FIFTY YEARS OF YACHT BUILDING.

By Dixon Kemp, Esq., Associate Member of Council.

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It can fairly be said that yachts, such as we are now accustomed to, have been entirely developed during Queen Victoria's reign. Fifty years ago there were probably not one hundred yachts in existence above 20 tons, and these were modelled after the brigs, schooners, or cutters of the Royal Navy. Their scantlings were somewhat lighter, and their ballasting perhaps not quite so good, as in some cases weight was made up with stone. The brigs were about the size of those of the Royal Navy, and were considered superior to them in sailing qualities. One of the best known of these brigs was the *Waterwitch*, built by Mr. Joseph White, of Cowes, in 1832, for the Earl of Belfast (afterwards Marquis of Donegal). This brig had a great reputation for speed and weatherliness, and beat H.M.S. brig *Pantaloon* about four miles in a six hours' sail to windward. This achievement led to the *Waterwitch* being purchased by the Admiralty, and subsequently to the employment of Mr. White to build other brigs for the Royal Navy, notably the *Daring*. This vessel and the *Waterwitch* performed the best to windward in a strong wind and head sea in the experimental sailing of 1844.*

Although brigs and schooners were occasionally sailed in competition, it was found that the cutter rig was so vastly superior in point of weatherliness, that its adoption for almost all yachts intended for racing was a matter of natural selection. At first—that is, between the years 1815 and 1837—there was seldom any time allowed for difference of size, and the result was that with anything like a breeze the largest vessel came in first and won. As there was no tax of any kind on any of the dimensions there was no inducement on that score to alter the proportions of length, breadth, and depth from the prevailing Admiralty type. These proportions were from 3 to 3½ beams to length of water-line, and the greatest transverse section was placed ahead of the middle of length, varying in distance from one-tenth to one-fiftieth of the length. The centre of buoyancy was generally situated at about the centre of length, and it appears to have been an aim of the designers to keep the displacement of the fore-body and after-body

* *Vide* Parliamentary Paper, No. 394 (B), 1845.

equal. The upper horizontal water-lines of the bow were short and full, making an angle of about 30° with the centre fore and aft line; and the load water-line aft was generally a trifle fuller, but the buttock or vertical lines were long and flat. This kind of yacht is familiar to us as the cod's head and mackerel's tail type, and was firmly believed in even by men who took some trouble to investigate the qualities of hull which led to success in sailing. Such was the late Mr. Fincham, master shipwright of H.M. Dockyard, Portsmouth, who designed several yachts for members of the Royal Yacht Squadron, Cowes. One of these was the *Fair Rosamond* schooner, built in 1846 by Mr. Camper, of Gosport, for the late Duke of Marlborough. Mr. Fincham, in his papers on Naval Architecture and Yachts, states that the centre of buoyancy of the *Fair Rosamond* was ·004 in terms of the length abaft the middle of length; she won some prizes at Cowes, but Mr. Fincham concluded that she would have performed better in a head sea had her centre of buoyancy been farther forward. Accordingly in the following year—1847—he designed the *Novice* schooner for the Earl of Desart, and placed her centre of buoyancy ·01 ahead of the middle of length, or, in other words, nine inches farther forward than the other's was. Mr. Fincham declared this to have had a great effect on the performance of the vessel, but, judged by the light of subsequent events, there is no doubt that Mr. Fincham was much mistaken in attributing so much subtle influence to slight variations in the fore and aft positions of the centre of buoyancy.

About this time the theory of the late Mr. John Scott Russell (that the bow should be longer than the stern) began to be accepted as nearer the truth than the old theory of the cod's head; and in the year 1847, whilst Mr. Fincham was designing the *Novice*, a very remarkable vessel was built on the Thames as an exponent of Mr. Scott Russell's theory. This was the *Mosquito* cutter (Plate xx.), of 59 ft. water-line and 15 ft. 4 in. beam, built by Mr. Mare,* of Blackwall, and launched in 1848. The *Mosquito* was like one of the cutters of the period turned end for end; her bow was long, and made an angle of only 17° with the centre fore and aft line, and had besides 2½ in. hollow. Her after-body was short, showing great fulness both in the horizontal and buttock lines. Her midship section was placed 4 ft. 6 in. abaft the middle of length of water-line, and her centre of buoyancy was 2 ft. abaft it.

According to the old practice, the *Mosquito* should have had no good qualities at all, especially in strong winds; but the fact is, she excelled in all the good qualities claimed for the bluff-bowed craft; she was faster than any other yacht of her length, on any point of sailing, and in a strong wind to windward was a marvel compared with other yachts. However, so strong was the prejudice against the "long, lean bow," and

* There is some doubt as to whether Mr. Ditchburn or Mr. Waterman or Mr. Mare designed the *Mosquito*, but Lord Brassey, in an article in *The Fortnightly Review*, 1883, says: "Mr. Mare was the author of her existence both in idea and in fact." It should be said that Lord Brassey at the time she was building had special means of knowing.

so alarming the predictions—that some day the *Mosquito* would take a dive and never come up again—that no one could be found to try the experiment on a more extensive scale. It thus seemed likely that the old type would be continued in spite of the *Mosquito* having, in a superior degree, all the good qualities it was contended a yacht should have.

