<u>Practical methods of sailing Traditional Maltese Vessels</u>.

Fig.1

The pedigree of the traditional Maltese sail vessel has been well documented by historians elsewhere. The hull and rig follows in the quintessential `wakes` of other vessels of the Mediterranean Sea. To risk stating the obvious, it would seem self-evident that these features were not arrived at by chance but by a gradual evolution, in the face of: local weather conditions the `use` to which these vessels would be put and primarily the practical experience of the men who built and more importantly sailed these vessels.

Unfortunately, a critical loss is the extinction of the practical experience of rigging and sailing these vessels. Very few men remain who have first-hand experience of the operation of these vessels in the prevailing conditions of the Maltese islands and those that do gained their experience, as young children, in vessels which had already been converted to motor power and the sails were only used as auxiliary power when the motor failed or the conditions were extremely favourable.

It is the purpose of this series of experiments is to recreate this `practical experience` by rigging and sailing traditional Maltese vessels and, by a process of deduction, try to establish the `how` and the `why` of hull design, rig and sailing practises.

To this end a Maltese Ferilla was purchased. The choice was limited! The parameters imposed by the intended experiments necessitated a vessel which had been built exclusively to be sailed and rowed (to insure that no modification to the original hull design had been incorporated during construction). This meant that the construction date of the youngest vessel under consideration had to pre-date the general introduction of motor power. It was also vital for these experiments that the vessel should be structural, sufficiently sound to survive the rigors of being sailed. In addition it was important that all post-construction modifications should be rectifiable and finally that the purchase and restoration costs should be within the limited budget. The vessel finally selected was built in 1925 (eighty years old at time of purchase). Measuring 6.09 M by 1.83 M.

The project was divided in to two main phases:

Phase 1 was the restoration of the hull and the rectification of all post-construction modifications.

RESTORATION DETAILS

Before describing the procedure of restoration I must pay tribute to all the local people who, by their enthusiasm and encouragement, were instrumental in assisting the project. When the project was first muted the owners and customers of the Gleneagles Bar in Mgarr where incredulous but very supportive. Without one in particular, Mr. Andrew ************ the project would have failed at the outset. Mr. Andrew *********** first located a suitable vessel and then provided an original, hand sewn, suit of sails (at least sixty years old according to his recollection) which had belonged to his father and been used on his fathers boat.

The value of these sail in the success of the experiment cannot be underestimated, from them it was possible to calculate spar lengths and from the cut it was possible to evaluate innumerable other details the details of which will follow.

The initial condition of the Ferilla was as follows:

The hull was in good physical condition, the side decks had been re-laid using marine ply as had all lower bulwarks with the exception of one section (two metres long) on the Port after quarter which appeared to be original. Two engines had been fitted with engine beds, one central and one wing, in the case of the main-central engine the stern tube had been fitted through the aft dead wood and a propeller aperture cut in the keel section forward of the stern post . The wing engine shaft had been fitted through the hull on the port aft quarter. The central thwart had been cut and a section removed above the wing engine position. Holes had been made in the hull and topsides for cooling water inlet and outlet. The mast deck had been removed, although traces of it could be discerned in the remaining timbers. The sprit deck was present although it had been altered from its original condition. Research revealed that no major alterations had been carried-out to the original `as built` hull. Despite 80 years of wear and tear the Ferilla was in remarkable good condition.

From the outset the choices, from the myriad of possibilities, which the builder had made during construction, were examined and an attempt was made to deduct the reasoning behind these design decisions.

The Ferilla is fundamentally an open boat, its purpose was to convey `cargo` (including people) between points on the Maltese coast and within the harbour of Valletta. It was sprit rigged with a long bowsprit; one main sail and one jib were used. It was not expected to make long, deep sea, voyages usually sailing no more than three to five kilometres (or one hours sailing) off shore in modern parlance ´a water taxi`. A comparison with the more common Luzzu illustrates the major differences in size and shape. Compared to a Luzzu the Ferilla is “a young Maltese girl compared to a middle-aged Maltese woman”. To quote from a very knowlegeable expert who, on the grounds of political correctness, shall remain nameless. This is a reference to the Ferilla`s thin, sleek hull shape compared to the more rotund hull shape of the Luzzu.

