

Experimental archaeology and boats

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Experimental archaeology has now a definite place in research and the late Paul Johnstone was a pioneer in organizing such experiments especially with boats. In our February issue we published a reconsideration of his experiment, in collaboration with Professor Marstrander, on building a hide boat. We now welcome a discussion by Mr Christensen and Dr Morrison on the recent publication The building and trials of the replica of an ancient boat: the Gokstad faering Part 1. Building the replica by Sean McGrail. 59 pp. 50 figs. Part 2. The sea trials by Eric McKee. 38 pp. 25 figs. National Maritime Museum. Maritime monographs and reports no. 11, 1974. London. Ed.

Part 1. The Gokstad *faering* replica

Arne Emil Christensen, Jr.

Danish sea-scouts have been sailing Viking ships for several years now, ships they have built themselves in as traditional a way as possible. The work began by selecting the trees in the forest; only hand tools were permitted and Viking Age methods were used where they were known or could be deduced. A square-sail rig has been reconstructed and the vessels, four or five all told, are handled under sail or oars by their young crew. The Viking Ship Hall at Roskilde has advised on various problems. The ships are not built for experimental purposes, but Ole Crumlin-Pedersen has reported briefly on experiments conducted, and it is to be hoped that more will be forthcoming (Crumlin-Pedersen, 1965, 1966). The Viking Ship Hall sails its Norwegian Nordlandsbåt with a square sail, and plans a series of experiments. Volume 5, Number 1 (March 1976) of this Journal contained the report by Prof. Sverre Marstrander on an experimental vessel built with a definite purpose. The skin boat made by boat-builder, Odd Johnsen was based on Prof. Marstrander's interpretation of the Bronze Age rock carvings as skin boats. The experiment proved the vessel to be seaworthy and capable

of carrying quite heavy weights. Due to fair weather, it was difficult to obtain realistic tests of seaworthiness. Even if the vessel as such was successful, it is, in my opinion, still not proved that this is the kind of boat depicted on the rock-carvings.

The National Maritime Museum of Greenwich has built a replica of the smallest of the Gokstad boats, the *faering* and tested her. So far this is the best well-documented piece of experimental boat archaeology carried out.

The aim of this project in experimental archaeology is stated in the preface by the director of the NMM to be twofold:

1. To gain experience in this kind of work before the much larger project of a replica of the Graveney boat is undertaken.

2. To devise methods for boat replica building that may develop into accepted standards for such work.

As regards Part 1 of the book, the reviewer is in a rather special position, as the replica was built to my drawings, and I have discussed the project with Sean McGrail during the planning stage. However, I feel free to offer some comment.

McGrail starts his paper with a short section on experimental boat archaeology, stressing that previous replicas have not been built with experiments in mind, and that the reports are

seldom sufficiently detailed. He then goes on to describe the original boat and some of her Scottish and Norwegian descendants. This is followed by a brief, but well-illustrated description of the building. The rest of the paper is devoted to two important chapters on 'the theory and practice of experiments' and 'aspects of Viking age boatbuilding'. The plans for building a replica of the Graveney boat are briefly mentioned, and there is an appendix on the properties of shipbuilding timber, a glossary and a select bibliography.

As she stands, the replica is a lovely vessel. The man chosen to do the job, Harold Kimber, master boat-builder from Somerset, has indeed done a fine job. However, there are differences between original and replica. Some of these are due to problems in getting the right materials, some seem to be the result of Harold Kimber being trained in another variation of clinker practice than the one in use in western Norway today. The latter seems to be closer to Viking age methods.

The use of laminated jelutong instead of oak for the stem, and Oregon pine instead of Scots pine for the sheerstrake are rather serious departures from the original, but were probably unavoidable. Like many other replicas, the boat has strakes made from boards sawn 'through and through' where 'quarter-sawn' or split boards would be right. The pictures indicate that all wood is slightly larger in dimensions than the original, giving a somewhat heavier hull and accordingly less freeboard. This will in all probability influence the test results.

The original garboard has small cleats where the treenails for the midship rib pass through, presumably to give more secure fastening for the countersunk head of the treenail. The rib rests on the keel and the cleats only, while in the replica the rib rests snugly on the whole garboard. (McGrail: fig. 34). The scantlings of all ribs seem too sturdy. These details, and the use of glue in some of the scarves, would probably make the replica less elastic than the original. In his section on the theory and practice of replica building, McGrail stresses the importance of choice of replica builder. I have the feeling that Harold Kimber was in a way too good a boat-builder for the job, his deviations from the original seem to be subconscious 'improvements'.