It will be here convenient to take a glance at what was being done on the other side of the Atlantic at this time. It should be said that the Americans had not as yet settled down to any kind of sport so as to give it a nationality, and had consequently evolved no special type of yacht. So far as can be learned, the first American yacht race took place just fifty years ago, and it does not appear that any yachts existed in the States before 1835, and those built subsequently, up to the year 1844, were small schooners. In the year named, however, a remarkable vessel was built at Hoboken named *Maria*, on the lines of the flat-bottomed coasters. She was 100 ft. on the water-line, with an extreme beam of 26 ft. 8 in., and draught aft of 5 ft. 3 in. She was fitted with a centre-board which dropped 16 ft. below the keel, and also had a small one aft to prevent her griping. She had a long hollow bow, and was sloop rigged, with jib and mainsail only. The foot of her mainsail was 92 ft. long and the foot of her foresail or jib 70 ft. This vessel may be said to have been the original of the American centre-board yacht; but although she showed extraordinary speed and weatherliness there appears to have been a conviction that more depth of body and less beam would be better for good sea-going qualities. At any rate George Steers (the son of a Devonshire shipwright who had settled in New York) produced the keel yacht *America*, which was destined to have such an important influence on British yacht building and sail-making. In the *America* (Plate xx.) the principles so successfully carried out in the *Mosquito* were embodied with equal success; her bow was long, making an angle of 16° 30′ with the centre fore and aft line, and showed besides 7 in. hollow. She had a short run, and the centre of buoyancy was considerably aft of the middle of length, as will be gathered from the accompanying table:—

	Mosquito.	America.
	Feet.	Feet.
Length on water-line	59·2	87·8
Breadth, extreme	15·8	23·8
Draught of water, extreme	11	11·5
Proportion of beam to length	0·257	0·272
Midship section aft centre of length in terms of length of L.W.L.	0·076	0·071
Centre of buoyancy ditto	0·032	0·041

The *America* visited us in 1851, and achieved a remarkable success at Cowes over our schooners. This success was no doubt mainly due to the qualities of her hull, but the unusual flatness of her sails contributed greatly to her fine weatherly qualities. The immediate effect of the *America's* success was rather startling; almost every yacht in existence at that time, including the *Fair Rosamond*, was lengthened by the bow, her masts raked, and sails laced to the booms; and the principles which had been so strikingly exemplified in the *Mosquito* three years before, were now adopted as a new discovery of infallible merit. This marked the commencement of a new era in yacht designing, and the subsequent development of yachts into the now fashionable narrow type, has shown no considerable departure from the principles observed in the design of the *Mosquito*, so far as relative length of bow and stern goes.

There have, however, been causes at work which have largely influenced the proportions of yachts. Allusion has already been made to the fact that fifty years ago there was no such compensating reckoning to deal with as time allowances for differences of size. As soon, however, as yacht racing became a general summer pastime, a rating for size became a necessity, and the size test adopted was simply the registered tonnage of the day, or what we now know as builders' measurement.* This measurement took no account of depth, but assumed that it always equalled half the breadth. Frequent competition, and the teachings of investigators of naval science, impressed yacht builders very forcibly with the fact that the element of size which gives speed is length; and that if two yachts were of equal tons, but one should happen to be longer than the other, then the longer boat would be certain to prove the faster, all other things being equal, such as sail spread, stiffness, fairness of lines, &c. Or if two vessels were of equal length and one measured fewer tons than the other, then her rating would be smaller, and she would receive a compensating time allowance.

For a great many years the obvious tendency of the tonnage rule to produce relatively long and narrow boats had little effect, because breadth was so essential to enable a vessel to carry a large sail spread. Naval architects were, it is true, alive to the fact that stiffness could be gained by depth of hull, suitably ballasted, and Mr. T. Wanhill, of Poole, was the first to recognise this and make use of depth; but this untaxed quantity could not be made use of to any great extent, on account of the heavy displacement it involved; consequently, down to the year 1870, the racing yacht developed very slowly, and at that time a length of $4\frac{3}{4}$ beams for cutters and 5 beams for schooners was considered sufficiently extreme. From the date named, however, length for any given tonnage showed a very rapid increase, whilst breadth necessarily decreased. Lead keels, it should be said, had some years previously—about the year 1846—been introduced as a means of increasing stiffness after shifting ballast to windward during

* This measurement is $\frac{(L - \frac{3}{4} B) \times B \times \frac{1}{2} B}{94}$.

match sailing had been abolished; but lead keels were regarded with a great deal of disfavour by yacht-owners, from the prevailing belief that they made a vessel pitch and roll heavily in a sea; thus up to 1870 no yacht was to be found with more than about a tenth of her ballast on the keel, and the majority had none at all. Some experiments, however, with small vessels, and a better knowledge of the good effect of concentrating the ballast in the middle third of the length of the vessel, rapidly led to a larger quantity of lead being placed outside, until, at last, the whole ballast was placed outside on the keel.* This lowering of the ballast, and consequently of the centre of gravity, enabled the designer to dispense with a considerable quantity of breadth and add to the length, for any given tonnage, until in some of the smaller yachts the length has been equal to 6½ beams, and in the larger, 5¾ beams.

