get close to what is required and use

the adjustment as a fine control. They do not recommend that the smallest travel be used because it overloads the winch. So the primary way of matching the sheeting travel to the movement required to control the rig is by the selection of the diameter of the winch drum. So we cannot just fit any old winch and rely on the travel adjustment facility whether this comes from the winch or the ATV[7] of the transmitter. We must decide what travel we actually need and sort out the control equipment to give it. Do not fit a gate to the transmitter because even the smallest stick movement gives much too much movement of the sails. Controlling a yacht is difficult enough without adding to it.

In order to decide on the sheeting travel that is required we have to look at the rigs that we intend to fit to the boat.

Three rigs can be fitted to a metre boat, the top suit and the second and third. The essential difference between the rigs is the total area of the sails. Those who race on sheltered waters will probably use only the top and second suits. Others may need all three to cope with high winds and waves. The reduction in the areas of each sails is obtained more by reducing the height than by reducing the length of the foot. Even so the length of the foot of the jib of the third suit is shorter than that for the top suit. It would be convenient if we could keep the same length of boom for all three sails and let the gap between the leech of the jib and the mast increase for the smaller rigs but the evidence from full sized yachting suggests that the rig fitted with a Genoa is the best. In these rigs the Genoa overlaps the mast. As model yachts cannot have a jib sail that overlaps the mast the best that we can do is to fit the jib sails with the clews of the jib as close to the mast as possible bearing in mind the need for a sheeting eye on the boom. This means that the booms get shorter as the area goes down. We know that we have to fit the swivel at about 30% of the foot from the tack in order to let the sail set during a change of tack so, on the small suits, the length between the swivel and the sheeting eye on the boom gets to be somewhat shorter than that of the top suit.

Almost everyone uses the same sheeting travel for all the rigs. *Then if the three jibs are all to swing through 70° they must all have the same distance between the swivel and the sheeting eye on the boom.* This distance must be that of the smallest rig that will be fitted to the boat. This gives as large a sheeting arm for the jib booms as is possible. This is a snag because I suspect that you will not be able to buy a drum with a small enough diameter. Get one made by a friend.

The sheeting arm on the main becomes much smaller than is commonly used.

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[1] Charging batteries is singularly difficult because most chargers are designed to charge the batteries from 1 volt per cell (ie discharged) in 14 hours. The rate of charge required to do this is too high for the batteries to withstand once the batteries are fully charged. It is difficult to discharge a battery and stop at 1 volt per cell and most people charge without discharging. It is all too easy to overcharge with resultant battery damage. The best way is to charge for a long time at about 40% of the 14 hour rate.

[2] It is sad that so many skippers pass derisory comments when a transmitter has more than two functions. Mostly they are frightened of any complexity and the fun to be had from a computer transmitter is lost to them.

[3] This is not necessary. Winches can be inside the boat with the drum on the deck and the sheeting mechanism on the deck. Then the hull can be sealed and the servo and winch operate in dry conditions.

[4] This is perverse because the set up should suit the smallest suit of sails to be used not the large suit.

[5] Some skippers pre-bend their masts. See item in Miscellany on curvature of luffs

[6] Newcomers to racing have to start their first race with an upwind leg. There is plenty of opportunity to get things wrong. If the newcomer cannot recover from going into irons the fleet may make a whole lap before he can get to the first mark. It may seem to be very embarrassing but it happened to us all in our turn.

[7] ATV is the name for the travel adjustment facility.