(editor's note: This paper was transcribed from a handwritten cursive copy with various difficulties. For a perfect rendition, the reader might wish to consult the original, itself a copy, in the volume entitled *Literary Club Papers*, May 30, 1891 to February 6, 1892)

The Evolution of the Sailing Vessel

Among the first of the Ancients that used the sail, were the Chinese. Their commerce was extensive before either Phoenicia or Egypt was a maritime nation. Of the construction or form of their ships of that period we are without knowledge. But we do know that the mariners compass was long in use by the Chinese before it was known elsewhere and the fact that their commerce extended across the Arabian Sea before Phoenicia was a maritime nation, would go to show that the compass was then in use. The same authority says that an edict of a jealous emperor forbade trading with foreigners; and to discourage navigation, it was said that he ordered that hereafter ships should be constructed on the model of one of his Majesty's shippers; hence the Chinese junk.

The most ancient representations of ships are those found among the paintings and sculptures of ancient Egypt. They are galleys informed, such as were used by the Greeks several hundred years later, and not unlike some that may yet be found in parts of the Mediterranean. They were generally large, and cumbrous in management, propelled with oars on one or more decks, and as many as twenty oars on the side of each deck, some writers say more than double that number. These ships ranged in size from the small galley used for pleasure, to ships of 500 to 600 tons burden. Next to China, Egypt seems to be among the first of the Ancient nations to engage in shipbuilding, but soon the Phoenicians became successful rivals, far excelling them in all that related to shipping and seamanship.

Occupying a long strip of coast, 20 miles in length with an average of only three miles in breadth the chief reliance of the Phoenicians was the sea, of which they made profitable use. While they had the credit of excelling in some of the useful arts as glassmaking, dyeing etc. their attention was directed chiefly to the fisheries and the improvement of their ships and navigation. Possessed in a large degree with a genius for invention and imbued with a spirit of of irrepressible enterprise the Phoenicians were the Yankees of their day.

They built up a marvelous commerce extending all the way to the British Isles, founded great maritime cities at home, and established colonies in many of the Grecian Islands and along the coast of Spain. Their chief cities were originally the Tyre and Sidon of Sacred History. Rivaling these, other great cities soon sprung up, Byzantium, Thebes, Carthage and Cadiz. With the Phoenicians, as with enterprising people of later dates, tin was a potent faction if not in politics, in trade and commerce.

Then, as now, Cornwall furnished much of the metal, a fact that for many years was known only to one nation of the Mediterranean, Phoenicia. On one occasion the captain of a Tyrian vessel on her way to the mines discovered following in his wake, a Roman

galley. They were nearing the Scilly Isles but rather than expose his country's secret the Tyrian captain ran his vessel on the outlying rocks where both suffered shipwreck.

Of the development of the sailing vessel we have little to learn from the Ancients. Phoenecian and Egyptian vessels had only one mast on which was set a square sail when going before the wind. Having no knowledge of the mariner's compass and little if any of the art of sailing with a side wind, they did not venture far from land. For their guide they used the sun and the polar Star, which served them little purpose in cloudy or foggy weather. Yet they have the credit of circumnavigating Africa and being the first to round the Cape of Good Hope.

The Greeks and Romans obtained their knowledge of shipbuilding and seamanship from the Phoenicians though in those industries they proved very much the inferiors of their exemplars. They were not only sedulous copyists, but went so far as to name the sea they navigated and their celestial guide after the nation they copied, calling them that the Phoenician sea and the Phoenician Star. We have little to learn, therefore from these nations regarding the sailing vessel, and will look for development later in history. And here we encounter the difficulty of a missing link, but that pertains to evolution.

Navigation and Shipbuilding began to decline in the middle ages, till near the close of the 14th century when the best ships were those of Norman construction. The credit of building exclusively for sailing, has generally been conceded to the Genoese, though in England sailing vessels were employed as early as 1344.

The Genoese ships, like others of a later period, were remarkable for the great height of the prow and Stern and their bulky rounded figures. They had no bowsprit, one great mast upon which were one or two yards and sails, the larger being lowered to the deck when not in use. Besides these two smaller masts were sometimes used, on each of which was a square sail as in the illustration. Their ships were manned with 15 to 20 sailors.

Having some knowledge of the mariner's compass, and the astrolabe, as well as of the art of sailing by a side wind, mariners could now not only venture far out of sight of land, but extend their commerce to distant countries, and even enter upon exploring expeditions. Hence about this date we find the intrepid mariner Columbus, negotiating with his townsmen for a fleet of vessels to enable him to undertake his great voyage of discovery. The illustration represents the model of the ships of his time, the Spanish vessels differing little from the Genoese. In England Henry began to collect the fleet for war purposes, his vessels carrying 100 to 600 tons each, some with one, others with two or more masts, short topmasts and a forecastle of considerable height for the accommodation of soldiers. At the mast heads were top-castles on which men were stationed with darts and missiles to injure or annoy the enemy.

The navies of the Netherlands, France, Spain and Portugal had also attained great eminence in that century. The Great Harry built in 1488 is supposed to have been the first ship of the British navy as seen today. She had four masts, carried courses, had fore and main tops sails and top gallant sails and guns on broadside of her double decks. Built with high castellated structures at each end, she seemed intended for display rather than service.