For any given nominal tons the displacement has been largely added to, as may be gathered from the table on next page; but this, whilst perhaps it has checked the attainment of the highest possible speed for any given length of hull and sail spread, has prevented the yachts being useless as seaboats.

These large additions to the displacement, whilst the power for getting through a head sea may have been increased, have had a prejudicial effect on the attainment of high speeds, mainly on account of the enormous wave-making it induced. Thus, so recently as 1880 the *Arrow* (Plate xx.) has been driven in strong winds as fast and sometimes faster than the *Formosa* or *Samœna*, and with very considerably less wave disturbance. The principal characteristic of this wave-making is a huge hollow under the weather bilge, although there is a considerable hollow on the lee side as well. The fact, however, that the greatest disturbance is found on the weather side is accounted for by the circumstance that, upon heeling over, the bulk of the deep displacement is on the weather side of the middle fore and aft line. The lead keel of one of these long narrow yachts, it should be explained, is in breadth about one-third of the main breadth of the vessel; and in weight is equal to about 0·5 of the total weight of vessel in a yacht like the *Galatea* (Plate xx.), to 0·7 of the total weight in a 3-tonner.

The Americans, it should be observed, did not much alter this centre-board type of yacht and keel yacht during the period between 1845 and 1885. The reason of this was mainly due to the fact that they frequently changed their method of rating for competitive sailing, and, moreover, did not pursue yacht racing to the extent we did on this side of the Atlantic. Their yachts for any given length were capable of a greater absolute speed than our yachts in moderate breezes and pretty smooth water, because they were of much lighter displacement; in very light winds the British type seemed to have the advantage when the sail spread to immersed surface was about the same in each yacht; in strong breezes the shallow American type had the advantage in speed

* A paper on this subject will be found in the Transactions of the Institution for 1880.

	Arrow.*	Formosa.	Vanduara.	Samœna.	Genesta.	Galatea.
When built... ...	1822	1878	1880	1880	1884	1885
Length on load-line..	76 ft. 7 in.	82 ft.	81 ft. 3 in.	80 ft. 8 in.	81 ft.	86 ft. 9 in.
Breadth, extreme ...	18 ft. 9 in.	16 ft. 11½ in.	16 ft. 2 in.	16 ft. 2 in.	15 ft.	15 ft.
Draught, aft ...	11 ft. 6 in.	12 ft. 6 in.	12 ft. 4 in.	13 ft.	13 ft.	13 ft. 6 in.
Yacht tons	99	83	89	88	80	90
Displacement in tons	106 tons.	130 tons.	130 tons.	129·8 tons.	141 tons.	157·7 tons.
Area of midship section	89 sq. ft.	100 sq. ft.	—	—	—	114 sq. ft.
Midship section abaft middle of length of L.W.L. ...	5 ft. 5 in.	4 ft. 6 in.	3·75 ft.	5·5 ft.	4 ft.	4·2 ft.
Centre of buoyancy abaft middle of length of L.W.L.	3·2 ft.	2 ft.	1·98 ft.	3·52 ft.	—	2·1 ft.
Area of immersed surface	1,940 sq. ft.	—	1,892 sq. ft.	2,022 sq. ft.	—	—
Ballast	40 tons.	60 tons.	—	—	72 tons.	81·5 tons.
Portion of this ballast on keel and in garboards ...	13·7 tons.	14 tons.	—	—	70 tons.	81·5 tons.
Area of mainsail ...	3,000 sq. ft.	3,150 sq. ft.	—	—	—	—
Area of foresail ...	700 sq. ft.	750 sq. ft.	—	—	—	—
Area of jib	980 sq. ft.	990 sq. ft.	—	—	—	—
Total area lower sail.	4,680 sq. ft.	4,890 sq. ft.	4,500 sq. ft.	4,575 sq. ft.	—	—
Mast, deck to hounds	49 ft. 4 in.	48 ft. 8 in.	48 ft. 6 in.	50 ft.	52 ft.	53 ft.
Main boom	64 ft.	68 ft.	68 ft. 3 in.	68 ft.	70 ft.	73 ft.
Main gaff	46 ft.	44 ft. 8 in.	43 ft. 3 in.	44 ft.	46 ft.	45 ft.
Bowsprit outside ...	34 ft.	34 ft.	31 ft.	34 ft. 3 in.	35 ft.	36 ft. 6 in.