The 'aspects of Viking age boatbuilding' sums up knowledge and theories nicely, but it is evident that the author does not know all the relevant Scandinavian literature on the subject, especially as modern comparative material goes. When discussing what tools the Viking age builder used, and accordingly, what a modern replica builder may use, McGrail includes the plane on the evidence of a few Iron Age planes, and possible plane marks on some parts of the Skuldelev ships. The small planes referred to are special-purpose tools, one of the Vimose planes has a hollow sole and was in all probability used in arrow-making. The plane was known to some craftsmen before the Reformation, but it was not commonly adopted by woodworkers until the 16th century, and should be very sparingly used by the replica builder. Wood was smoothed by a tool known in Norwegian as 'skavl' or 'skjøve', a forerunner of the spokeshave. This should be included in the replica-makers tool chest rather than the draw-knife and plane.

It is also rather improbable that the boat-builder would use metal shears and draw-plate. The shears are for cutting thin sheet metal, and draw-plates from Viking age finds come from tool groups indicating that they were used for drawing silver wire.

Eric McKee's description of the sea trials start with a short summary of the work carried out. The trials were run under various conditions of wind and tide during one week in August 1973. Then the data of the boat are given in a number of tables, including figures for displacement and stability.

Rowing, steering and towing trials are described, and in seven appendices, themes as different as comparative rowing geometry, a list of instruments and equipment and predicting the boat's movements by computer, are treated. The text is illustrated by a number of photos taken during the trials, and by the author's sketches.

As this is the first experiment of its kind, there are no comparative figures for other boats to refer to. Some of the results are noteworthy. The maximum sprint speed obtained under oars, 7.4 knots is impressive, and above the theoretical, maximum efficient speed of 5.66 knots.

Both the *faering* and most of her descendants in western and northern Norway are very

light craft; so light, in fact, that they cannot be described as true displacement hulls. Of course, they do not plane like a modern speed-boat, but under some conditions they seem to have a certain 'planing tendency'. The accompanying photograph (Fig. 1) shows one of two *fembøring* replicas of Åfjord (Trøndelag) type sailed to Iceland in the summer of 1974. Speeds of above 15 knots were reached, and in favourable conditions, the boat would ride a wave as in Fig. 1 for a considerable amount of time (pers. comm. from the expedition leader, Jon Godal). Somewhat further south on the coast, at Nordmøre, old fishermen state that a good *faering* should 'lift one strake out of the sea' when under sail, and half a strake when rowed by two men. This tendency to plane somewhat would explain some of the behaviour reported both on Viking age replicas and later craft, and it should be investigated further.



Figure 1

The oar given in the drawing, reconstructed from the existing fragments, proved to be uncomfortably long, and oars were made to the traditional rule of length = twice the width of the boat at the rowlock.

The main results, that the boat is fast, skittish but seaworthy, can be deduced by just looking at the hull, so it will be hoped that further trials will give figures for other boats, enabling us to compare the various constructions properly. Sailing experiments were not carried

out during the trials in 1973, but they would surely give interesting results. As Dr Morrison points out in his section, it is of more interest to test the possible operational aims of the original users than optimum performance of the object. In a square-rigged boat, this means that tacking ability, or the lack of such, should not be seen as an isolated characteristic of a boat. It is clear beforehand that the *faering* will not tack as well as a fore-and-aft rigged boat, nor will her descendants. Adding to Dr Morrison: at the regatta held at Stavanger during the Fisheries Fair in 1868, the square-rigged boats, like the Åfjord *fembøring*, were far inferior to the sprit- and gaff-rigged boats of southern Norway. On the other hand, they proved superior in all rowing trials.

Comparing the ship pictures on the Gotland stones with medieval ship representations seems to indicate that sometime in the 11th or early 12th century, the square sail as we know it, with two sheets, two braces and rows of reef-points, developed from something much more complicated. The rigging shown on the Gotland ships is still not fully understood or convincingly reconstructed, in spite of several attempts Åkerlund (1956); Christensen (1966). Before we can come closer to the solution of this problem by experiment or otherwise, we need to re-establish the skills needed to sail small open boats with a square sail. I fully agree with Dr Morrison in his idea of trying the Gokstad *faering* replica in Shetland waters, but I hope that Scandinavians also with square sailing experience will be permitted to take part.