On the grounds that these vessels were primarily operated by owner skippers. It can, I suggest, be assumed that the commissioning of a new vessel was a once (or at most twice) in a life time experience. Coupled with the undoubted expense that this would entail it must be assumed that it was not an enterprise which was entered into lightly. It follows that the selection of design features to be incorporated into the construction would have been the source of considerable discussion and the choice of boat builder, although perhaps constrained by family and/or geographical considerations would have been made on the basis of the performance of previous vessels. All Maltese vessels, at the time, were built without paper plans. Each boat building family had sets of patterns, the secrets of which were closely guarded. Commercial considerations by these boat building families would have influenced their decisions.

I feel it is appropriate, at this point, to very carefully examine the design and construction of this Ferilla with a view to discovering the reasoning of the owner and builder, taking into consideration the sailing potential.

The Ferilla is a double ended vessel, virtual symmetrical fore and aft although the sheer of the deck is higher forward. The hull shape, when compared to other local boat designs, is such that it can be assumed that these vessels were built for speed. In this it is possible to discern the most important compromise; that of, the sacrifice of weight carrying capacity in favour of boat speed under the most commonly experienced metrological conditions expected in the area of operation.

Fig2
Luzzu

Fig3
Ferilla

The keel is parallel with the waterline and the stem and stern posts vertical to it. The floors and frames follow the construction method of most wooden vessels of this size around Europe.

The decks fore and aft are small and the side decks narrow and steeple angled. The cargo carrying area is surrounded by a combing which rises almost to the level of the bulwarks, which have numerous drain hole (scuppers) each side of the frame ends, where they protrude through the deck.

These side decks are too narrow to be walked on without difficulty. It would seem self-evident that these side decks where, during sailing, expected to be submerged from time to time. From which it is possible to deduce a maximum anticipated heeling angles of forty-five to fifty degrees.

The conundrum is why have these decks at all?

Light may be shone on this situation by the knowledge that, on the larger Dhasja Tal-latini type vessels these side decks were built at such a steep angle as to make walking along them impossible, in the case of the Dhasja Tal-latini the side decks are demonstrably an extension of the topsides, effectively raising the topsides but without increasing top hamper or windage. I would postulate that they served the same purpose on the Ferilla and the Luzzu.

This semi-wet area also served as a useful storage area for fish should any be caught.

Restoration: The Hull.

Fig 4

Fig5

When discovered the Ferilla had been stored for six years. As previously stated the overall condition was remarkable good as can be seen from the pictures above. The first task was to remove the engine beds and repair all the damage that their installation had caused. Each of the beds had been secured with bolts through the hull, the deadwood had been drilled for the main engine shaft and a propeller aperture had been cut. In the case of the wing engine the hull had been cut and the stern tube passed through the hull, the outer end of the shaft had been supported by an `A` bracket again bolted through the hull. Finally the cooling water inlet and outlets had passed through the hull below and above the water line respectively. To facilitate the installation of the wing engine the main transverse beam, at deck level, had been cut. Fortunately sufficient of this beam remained for a replica to be constructed.

The mast deck had been completely removed although there were indications on the remaining timber in the area which permitted an accurate substitute to be constructed
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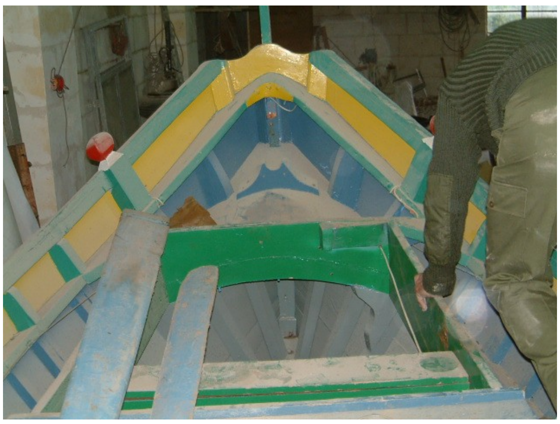

Fig 6.   Forward view showing sprit deck

It was fundamental to the validity of these experiments that the rig was a faithful reproduction of the original. To this end, considerable research was entered into to establish how these vessels were rigged.

Restoration: The Rig

Fig 7 Fig 8

Needless to say mistakes were made, the first attempt with the mast (see fig 8) was considerable too long, the ramifications where that the main and jib were set too high and the sprit and main sail sheeting angles were incorrect. When this was rectified (see fig 7) the mainsail was set lower in the boat and the sprit angle fitted the sail construction and sheeting angles, for both main and jib, were modified enabling more natural locations for attachment to the deck.