* Although the *Arrow* was built so far back as 1822, she has been many times altered, and originally her length on the water-line was 59 ft., and beam the same as it is now.

when sailing well off the wind, but when pressed close to the wind the advantage was just the other way. This appears to be principally owing to the fact that the narrow, deep yacht has practically an unlimited range of stability, whilst the shallower and broader yacht of the American type reaches the maximum of her range at an angle of about 30°. In a short head sea the heavy narrow yacht has an advantage over a lighter yacht of the same length.

The results of some encounters between small yachts of the United States and those of England during the years 1881, 1882, and 1883, at New York, Boston, and other places, led Americans to consider whether some adaptation of their centre-board type to the British type could not be carried out with advantage. It was made plain to them that a yacht of the British type would win a majority of races, but the type was already condemned in England, and Americans could not be persuaded to adopt it without modification. Accordingly, when in 1885 the owner of the British cutter *Genesta* challenged for the cup won by the *America* at Cowes, in 1851, the Americans set to work to produce a compromise yacht, but distinctly more American in type than British. This yacht in section was of the broad **V** character—very like the *America* of 1851—with almost twice the draught of water that the ordinary shallow centre-board yacht had. Beyond this she had nearly the whole of her ballast outside, in the form of a lead keel supplemented by a centre-board of considerable area. This yacht was named *Puritan*, and, so far as can be judged, she defeated the *Genesta* on her merits. The same fate befel the *Galatea* last year, the Americans having built another yacht, the *Mayflower*, of this new type to meet her. They compare as follows :—

	Galatea.	Mayflower.	Genesta.	Puritan.
Length on water-line ...	87·0 ft.	85·7 ft.	81 ft.	81 ft.
Extreme beam	15·0 ft.	23·5 ft.	15 ft.	23 ft.
Draught of water ...	13·50 ft.	9·0 ft.	13 ft.	8 ft. 3 in.
Area of transverse section	114 sq. ft.	85·0 sq. ft.	—	—
Displacement	157·63 tons	110·0 tons	141 tons	105 tons
Total ballast	81·50 ,,	48·0 ,,	72 ,,	44 ,,
Ballast on keel	81·5 ,,	42 ,,	70 ,,	27 ,,

The success of *Puritan* over *Genesta* and *Mayflower* over *Galatea* naturally produced a great impression on this side of the Atlantic, especially as the two American yachts were the work of one who at the time could only be regarded as an amateur at yacht designing. But there is no doubt that Mr. Edward Burgess had made a very

close study of both English and American yachts, and his success was as much the result of a correct appreciation of what was required to achieve a certain object as that of George Steers was when he designed and built the *America* in 1851.

The practical outcome of the victories of the American yachts was that the British Yacht Racing Association realised the situation that whilst its rating rule (which taxed beam heavily, and depth not at all) might produce yachts which were in some respects superior to the American type, yet that there are intermediate types of surpassing excellence so far as match-sailing is concerned. The old tonnage rating, it can be said, had assisted in bringing yacht building to a stand-still in this country, as no one could be found willing to build a longer, narrower, and deeper boat for any given tonnage than those which already existed, and the rule* would not admit of trying experiments with beam.

Under these circumstances the Yacht Racing Association appointed a committee to report upon the existing rating rule, and recommend such new rating as might be considered necessary. The committee obtained the opinions of all the leading yacht designers and yacht builders, and these were almost unanimous in recommending that the rating should be in future by length of load-line and sail area, the working formula being—

$$\text{Rating} = \frac{\text{Length} \times \text{sail area}}{6{,}000}.$$

The first outcome of this rule has been that the new Scotch yacht *Thistle* (built expressly to compete for the *America* cup) has been designed of proportions very similar to those of yachts of thirty years ago, before the squeezability of the old tonnage rule had been discovered. The actual dimensions of this yacht are :—

Length of load-line	85·00 feet.
Breadth, extreme	20·30 „
Depth of hold	14·10 „
Registered tons †	100·67 tons.

The *Thistle*, it should be said, has been designed by Mr. G. L. Watson, of Glasgow, and is the first attempt since the *Livonia* was built, in 1871, to meet the Americans on their own lines. She will probably have to encounter one of the powerful centre-board sloops, and it is contended, with some reason, that a contest between a keel yacht and one fitted with a centre-board cannot be considered a satisfactory trial of merit. So far as sailing by the wind is concerned, the board does not appear to hold the yacht to

* The rule had been modified from the old tonnage rule to $\frac{(L + B)^2 \times B}{1730}$.

† The apparent large registered tonnage of this yacht is attributable to the fact that she is built of steel, and that her keel is specially constructed to form a kind of ballast box, thus giving great depth of hold. Vide the paper on "Construction and Ballasting of Yachts," in the Transactions of 1882, by Mr. T. Phillips.

more advantage than the fixed keel does a modern yacht with a deep cross section ; and often if, as the Americans say, the centre-board is out-pointing the keel yacht, the feat is probably more attributable to the sit and trim of the sails and to the manner of sailing than to the board, unless, of course, the keel yacht has a deficient area of longitudinal vertical section. Where the centre-boarder has the advantage is in lifting the board for sailing off the wind. By housing the board in a yacht like *Mayflower*, a reduction of about 10 per cent. is at once made in the area of immersed surface, and the effect of this is always manifest, especially in light winds or low speeds. However, so far as the *Thistle* is concerned, it can be taken for granted that Mr. Watson, whilst providing her with sufficient area of longitudinal section for lateral resistance, has so fashioned away the ends that she will give a good account of herself in any contest with American yachts, whether on or off the wind.