When visiting the Viking Ship Museum one gets the impression of a near-perfect form in shipbuilding. Visual perfection is not always structural or practical perfection, but as one works with the originals or with replicas, the respect for the old shipwrights keeps on increasing, and I feel tempted to end this review by quoting the two authors: 'In March 1972 Harold Kimber visited the *faering* in the Viking Ship Museum, Oslo, and returned with "a profound respect, almost reverence" for the boat-builder who had produced such a beautiful craft 1000 years ago' (McGrail: 10).

'This boat is a classic. This might be proved by the time the design has lasted or by the number of other designs that have followed. However, after these trials, one feels one has

had an experience, which has given men the same pleasure over the centuries. Not only does she look, row and ride better than she should, but there was the added pleasure of finding a boat that would pass the ultimate test. This

was the feeling that the boat could look after herself, when the weather had so tired and perhaps frightened her crew that they were no longer able to do their best for her' (McKee: 26).

Part 2. The trials of the Gokstad *faering* replica. An assessment in terms of traditional Shetland practice in boat building and seamanship

Ian Morrison

The National Maritime Museum monograph on the Gokstad *faering* replica draws attention to the close links between the Viking tradition of boat building and that represented in present and recent craft of Shetland, as well as of Norway. This would seem worth pursuing further, since boat building and handling techniques in Shetland cast interesting light on some of the experimental findings of the Greenwich team.

The background to the strong Norse element in the regional culture of the Shetlands and its expression in the various boat types of the islands has been discussed elsewhere by the present writer (Morrison, 1973a) and by others including Goodlad (1971), Halcrow (1950), March (1970), Sandison (1954) and Thowsen (1969).

Shetland clinker building practice, like that of western Norway cited by Arne Emil Christensen, would appear to support his view that the *faering* replica is not only heavier but also less elastic in structure than the original. The premium traditionally placed by Shetland boat handlers on elasticity and lightness is illustrated by local stories quoted by Charles Sandison (1954: 14 & 21). Securing this, ribs crossing the keel arch right over it without touching (Fig. 2), and bear only on the outboard portion of the garboard strakes instead of being seated firmly on their whole width as in the replica. The sailman would keep the sole of his foot on the garboard to feel from the extent it was quivering whether the boat was being over-driven.

This emphasis on strength through resilience, rather than through weight of structural members is demonstrated further by the way that the resistance of the bows to pounding in a head sea was enhanced in some of the lighter yoles, close in size and form to the *faering*, not by reinforcing them but by increasing their elasticity. In these, the wales strengthening

them longitudinally were tapered away finely (so as not to localize stresses) and ended completely around half a metre from the stem. Consistent with this, the internal structure of these Ness and Fair Isle yoles is minimal. There are only two major ribs in the two-man version, three in the three-man, each surmounted by the *tafts* or rowing thwarts. As in the *faering*, these are grouped tightly together amidships, only circa 0.9 m apart.