The Sails:

- Imperial measures will be used throughout because it is undoubtedly that sail makers, at this time, would have used this system.*

It is impossible to over state the importance of the acquisition of a suit of original sails, many aspect of these sails could not have been guessed at or gleaned from pictures, models or photographs. Of primarily importance is the magnitude and location of seam width on the main sail. The final shape of the sail is first influenced by the sail maker, this is achieved by widening or narrowing of the seams in various parts of the sail and by shaping the curves of the edges of the sail where the sail maker can assume the curve will be held in a straight, or nearly straight line, such as the luff attachment to the mast. If the luff, and foot have suitable convex or concave curves built into them and these curves are then pulled straight or straighter by the tension on the halyard, down-haul and out-haul (or main sheet) the addition sail cloth has to `go to or come from somewhere` and this induces greater or lesser curve into the sail. Ipso facto, the tension of the luff, foot and leech of the sail are critical to sail shape and therefore sail performance. Although some shape can be achieved in this way, jib shape is more difficult to control in this way as they are only held by three points, so it was normal to have a variety of sized jibs the smaller the flatter the larger the fuller cut by the sail maker. However, it must be remembered that the optimum degree of curve in the sail varies with wind strength

Material 8-10oz. Egyptian cotton hand sewn.

Fig 9. Head sail:

Luff 10ft.4in. convex curve 2in. max. 5ft. from head, single roped with loop at tack and sewn metal eye at head.
Leech 5ft.6in. concave 2in. curve max. 4ft. from head, rope loop at clew.
Foot 6ft. 10in. straight.
Five panels, centre three 1ft.5in wide, leech panel 10in at head 6in. at clew.
All seams 7/8th. In. wide.

Fig. 10 Main Sail

Hoist 6ft.8in. straight, single roped
Head 14ft. 7in, double roped

16ft.7in. 4in convex curve max. 10ft.6in. from head. Leech line sewn into leech seam.
Foot 11ft.10in. 2in convex curve max. midway. Single roped.
All soft eyes. Wooden toggle at head.
Brailing line.
Maximum draft of 2ft.4in. coincides with centre of effort.
Panel width 2ft.6in.
Re-enforcing patches in corners.
The single most important clue regarding the main sail is undoubtedly to be found in the seams. Sail makers, working in three dimensions, control the final shape of the sail primarily with seam width. In the Ferilla sail the panel width is two feet six inches. The sails had indications (wear and chafe) of some use in the past but the indications of cloth stretch was minimal. It would be typical of a stretched sail that the panels showed more draft than the areas of the seams, this was not the case with this sail.

The sail consists of five panels and four seams, the first seam begins at the head with a width of two inches and this is gradually reduced over two-thirds of the seams length, at which point the seam continues with a width of one inch. In the second and third seams the commencement width is three and one quarter inches the reduction mirrors the first seam with the bottom third having a width of one inch.

Three and one quarter and two inch seams

One inch seams

Fig 11.

<u>This alone has the effect of introducing two feet four inches of draft permanently into the sail over the lower half. The location of this maximum draft coincides with the centre of effort of this sail.</u> I will examine the ramifications of this later. This draft is further enhanced with a convex leech curve of four inches at its maximum again two thirds from the head of the sail (a leech line was fitted).
This sail is designed to be set `Loose footed` with no boom. Because of the nature of the sprit rig, the head and hoist are held straight. The tension from the sprit end being transferred through the head rope to the luff rope. Control of the clew, by the main sheet, enables the helmsman to induce addition draft into the sail, <u>but not remove draft lofted into the sail by the sail maker.</u> There was no facility for reefing this sail, although a brailing line was present.

Phase 2 was the performance of sea trials, under a variety of conditions, during which the sailing characteristics could be established and recorded.

Fig. 12.

Fig. 13 First Sail.

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Every aspect of sailing Traditional Maltese Vessels, from boat design and type to sail size and courses sailed are a series of delicate compromises. Rediscovering the art of sailing these vessels is therefore the skill of making the most appropriate decisions, taking all the relevant factors into account. This is never more obvious than when sailing.
Traditional Maltese Vessels(or any others), will not sail directly into the wind. How close you can sail into the wind is controlled by a myriad of factors. It depending on: (Among other things) the hull design, boat type and size, rig design shape and size, which is connected with wind speed, sea state and water flow and the helmsman's experience . All the above and others are constantly varying.