DISCUSSION.

Captain C. C. P. FitzGerald (Associate) : My Lord, I have been asked to open the discussion. I feel very unworthy to do so, although I may say that this is a subject I have taken a great deal of interest in all my life, ever since I was big enough to get into a boat. No doubt Mr. Dixon Kemp has hit on the secret of the whole question in alluding to the difference of measurement. The extraordinary shape of our yachts which we have arrived at now is of course due to the rule which we have been guided by of taxing length very little and depth not at all, so we have arrived at what a seaman cannot help looking upon as a monstrosity in the shape of a three-tonner carrying 7 tons of lead placed upon her keel. It cannot be for the advantage of naval architecture in any sense that it should be simply a case of a lead and sail balance, that the vessel should be more like an up-ended soap box, without any regard to the beauty of her lines or anything, but simply a question of how much lead she can carry and how much sail she can stick up at the other end of it. I, for one, shall hail with very great delight any alterations in these rules, which I understand are being made where sail area shall be taxed without regard to the total displacement of the vessel, for there will be no use putting sail up unless you can carry it. I am sorry that Mr. Dixon Kemp did not touch more upon our recent yachts of the *Chittywee* class, which seem to have opened people's eyes to the absurdity of going on on our present rules. He has touched on the *Thistle*, I am glad to see. There is one question which I should like to ask about the *Thistle*, if he can inform us. He says she is built somewhat on the type of vessels built some years ago, and also on the type of the American yachts which beat our vessels lately, but I see " 14 feet depth of hold." I should like to know whether that is to the garboard or the extreme depth.

Mr. Dixon Kemp (Associate Member of Council) : She is built of steel. The lower part of the hull forms a sort of ballast box ; she has no floors like a yacht ordinarily would have, and the depth of the hold would be to the top of the lead.

Captain FitzGerald : She is something new, I imagine.

Mr. Dixon Kemp : The frames go round under the keel much the same as the *Vanduara's*, described by Mr. Phillips in Vol. xxiii. of the Transactions.

Captain FITZGERALD: In the *Chittywee* I happen to know the keel is nearly half the width of the vessel. She scarcely "falls in" (from the top) at the side at all, but is exactly like a soap box turned on end. Now, with reference to the general question of building yachts, I have sailed a good deal about the world and have seen boats in nearly all parts of the world, and the conclusion at which I have arrived is that vessels are built to suit the special local circumstances they have to meet with. What is good in one sea is no good in another. I have seen every sort and variety of vessel, the Chinese boats, the Bombay boats, the Bermudian boats, and a great variety of others; the latter boats are the most extraordinarily built boats that ever one saw for speed, and yet very hard to beat in their own waters, although they were beaten last year by an American centre-board. The English type of yacht is a type specially adapted for the British Channel, where there is a short lumpy sea; and I doubt very much if those Americans had come over here and we had had any sort of bad weather and a British Channel sea, that they would have beaten the *Galatea* and the *Genesta*. I do not think they would. It was a regular smooth water race, a skimming dish race, and a nice breeze eminently suited for that description of yacht, and our yachts sailed under a great disadvantage. Mr. Dixon Kemp has given us here the displacement, on page 238. The displacement of the *Galatea* is 157 tons, and her transverse section of area is 114 square feet, as against 85 feet of the *Mayflower*, the sail areas being about equal; and it stands to reason that in smooth water you cannot shove that through the water with the same sail power as you do the other. In anything of a head sea I very much doubt whether the *Mayflower* would have been "in it." As I remarked at starting I shall hail with delight any change in the rules which will induce yacht builders, instead of making these shapeless masses full of lead, to go in for beauty and symmetry of lines, and all other things being equal I have no doubt we shall be able to sail against the Americans. We all know that Mr. Watson has been hitherto a very successful builder on the lines he has been forced to take up, and I sincerely hope that under the revised rules he will be equally successful, and will bring back for us the *America's* Cup.

Admiral A. F. R. DE HORSEY (Associate): My Lord, if I might take exception to Mr. Dixon Kemp's title, I should be inclined to say that I have been a little disappointed at its having been changed. I thought the title of the paper was to have been "A Comparison of American and English Yachts," and it has been changed to "Fifty Years of Yacht Building."

Mr. DIXON KEMP: Yes.