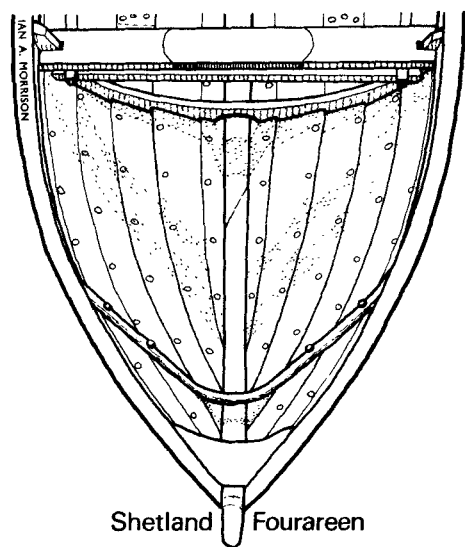
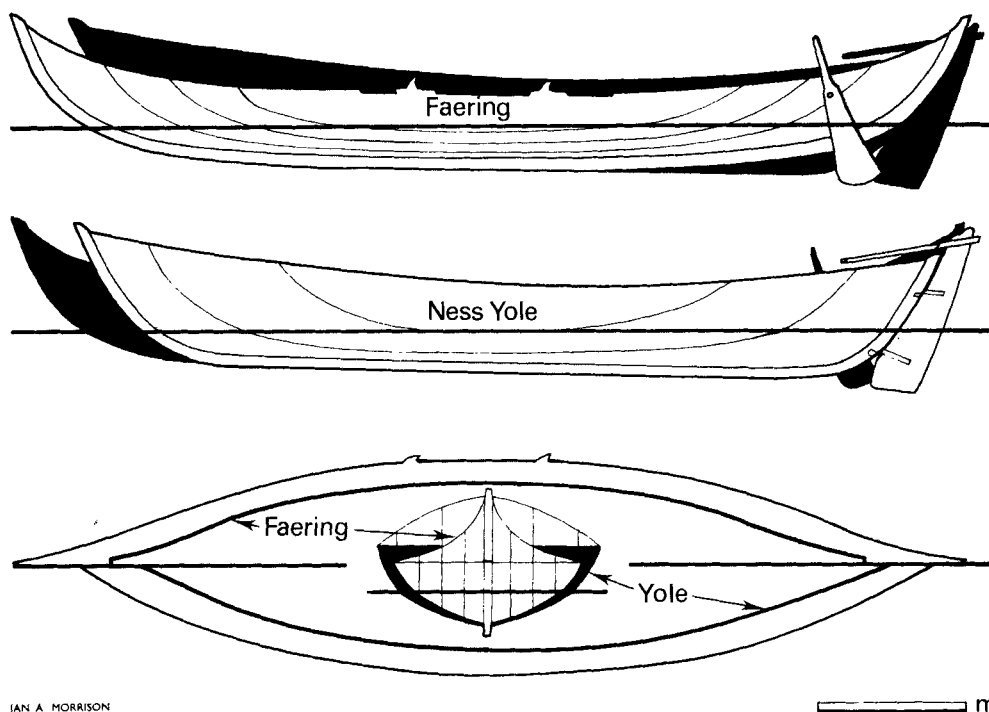


Figure 2

This close spacing gave rise to some dissatisfaction in the trials of the *faering* replica. However in Shetland terms it may be considered a key element in the yole's design philosophy for coping with the exposed coastal waters. There, as along much of the Norwegian coast, short lumpy seas are common. In rough weather, reflections of waves from the coast and skerries



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Figure 3

can set up an inshore zone of confused seas several kilometres wide, often exacerbated by tide rips. To live in such waters, a small open craft must be a lively seaboat, responding fast to the steep irregular waves if it is to avoid being swamped.

To secure this response in roll, the yoles have the same slack bilge profile as the *faering* (Fig. 3). They also share her strong sheer, with the high flared ends to throw water clear but minimal freeboard elsewhere to reduce wind resistance. For good rowing qualities, and for the directional stability vital to prevent broaching to in such seas, the boats are long and slim built (Fig. 4). The ends are however kept light and empty to minimize inertia. This, combined with the close concentration of the main structural weight and the crew's weight amidships, enhances the boat's lively response in pitch (Fig. 5).

Desirable though this tight midships grouping may be in Shetland or Norwegian eyes, the replica trials team felt that 'none liked the close proximity of the two rowers, as collisions occurred when they got out of time when the stroke was long' (NMM, 1974, 11 pt. 2: 18).

They note that their various rowers characteristically used a medium to long stroke, and indicate that in their terms 'a total sweep of 54° is not extreme. A racing shell with a sliding seat will have a sweep of 70° ' (p. 34). This, and the graph of stroke rate (22; fig. 20) suggests that while the replica was certainly being rowed effectively (the $7\frac{1}{2}$ knot sprint speaks for itself), the trials oarsmen, some regatta trained, were using a very different style from that characteristic of the yole men of Shetland and Fair Isle.

These islanders use a markedly short but powerful stroke that Edgar March (1970, 1: 49) describes not unfairly as a 'chopping' one, with rates of striking that sometimes reach as high as 45 strokes per minute, when they have to cut a tide string. It is a safe and effective style, well suited to the boisterous conditions where the balance of both man and boat can be vulnerable with a longer stroke. This, taken together with its full compatibility with closely spaced thwarts suggests that this traditional northern style would be well worth investigating quantitatively in future trials with the *faering* replica.