Hull design: It is a futile gesture to consider the underwater hull shape of any sailing boat while it is at rest in the harbour or in a museum, the only certainty is that this hull profile will never be achieved when the boat is sailing! Heeling angle and the fore and aft profile will alter dramatically and constantly dependant upon wind strength, sail size and sea state.

While sailing, because each of the proceeding influences are themselves subject to constant modification, the combination of these variables produces a cacophony of influences, independent but mutually modifying.

Boat type: The fundamental `type` is itself a collection of compromises, usually the major influence is anticipated use. Heavier, surface piercing hull designs (Like Traditional Maltese vessels) are in the position of having to `sit there` and take what the sea and weather has to throw at them, this in turn influences scantling sizes, boat weight and displacement . In making the original design decision, the weight carrying capacity is usually the main criteria, here the power to weight ratio is a major factor. Weight in this case represented by cargo, human or otherwise.

Size: The relative size of the boat in relationship to wind and sea conditions is obviously crucial. Again this is primarily a response to anticipated use, cost and the availability of building materials.

Rig design, shape and size: Until very recently, rig design was primarily confined by the availability of suitable building materials. The expected metrological conditions in the operational area was also a major factor. Obviously the ability of the crew to control the individual sails was the controlling factor in the size of each sail.

When sailing traditional Maltese vessels certain factors (common to all sailing vessels) are of primary importance, foremost is an understanding of what we are trying to achieve and how best we are able to achieve it. So I begin with some of the basics of the science of sailing.

There are three directions you can sail:

Down wind (Running .....Wind blowing in the direction of your destination),

Across the wind (Reaching..........Wind blowing across your propose course)

Toward the wind (Tacking.......Wind blowing from the direction of your destination).

Sailing down wind.

The boat is steered in the direction the wind is blowing; all the sails` controlling ropes are loosened until Maximum Projected Area (M.P.A.) is achieved. This means as much sail, at ninety degrees to the wind, as possible. If possible, the mainsail is on one side and the foresails/jibs on the other (goose winged).

N.B. There is always a danger that the mainsail may whip across from one side to the other (jibing) combined with the possibility of a tangled main sheet. Careful observation of the main sail and mainsheet in strong winds is necessary. The sail is quite capable of pushing people overboard. Jibing also has the tendency of rounding the boat into the wind, this is the most common cause of capsize in small boats and the `laying flat` of larger vessels. So it is always necessary to maintain the main sheet and keep it free of tangles and obstructions. A controlled jibe is preferred. When sailing `by the lee` (this is a condition, when sailing down wind, where the wind is not directly astern but slightly from one side, the broadest of broad reaches). It is always preferable to deploy the main on the down wind side.
For reasons, described latter, it is preferable to reach down wind, even if this means that the boat does not travel directly to the destination

This is the easiest and most pleasant way to sail.

For the reasons stated above the helmsman must not be lulled into a false sense of security.

Sailing across the wind.

Steer the boat until the wind is coming from the side, pull the sails in, on the opposite side, until you get an aerodynamically appropriate curve(more of this later). This will depend on whether the wind is directly from the side or more forward or backward.
The sails should be deployed as loosely as possible without shaking.
This is the fastest way to sail. Even when you can sail directly down wind it is better to keep the wind slightly to one side (of the stern) or the other (see above). It will increase the boats` speed and allow much better control than directly down wind and reduce the danger of jibing. Even on this point of sailing it is appropriate to keep in mind the fundamentals of sailing science, in that (with the exception of running) boats equipped with sails are, primarily, sucked along by the wind, rather than blown along as would seem intuitively more sensible. The forward progress is, to a greater or lesser extent, achieved by the lower air pressure between the leeward and windward sides of the sail. This pressure differential is achieved by the aerodynamic curvature of the sail. Air travelling around the outside of the curve has further to travel and therefore get stretched `thinner` than that on the inside. This is the foundation of aerodynamics and flight. The shape of the sail is therefore critical and the less permeable the sail clothe the more efficient the sail.

It is a fact of life that even at the relatively small distances from water level to mast head the wind speed (and direction) varies. This is caused primarily by the drag factor of the interface between wind and water. This is a dual effect, wind affects water (thus creating waves and currents) water effects wind direction and strength. This drag factor removes energy from the wind thus reducing the forces at lower (i.e. deck) level. In addition, wave action produces boat movement which is often instrumental in propelling the upper part of the mast and sail to windward (mast tip speeds can be remarkable high even over the relatively short distance from deck to mast head).