Admiral DE HORSEY: The only reason I mention this is, that the pith of the whole thing lies in the question of tonnage measurement for racing purposes. The Yacht Racing Association have discovered that their late measurement is not right, and they have tried to improve it. But, do the Yacht Racing Association deserve our confidence, and should they be allowed to lay down what the tonnage of yachts shall be, or rather, how it shall be measured? For some years past we have been sailing under their rules, and measuring our racing vessels by their length and breadth alone, and we have been taking no account of their depth or displacement. This absurd system of measurement induced narrow deep vessels, and culminated in a design for a monstrosity well named a "a plank on edge"—so contrived that, although carrying some nine or ten tons of lead in her keel, she only measured about one ton by Y.R.A. rules! So narrow was this vessel to be, that it was said a broad-shouldered man would have to turn edgeways to get below. The Yacht Racing Association, having maintained this faulty tonnage rule for some years, have now established a system dependent on length and sail area. I am not aware whether American yachts will agree to sail under this new

rule—if they do it will be fair for both—but nevertheless, I think we should take exception to a hard and fast rule of that sort, which takes only one dimension of a cubical body-length, and having applied to it the measure of sail area and an arbitrary divisor, calls the incongruous result tonnage, and binds the builder to be guided by those two measurements. I would ask whether anybody building a ship to catch a privateer in former days would have been content to limit the designer as to length and quantity of sail? Surely that would not be the way to get the fastest vessel of her size and cost. To take a more modern example: if you wish to build a blockade runner of utmost speed, would you not let the designer (provided he kept within the limit of size) select proportions and horse-power which would give the greatest speed consistent with other necessary qualities, or would you cramp his talents with limitations as to length and power? (for limiting the power of a steamship is much the same thing as limiting the sail area of a sailing vessel). To make matters worse, I believe that the Yacht Racing Association have established that this rule shall continue in force for five years to come. For five years we are to have a measurement which is vicious because it paralyses the two elements of length and sail-power, and takes no account of the two other essential elements of breadth and depth. Under such a system we cannot expect to encourage the construction of vessels best proportioned for speed. I should have thought that naval architects and also the great yacht clubs which enjoy certain privileges in consideration of the benefit they afford to naval architecture—would have rebelled against empirical rules which tend to fetter the talent of designers. This brings me to the remedy I would suggest—measurement by displacement. Until we accept the principle of displacement there will be no fair sailing between our yachts and those of foreign nations. There may be slight drawbacks to it, but it is undeniable that the *real* measurement of a vessel is the size of the hole she makes in the water. Under existing and late Y.R.A. rules, a builder ordered to construct, say, a 100 ton racing yacht has to devote his ingenuity, *not* to building the fastest vessel of the size specified, but to adopting such proportions and stratagems as will enable him to take advantage of the rules, by constructing a vessel to sail under a fictitious tonnage and thus get a large time allowance. It has been alleged that displacement measurement might lead to the construction of vessels having too little body compared to their length, breadth, and depth. I do not think that would result. Models do not prove much, but, as far as they go, I find, after three years' trial of a model regatta sailed by displacement (the number of pounds' weight of the model being considered her tonnage for time allowance), that the forms which have been built to be sailed in these races are not exaggerated in any respect. But, if the allegation be correct, I maintain that it is easy to discourage the construction for racing of unduly lean bodies by a rule establishing, that if the area of greatest transverse vertical section immersed be less than a minimum to be determined upon, then the tonnage of such vessel shall be deemed such as it would have been if calculated upon that minimum area. A co-efficient of ·053 multiplied into the length and breadth of a minimum area of immersed midship section would not apply this wholesome check to any vessel unless leaner than the celebrated yacht *America*, which vessel may be taken as the shallowest form English yachtsmen would tolerate. I do wish that naval architects would exercise their legitimate influence to bring about what appears rational, viz., that they should be allowed free scope, within reasonable limits, to build vessels as long, as broad, and as deep as they judge best for the tonnage required. This can best be done by adopting displacement tonnage, as has been done in the Royal Navy, the ships of which are now entirely measured thereby. I hope to live to see the day when we shall adopt it throughout the whole Mercantile Navy, so that a ship with a full cargo, a ship only partly loaded, and a ship in ballast shall each pay dues according to their respective displacement at the time. This is not connected with the paper before us, but I venture to mention it incidentally. It is so simple to have a displacement

diagram, by the help of which you would only have to go alongside a vessel and measure the distance from her plank sheer down to the water, and thus obtain her actual tonnage, whether for yacht racing, dock or other tonnage dues, or any purpose whatever, except for building and statistical records, for which the tonnage must always be a measure of cubical contents.

Mr. N. Scott Russell (Visitor): My Lord, I should just like to ask Mr. Dixon Kemp one question. Of course, in yacht racing there must be some measurement for time allowance. I should like him to tell us why the matter was complicated by introducing the sail area, when the length of itself alone would have given a basis for time allowance, and the shipbuilder would have been left free to make the best ship that could be built, whereas now he is again hampered, though in a less degree than under the old tonnage laws. I am afraid that if the displacement proposed by the last speaker were adopted we should get exactly back to the old miserable vessel, which would be long and narrow, and with enormous lead keels put in merely to balance the sail area.