The speeds attained in the Plymouth trials of the replica, together with Norwegian experience,

led Christensen to suggest that the tendency of the Viking vessels and their descendents to plane should be further investigated. Shetland evidence certainly bears this out. Some of the calculations and measurements by Sandison (1954) suggest planing, and the old description that he quotes to explain the traditional term 'sea-loose' is persuasive: a sixareen became sea-loose when 'she was travelling so fast that the "fluid" under her became a mixture of air and water, and the noise it made was said to be as if "she were being drawn through a beach of pebbles"'. When sail was reduced she would become normal again' (Sandison, 1954: 19). Equally graphic is the description quoted by Captain Halcrow of how a veteran halyard man, blinded temporarily by an accident while fishing well off shore, yet managed his vital task of controlling the sail-area from moment to moment as they ran before a storm in heavy seas. Asked how he managed without eyes, he replied 'My lugs did instead. Whin I heard da wend snoring under da third baand, I kent she

wis gettin eneugh' (Halcrow, 1950: 73) i.e. 'My ears served instead. When I heard the wind snoring under the third timber, I knew she was getting enough': so at that stage he would reduce sail ... (compare Christensen on modern Norwegian *faerings* lifting a strake out of the sea when sailing).

During the trials, the side rudder of the replica did not prove effective except for small angles of helm (NMM, pt. 2: 14, 15, 26) and Eric McKee expressed considerable reservations about its usefulness. These experiments were under oars and not sail, however, and one may wonder whether the *faering's* rudder was originally intended for this. In the similarly shaped Shetland craft, despite their well-developed stern rudders the oars themselves are the most effective means of close-quarter manoeuvring. Equally, on the long pulls out to *da far haaf* offshore grounds, though careful courses were steered to the fishing *meads*, the deadweight of a helmsman was not a welcome notion. Charles Johnston, for instance,