These factors must be taken into account when both making and, more importantly, setting the sail. A competent sail maker will therefore build a flatter curve into the upper part of the sail and a greater curve into the lower part. The tension of the luff and the foot when setting the sail dramatically affects the set and these tensions must be varied to suit the wind strength.

Keeping in mind the previously stated affect on wind speed by boat speed it is appropriate to adjust these tensions while underway, and provision to make these adjustments should be included into the sail setting and reefing apparatus by easily operated down-haul and out-haul (or main sheet) for the mainsail and halyard tension and/or sail size adjustments for the jib.

Sailing up wind.

This is the course which requires most skill.
It is always necessary to add the boat speed to the wind speed..........As the boat speed will change on a moment to moment basis the direction and speed of the wind will appear to change as well, to get the best out of your progress into the wind, this is the activity that requires concentration.

If the helmsman points the boat away from the wind a few more degrees, the boat won't make as much progress in the desired direction, but will be a lot less sensitive to speed changes and the wind will appear to be steadier. As the boat speed increases the wind will appear to increase, enabling the helmsman to point a little higher into the wind, until a balance between speed and comfort is achieved.

It has been established in practise that a Ferilla can sail at approximately forty-five degrees to the wind (dependant on wind strength), when you tack you can sail at about ninety degrees to your previous courser other factors permitting). Staying within the `lay lines` the longer the boat stays on one tack the better. If the wind is not blowing directly from your destination you will find that one tack will take you closer (to your destination) than the other.

First sail:
Location Qbajja Gozo - Wind SE force 1-2 - Sea state Slight - Visibility Good - Crew 2

It must first be stated that, at all times, the safety of the boat was the first priority. It was constantly born in mind that the boat represented an irreplaceable historic artefact, the loss of which was wholly unacceptable. With this in mind no activity or manoeuvre was ever attempted which could compromise the boat.

It had been obvious, since the mast was first erected in the boat, that it was longer than necessary. A decision was reached that this additional length would be retained until such time that an accurate length could be established, on the grounds that although removal of the excess was simple, any later need to lengthen it would require a replacement mast.

As previously stated, the boat had been stored out of the water for six years prior to our purchase. It was anticipated that the wood comprising the hull planking would have shrunk and that for some time after initial launch the hull would leak. This proved to be the case although there was much less ingress of water than had been anticipated.
With the safety of the boat being paramount in our minds it had been decided that the boat would be launched and recovered before and after each sailing trial. In an attempt to restrict the drying out process wet sacking was hung over the topsides and this proved to be very effective.

After the first launch the boat was tied along side the slipway while it was established the degree to which it was leaking. To our surprise, leaking through the underwater parts of the hull was minimal, however when we began initial stability tests we discovered that the topsides leaked dramatically. These initial stability tests also demonstrated that the weight of two men, on one gunwale, was quite sufficient to induce capsize although the boat returned to the vertical as soon as the weight was removed. It further confirmed that heeling angles of 45° -50°, although introducing water onto the side deck did not constitute any danger of capsize because the bulwarks prevented the ingress of water into the hull.

It was a moment of supreme pride, for all members of the project team, when the sails were hoisted on the floating boat for the first time. Previously the sails had been hoisted while the boat was ashore. It was immediately apparent that, although tethered to the shore by the mooring lines, the boat `wanted` to sail.

Fig. 14 Ferilla with faithful escort boat.

Sailing away from the quay, for the first time was an exciting experience. When the moorings where finally let go, the boat immediately moved forward, the wind was very light, force 1-2 there had been some discussion that the wind was too light but to our surprise the boat moved forward and answered her helm remarkable well.
When purchasing the boat we had been supplied with two tillers, one five feet in length and the other two feet. The longer tiller had been selected for the initial trip and this soon proved to be an error. Pressure on the helm was negligible the intrinsic balance of sail and underwater profile produced a docile sailing performance. Although the boat was moving, little on no weather or lee helm was felt through the tiller. Later we learned that the longer tiller had only been introduced with the advent of engines to allow the helmsman to reach the engine controls (throttle and gear change) which in early engines were attached directly to the engine. The long tiller was discarded and all further sailing was with the shorter model.

The boat proved to be extremely sensitive to crew weight distribution, examination of some of the large number of photographs taken by the crew of the support boat and shore support later confirmed this, (see below).

Fig. 15.
As can be seen, the long tiller places the helmsman too far forward burying the bow and lifting the stern. It also interferes with the sheeting of the main-sheet; crew weight forward is also a factor.