Mr. B. Martell (Vice-President): My Lord, as a naval architect I entirely endorse what Admiral De Horsey has said, and I agree substantially with the remarks of Captain FitzGerald as well. I think it is simply lamentable, looked at from the professional point of view of the naval architect, to find that the Yacht Racing Association has encouraged as much as it possibly can the worst type of vessel it is possible to conceive. It has been very properly said it is similar to a plank on edge or to a capsized soap-box. This is to be deplored for many reasons. We know that the establishment of the Royal Yacht Squadron was for the purpose, to a great extent, of improving naval architecture. It was felt that those vessels competing with each other would improve naval architecture generally both for war-ships and also for merchant ships. No doubt it did so to a great extent. But this new rule altogether prevents that, because, although the old rule of allowing too much for the breadth of a vessel was no doubt injurious to a great extent, by taking the breadth and ignoring the depth, as in the old rule of builder's tonnage, yet, to dispense with breadth altogether, in my opinion, is far worse. I think that displacement should be an element in the consideration, and it is a most important element, in my opinion. The effect of the present type of yacht is that it has done away altogether with what was formerly the case when gentlemen built yachts for the purpose of comfort. If they build yachts now merely for comfort—yachts of decent form—they have entirely to dispense with the pleasure derived from the sport of yacht racing, because, to use a common expression, they are not in it. You are obliged to have a special machine built for the purpose, and those machines involve elements of considerable danger as well. The enormous amount of lead that is put on the outside of these yachts at the present time is a source of very considerable danger, unless very great care is taken. In the first place, it is exceedingly difficult to fasten it. Some time ago it was customary to fasten these lead keels with iron through-bolts, but the action between the lead and the iron, combined with the effect of the copperas water, the galvanic action which was set up corroded the iron bolts to such an extent that some of these yachts, when they were hauled up, showed that a bolt 1¼ in. thick was reduced to the size of a pipe stem. Had that yacht sailed for some little time longer, the great probability is that the bolts would have been eaten away entirely, the lead would have fallen off, and the vessel, having no stability, would have turned turtle immediately and drowned all on board. That, my Lord, I think is a point which requires considerable consideration now, the manner in which the lead keels are fastened to the wooden bottoms of yachts. They invariably should be fastened likewise with copper bolts. I think, if I mistake not, that Mr. Dixon Kemp rather disagreed with that on one occasion, but I hope that his experience has taught him to change his opinion.

Mr. Dixon Kemp: No; it was just the other way.

Mr. B. Martell: I apologise, because I thought that you did. I think most certainly a better type of vessel would be produced by allowing the displacement to enter in as one of the elements, that we should have more beauty of form, and should be able to indulge more, and with greater pleasure, in the art of the naval architect, in designing them, and I think that there would be a general benefit altogether; and I must say I cannot see very much difficulty myself why it should not be. I think, after the mountain labouring, as it has been, for a number of years to bring forth such a mouse as to merely take the length and the sail power, and to ignore all the other principal dimensions, is a very lamentable result to arrive at.

Mr. J. I. Thornycroft (Member of Council): My Lord, I would ask permission to make only a few remarks. I propose to look at the matter from an entirely different point of view—more from the point of view of a steamship builder. Admiral De Horsey has said that the displacement should be taken as a factor, and Mr. Martell also agrees with that. I think it is quite certain that the displacement is an important factor, and that we should consider it, but I think that Admiral De Horsey is wrong in saying that we should not impose any tax on sail area. The fact is that sail area is much the same thing as engine power in a ship. Admiral De Horsey is anxious that we should have beauty of form. If we are to have beauty of form, we want to drive as much displacement as we can at a given speed, with as little power as possible. Little power means little sail, and I think there is no doubt there should be a tax on sail. It is not a question I have considered much, but I do think we want to encourage large displacement with small sail area, because then we shall get well-formed vessels. I think we have to thank Mr. Dixon Kemp for laying the matter before us so clearly that any amateur on the subject would be able to follow it.

Mr. J. Inglis, Jun. (Member of Council): My Lord, there seems to be some consensus of opinion among the gentlemen who have spoken that it is a fact that yachts have deteriorated during the last fifty years, but I am not at all certain that this has been made out. I cannot recall any vessel which has been built within the last fifty years that I would care to possess in preference to such vessels as the *Amazona*, the *Irex*, or the *Marjorie*. I think those vessels I have named, and those Mr. Dixon Kemp has included in his list, can be called with great propriety sea-going vessels. The *Genesta*, one of the most modern, made her passage across the Atlantic and back without any accident. In the smaller classes what may be called an extreme type, having great length and great weight of lead keel, has no doubt obtained, but in the larger classes the real difficulty of handling such a vessel as the *Chittywee*, enlarged to 70 or 80 tons, is an effectual check on any extreme type of that kind being adopted. The adoption of so-called extreme types is not so much due to the action of the Yacht Racing Association, or any legislation with regard to measurement, as to the division of yachts into racers and cruisers, and it will be almost impossible to avoid the adoption of what some will call extreme types so long as racing is pursued with such ardour that it has become almost a profession. An old gentleman might keep a cob for his morning airing without thinking of entering it for a steeplechase, and so if we are to have racing yachts at all we must make up our minds to sacrifice a little comfort for speed. They are built for speed, and must have speed even at the sacrifice of comfort, and the enthusiastic sportsman will be quite ready to put up with a little discomfort for the sake of coming in at the head of a long string of racers.