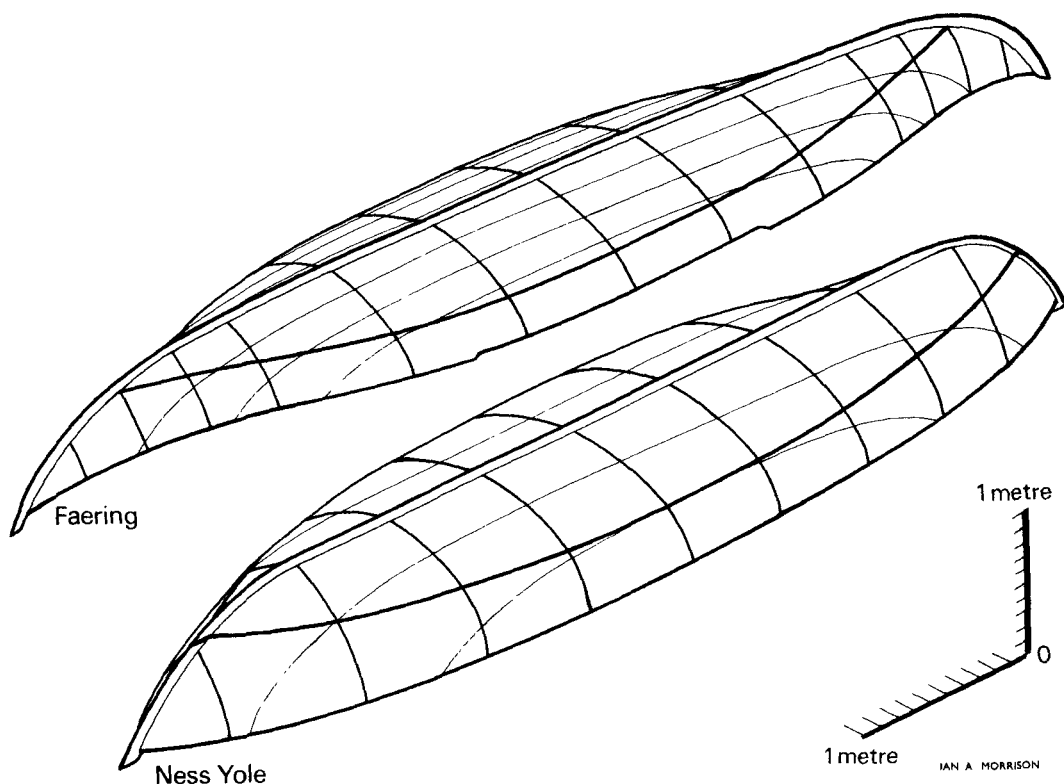
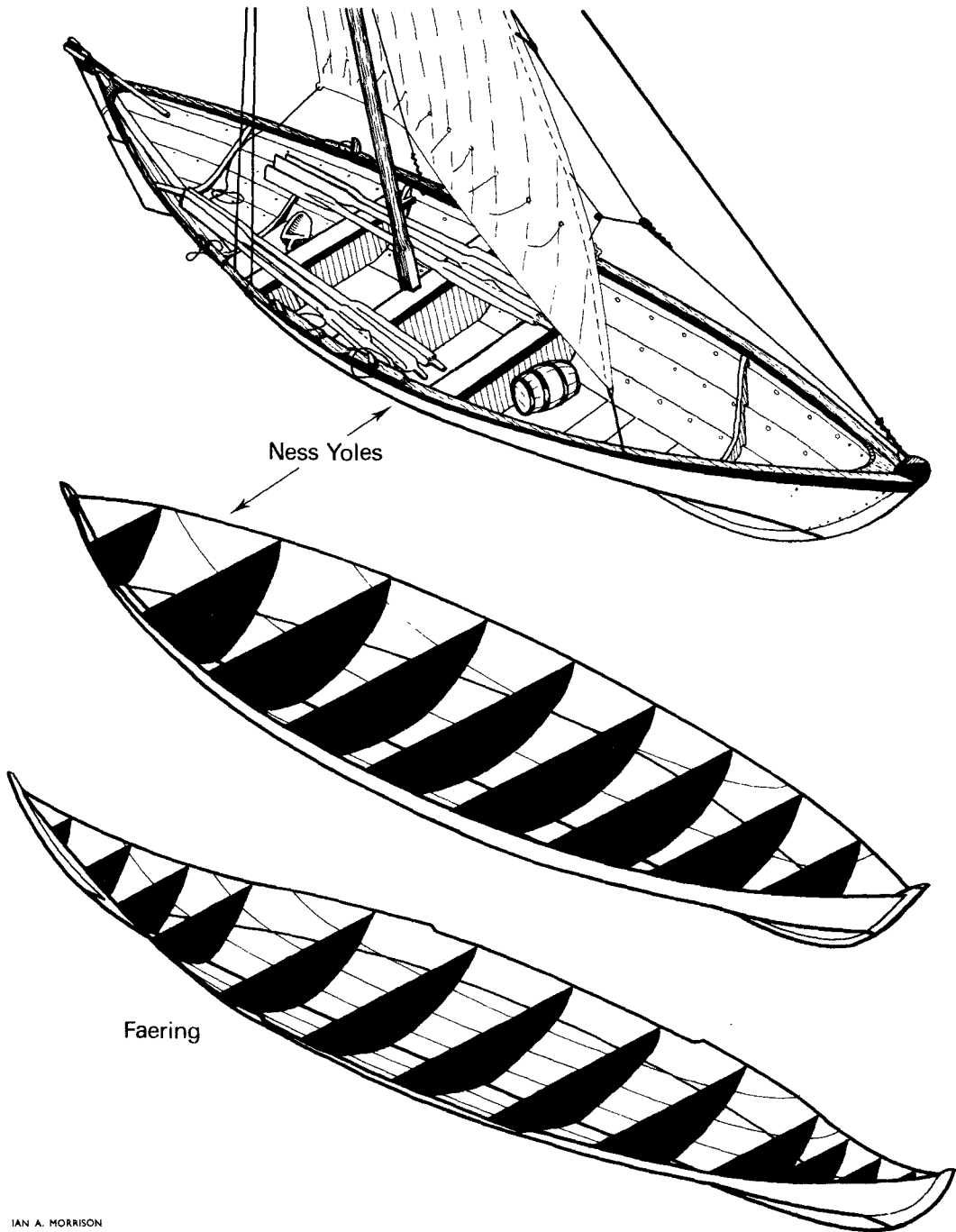


Figure 4

gives a clear picture of a routine nine hour row out to grounds thirty miles offshore in a sixern. The crew of four men and three boys pulled eight oars, stroke having the pair (Johnston,

1932). As Halcrow (1950: 75) comments, a helmsman 'would have meant a hand less at the oars'.

Whether the Gokstad *faering* was a sail boat



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Figure 5

or not has always been somewhat controversial, because of the imperfect state of the original remains. There are however what appear to be holes for shrouds. In Shetland traditional practice (Fig. 5), the mast step is on a removable *tilfer* (floor board), rather than being integral to the keel. The mast also locates in a notch in the sail *taft* (thwart), but this too is removable. Thus even in an undamaged boat, laid up or merely stripped out for beaching or portage (as was routine), there would be little to identify her as a sailing craft.