Another discovery from the first launch was that the water-line, although parallel with the actual water was six inches to high, it was concluded that this water line corresponded to the displacement when the boat was fitted with engines. It is of interest that the addition of engines and fuel tanks had introduced six inches of additional draft, a 30% increase.

The most important and surprising discovery was however, how well the boat sailed! With little or no wind, sails in the wrong place, crew in the wrong place the boat was able to proceed to the turning point, one kilometre offshore, and return, under its own sails on all points of sailing. After one and a half hours we returned to the quay, sailing along side with no outside assistance.

After taking the boat out of the water the entire crew assembled (in a near-by bar) to analyse the work of the afternoon. Many aspect, not noticed by the on board crew, who had been too busy sailing the boat, were brought forward by the support crew for analysis.
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In addition to all above there were; the measurement of leeway, heeling angles, sea keeping and many others.

Second sail.
Location Qbajja Gozo - Wind S force 3 - Sea state Slight to moderate - Visibility Good - Crew 2

Prior to the second sail the following modifications had been made.

1) Mast shortened
2) Main Sail rigged lower (Sprit higher)

3) Short tiller
4) Water line lowered by six inches.
5) Two wangs (to better control outboard end of sprit)
6) Main sheeting position moved one foot aft.
7) Cleat for main sheet.

Fig. 16. A Bone in her teeth.

The `improvements` had a dramatic effect, true the wind was stronger and the boats forward progress easier. My attitude to helm balance had changed from amazement to reverence; it was truly remarkable that, at speeds of four to five knots, the helm could be released all together and the boat would continue on the prescribed course, only rounding slowly toward the wind after a minuet or two. When the helm was applied the boat responded immediately. Heeling angles had become more acute and crew weight was needed to counter-balance heeling moment from time to time. Although there was a half meter swell coupled with a heeling angle of thirty degrees at no time did any water enter the boat, even the occasional bow spray was thrown clear and the boat appeared to ride the waves as comfortable as a sea bird. Progress was dramatic and we sailed two to three miles off shore in complete comfort.

Third sail.
Location Qbajja Gozo - Wind force 0 - Sea state Slight - Visibility Good - Crew 2


Fig 17 sculling in light airs.

Sail three was windless and we had an opportunity for rowing practise, this was not an unqualified success and eventually the tholepin block on the port gunwale carried away and we had to try sculling which proved to be more successful.

Forth sail.
Location Qbajja Gozo - Wind force 2-3 - Sea state Slight - Visibility Good - Crew 4

There is little doubt, the additional weight, of the extra crew was of beneficial effect on the sailing performance. It even prompted some discussion as to; the advisability of loading addition weight as ballast on a regular basis.

Fifth sail.
Location Qbajja Gozo to Mgarr Gozo – Wind NW force 4 - Sea state moderate to rough - Visibility Good - Crew 2

The final sail of the year was by far the most adventurous, we had for some time been receiving requests to take the boat to Mgarr. Due to the prevailing weather conditions it was thought likely that this would be the last chance to do so. The storage location ashore at Qbajja was also becoming untenable and we had already had to move the boat off the beach on one occasion due to a Gregale. Having arranged for an escort boat we set off from Qbajja on a broad reach with a quartering sea with swells of over a meter. Once again the boat demonstrated its sea keeping qualities, even in these difficult conditions no water entered the boat. Hugging the coast, 50 meters or so off shore the boat sped along at, or very close to, it's maximum hull speed. Even experiencing two accidental jibes caused by being back winded from the cliffs proved not to be a problem. The quartering sea made steering difficult, as each swell overtook the boat it was necessary to reverse the helm as the rudder reacted as though the boat were travelling backwards. Holding the main sheet became increasingly difficult as the wind increased but it was deemed too dangerous to secure it due to the constant need to spill wind from the sail. There is no doubt that these were the most difficult conditions we had ever sailed the boat in, this was mitigated by the fact that this was, to all intense and purposes, a one way trip and our intended destination was in the lee and sheltered. Rounding the corner at Ras il Qala we entered the sheltered waters of the North Comino Channel to be met by our escort boat, a large RIB, the skipper had decided that the weather was too rough to proceed beyond this point. Sailing on towards Mgarr we finally accepted a tow into port because of the restricted manoeuvrability and ferry traffic.

*1 Geographical and Metrological conditions at sailing locations.

*2 Design evolvement from an historical and construction material perspective.

*3 Balance as a design parameter.