Mr. Dixon Kemp: With regard to the question raised by Captain FitzGerald as to the depth of hold of the *Thistle*, and her registered tonnage, there is a foot-note on page 239 which bears on that.

Captain FitzGerald appears to have understood me to say that the *Thistle* was of the type of thirty years ago. That is a mistake. I did not say the type—but that the proportions—what the proportions of length to breadth were to those of thirty years ago. The discussion of measurement rules is rather beyond the scope of this paper, and I had no notion that it would be entered upon, but I should like to say a few words with reference to Admiral De Horsey's objection to length and sail area. He seemed to think it would be fair enough if the American yachts were rated by a similar rule. It so happens that they have been rated by such a rule for the last three years, and if any American yachts pay us a visit they will have to be rated by the same rule. I think Admiral De Horsey somewhat misunderstands the object of rating yachts. He condemned the new rating by length and sail area, because it placed a tax upon the two chief elements of speed; but it would be useless to rate yachts upon elements which bore no relation to speed or to success in match sailing. With regard to the rule fettering yacht designers, any rule to be of value as a test of merit was bound to be based on some element which bore a relation to the quality to be tested: otherwise the test would be absolutely valueless. There was no doubt that length and sail-spread were the prime elements of speed, and the designer was left in perfect freedom as to breadth and depth under the new rule. Of course, if he wanted a relatively long vessel, for any given rating, he would have to dispense with some sail; on the other hand, if he wanted a very large sail-spread, he would have to dispense with some length. The general objection to rating by displacement, which has been so greatly advocated for a long number of years, is this: that with two yachts of the same displacement one can be so very much longer and broader than the other, and thus be made to carry more sail, and in a little time we should have an extreme type of shallow boat just the same as we have under the old tonnage rule an extreme narrow type. The *Galatea* has a displacement of 167 tons. It is very certain that that 167 tons could be put into a longer, broader, and shallower form, so that a yacht anything approaching the type of the existing *Galatea* would never have the ghost of a chance against her at an equal rating of 167 tons. Displacement of itself is not an element of speed, but rather of slowness, and if the rating were based on it, the aim of the designer would be to use as small a quantity as possible for any given dimensions. That was the opinion of the leading yacht designers of the greatest experience; but of course it had not been proved, because the rating had not been used in this country. It has also at different times been suggested that what we know as the co-efficient of displacement should be used as the basis for a rating; or that a co-efficient, found by dividing the sail-spread by the displacement, should be so used. This latter method would meet the views of Mr. Thornycroft, that the test of merit should be the largest hull driven at the highest speed for any given sail-spread; but it is obvious that either of these ratings would produce what Mr. G. L. Watson, when discussing such a rule, described as a great "gutty hull," and in the end bring down the speed, as it would be useless building yachts which could attain the highest possible speed under the most favourable conditions for doing so, as their rating would be too high for them to succeed under other conditions. Mr. Scott Russell asked why the Yacht Racing Association had included sail-spread in the rating. It had been included for two good reasons among others: Sail-spread was the great controlling element of speed, and greatly added to the cost of racing. Increase of sail-spread meant extra cost for the sails themselves, and extra cost for the means of carrying them. A great outcry had been made that the expense of yacht racing was seriously interfering with the practice of the sport, and checking yacht building. Under these circumstances, it was considered wise to place a tax upon sails, but possibly that would have no influence in preventing a sail-spread being employed sufficient to develop the best qualities of a yacht in match sailing. So far as the rating by sail area of the Yacht Racing Association is concerned, it was adopted on the recommendation of the yacht designers themselves, and they

ought to be the best judges of what was most needed to meet the case, so the Association had really very little to do with it. The rating would appear to be capable of producing an endless variety of types, but the beauty of design, which Mr. Martell desired to see in yachts, depended upon the taste of the designer and skill of the builders in carrying out the design. The designer is practically left unfettered.

Admiral De Horsey: Not as to length.

Mr. Dixon Kemp: For any given rating, if he takes so much length he can do with a little less sail; if he takes more sail he must put up with a little less length. Gentlemen, I am extremely obliged for the manner in which you have received my paper, and I thank you all very much for your attention whilst I was reading it.

The President: Gentlemen, I am sure that you would wish me to convey to Mr. Dixon Kemp your thanks for his very valuable paper, and I may congratulate him upon the thoroughly useful and practical discussion that has ensued upon it.