Except in going about, in sailing one generally tries to avoid coarse angles of helm because of their braking effect, and the practical results of the trials would seem to strengthen the case for believing that the *faering* was intended to sail, by emphasizing the concentration on fine angles of trim in the mechanical and hydrodynamic characteristics of the side rudder.

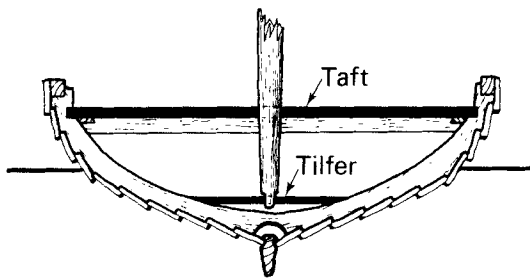


Figure 6

Eric McKee opens up an intriguing line of thought by suggesting that if trials of other boats with side rudders confirm this limitation to small angles of helm, 'then this limitation must have been a significant obstacle to the development of a sailing boat that could change tacks' (NMM, pt. 2: 26). He notes that the *faering* with her marked directional properties would have been hard to put about and comments 'A rudder right aft and astern of a skeg would have helped, as would a rounder hull. Indeed history has shown this to have happened when the fuller southern ship replaced the long narrow row-boats of the north. Even with the more efficient central rudder, it required the turning power of two or more masts to be added before sailing ships' hulls could be made fine again' (p. 26).

It could however be misleading to see the differences in either the potential power or the actual application of side and stern rudders in too black and white terms. Here the experiments carried out with the replica of the Vorsa side rudder on the Danish reconstruction of the Ladby ship seem very relevant. Although her length : beam ratio is as high as 7.2 : 1, with steady rowing and helm at 45° she changed course 180° within a turning diameter of 4 to 6 lengths. Furthermore, when a competition was tried between rowers and helmsman, the crew rowing one side only while opposite helm was applied, the 20.6 m ship answered the side rudder and turned against the oars '... and it was possible to hold the helm in position with a single finger in spite of energetic efforts on the part of the rowers to turn the ship the other way' (Crumlin-Pedersen, 1966: 257).

It would thus seem that neither the potential power of side rudders nor the ability of Viking boat-builders to develop versions that reflected their intentions should be underrated. This emphasizes the general point that emerges in a wide range of case studies collated in John Coles' book *Archaeology by experiment* (1973). This is, that in interpreting observations, the range of possible operational aims of the original users often merits just as close consideration as the absolute potential of the hardware itself. In this case it therefore seems reasonable to assume not only that the trials observation regarding the suitability of the *faering's* rudder only for small angles is correct, but also that (like the close spacing of the thwarts) this should be explicable in terms of an operationally effective way of handling the boat. Here again the combination of ethnographic parallel with direct experiment seems useful.

There is a considerable amount of evidence that emphasis on beating to windward under sail, and the high peaked lugsails that go with it, were distinctly late developments in Shetland, probably brought on by the shift to *far haaf* offshore fishing. Indeed the Ness and in particular the Fair Isle yoles retained lugs cut so flat in the head as to be essentially square sails right into the 20th century (Fig. 7). The square sail was a better sail for running, but not so weatherly as lugsails with taller tighter luffs. This was one disincentive for using the square

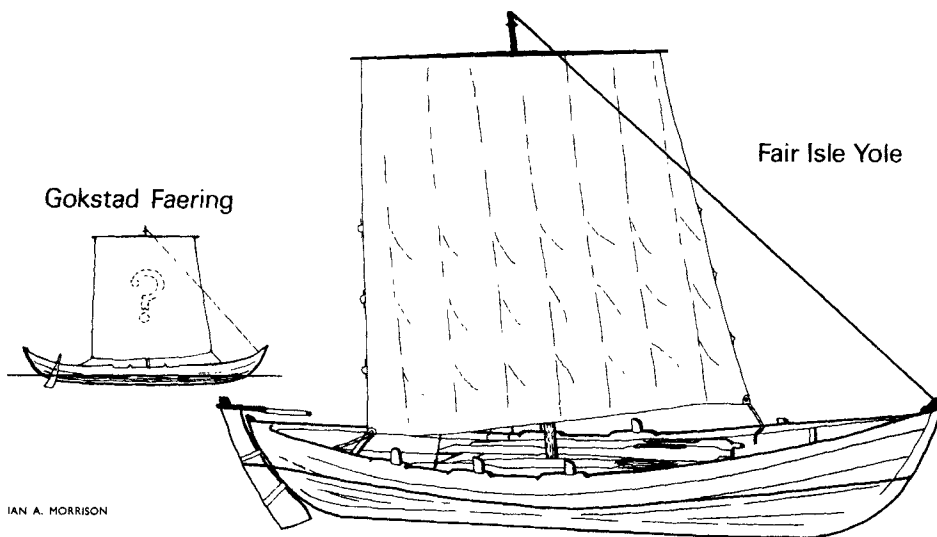


Figure 7

sail for working to windward; another was the laboriousness of handling the rig when going about. Edgar March (1970, 1) quotes oral evidence from Shetland that nicely illustrates the attitude to tacking that these factors traditionally engendered:

'The idea of the old-time fishermen was that they reached the fishing ground quicker by rowing than tacking' (p. 55)

'... a great deal of work had to be done when the boat was put about, so it was little wonder that the men preferred rowing when they had a head wind ...' (p. 55)

'... the son expressed the wish to put the sail up and tack to windward. The father replied that if there was any tacking he would refuse to steer ...' (57).

The practice was thus to avoid tacking as far as possible, by rowing to windward on a course chosen to place the boat strategically for making a long reach or run with the wind free: a stratagem also employed by Norwegian sail fishermen.

The 'great deal of work' involved first lowering the sail and undoing the *rakki* (parral). The yard was then drawn forward of the mast and turned, and the clew passed round to the other side. The tack was shifted across, the *rakki* refastened and the sail hoisted again. This all took time, and working in a seaway in boats with such low freeboard amidships (the Fair Isle yoles were sometimes barely 0.45 m deep

inside at the mast thwart), to avoid swamping if the seas threw the head off it was vital to have oars ready for immediate intervention. The system of *kaeb* and *humlabund* (thole pin and grommet) common to the *faering* and the Shetland boats is particularly well adapted for this. The flexible grommet allows the oar to be swung instantly inboard or outboard, yet restrains it safely in either position in the most lively seas.

Viewed in terms of an operational context of this kind, where i, ability in tacking is given relatively low priority; ii, the boat's momentum is lost in the time taken to re-set the sail and iii, the oars are of necessity kept readily available, there would seem little inconvenience in Eric McKee's conclusion from the *faering's* trials that she would 'almost certainly have needed the assistance of an oar to put her about' (NMM, pt. 2: 26). The possibility that this was an accepted part of the philosophy under which she was originally developed, and that her particular type of side rudder was thus perhaps conceived almost exclusively for fine trim under sail, and not at all for effectiveness in coarse-angle work while rowing or in going about, emphasizes the difficulties in extrapolating from specific experiments with particular craft to general conclusions about the development of the sailing ship.

Such difficulties however underline the desirability of undertaking more, rather than

less, experimental work in nautical archaeology. Thanks to the initiative of the National Maritime Museum staff, the replica is now in existence and has already taught much about the techniques of recording and instrumentation required. It would be a most intriguing and indeed exciting extension of the trials already carried out to combine the experimental and ethnographic approaches directly by taking her

to Shetland. She could be tested under square sail and oars in the exacting seas off the Viking settlement of Jarlshof (Morrison, 1973b), in the hands of the fast-striking Dunrossness men who still fish the edge of the Sumburgh Roost tide race in their yoles, in the very way Orkneyinga Saga tells us the *faerings* fished there when the boundary between Scandinavia and Scotland still lay far to the south.

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A note on the illustrations

The parallel perspective projections of the boats were constructed from the lines draughts of Charles Sandison of Unst (Ness Yole, Sandison, 1954: 13) and Arne Emil Christensen of Oslo (*Faering*, as published in NMM, pt. 2: 3). They were plotted using a Rost Variograph and a Forster-Schaffhausen Perspectomat P-40 at Edinburgh University. The remaining sketches were made on beaches in Shetland, and, by courtesy of Mr Tom Henderson, from models in the Lerwick museum. For convenience of comparison in Fig. 3, the side rudder has been drawn on the port side instead of the correct position to starboard.