Great advancement was made in shipbuilding as in many other industries, in the reign of Queen Elizabeth. The East India Company was chartered in 1600 and immediately a demand spring up for superior construction and seamanship. Sir Walter Raleigh gave much attention to ship building, and after him Phineas Pitt, who dispensed with the lumbering forecastle and after part, though giving more sheer to the whole than was afterward retained. In the meantime the French and Spaniards had been applying the principles of engineering in the construction of ships, while the English, like the Americans at a later date, modeled theirs from experience and by natural talent.

The American shipbuilders were the first to abandon the cherished features of the European models, the high poop and inflated topsides. Their frigates proved their superiority to all other vessels of war in actual service, and before the introduction of the Liverpool packets, were the finest vessels afloat. The Clipper schooners of the Chesapeake were specially famous under the name of Baltimore clippers. Brought of beam before the centre, but above the waterline, sharp in the bow, deep aft, long and low, with a movable centre board they presented admirable forms for capacity, stability to sustain a large amount of cancvas, great speed and tenacity holding their course in a wind with little drifting leeward. The masts were long, slender, and raking, the sails unusually large for vessels of their size and of so true cut and perfect set that no portion of the propelling effect of the breeze that reached them was wasted. We have the representation of these vessels in the model of the America which carried off the prize of the International Cup.

Reference has been made to the Liverpool packets. The era of packet ships was the result of demands for an increasing trade between the United States and Europe. The famous Black Ball Line was the pioneer line of the trade, the ships of which were unrivaled for strength, beauty, speed, and the regularity of their departure and arrival. It was founded in 1816, four years after the war of 1812, which had secured for American Commerce its rights and privileges.

During the first nine years, the time for sailing from New York to Liverpool was 23 days, and for returning, 40 days, the prevailing westerly winds accounting for the difference. Though considered large at that time, these vessels carried only 400 to 500 tons. In 1821 the Red Star Line was organized and soon other lines were founded, one of them called the Swallow Tail. Numerous ships were added to each of these lines, whose tonnage was greatly increased. Conspicuous among the names of the ships were the Patrick Henry of 1000 tons, the Ashburton and 1015 tons, the Henry Clay which with her three decks and a tonnage of 1250 was the marine wonder of the time. All New York rushed to the wharf to see her. Succeeding her came the New World, the largest ship afloat in 1846. A Liverpool line was organized in 1852, and in 1856 the Orient of 2100 tons was launched.

In the mean time the famous clipper ships had been piling up brilliant records of their marvelous speed and the prowess of their commanders. The flying trips between New York, San Francisco and the Indies were the nautical wonder of the time. They were built for speed, regardless of carrying capacity, and therefore modeled on a new plan suggested by the Baltimore clippers. While the old lines were bluff and bulky, the

clippers were long and narrow, sharp at the bow and tapering at the stern. Contrasting them with the old Atlantic lines a California editor said of the latter, “The antiquated hoax which like huge wash-tubs have been floating about the seas, sailing about as fast sideways as in any other direction, have been forced by the rapid Spirit of California to give place to entirely new models, graceful in their motions as swans on a summer lake and as fleet as the cloud that is blown before the gale.”

The first clipper ship was the Rainbow of 700 tons, built in 1843. Others followed but proved lacking in capacity and strength; so in 1851 W. H. Webb of New York, the greatest naval architect of his day, put on the stocks four clipper ships which should solve the problem of combined capacity, strength and speed. These noted vessels were the Challenge of 2000 tons, the Invincible of 2150 tons, the Comet of 1209 tons can be Sword Fish of 1150 tons. Of this number the Comet proved alike remarkable for speed, seaworthiness, strength and productiveness or in the parlance of the forecastle “Good-Luck.” She was commanded by an able mariner, Captain Gardner. Other ships were built and christened with names quite as poetic and euphonious. The Flying Cloud, the Sovereign of the Seas, the Rainbow, the Black Squall, the Sea Witch, the Northern Light, and Tornado.

The Sovereign of the Seas was built by Donald McKay and commanded by his brother Captain L. McKay. The record of this noble ship eclipsed that of all her predecessors. Take a single voyage: Leaving New York, June 15, 1852 for Liverpool she ran out to the Banks of Newfoundland, and all day on Sunday 26th, was becalmed. Catching the rising breeze in the night, she sped away reaching the Mersey at five o'clock P.M. on the following Saturday, where she cast anchor, only five and one half days from the Banks. Her entire time between New York and Liverpool was thirteen days, nine hours in one day of which she made 840 miles. It was discovered afterwards, that on the same day going from Boston to Liverpool, the Cunard steamer Canada made only 306 miles. Wonderful speed under canvas, though the Flying Cloud excelled that; making from noon to noon 488 1/4 miles, when on a voyage to San Francisco.

Principles

How ships sail - Propulsion By Wind.

Floating in the water, with a part immersed, a vessel is susceptible to any force that may be applied to change its position. The movement of the vessel implies the movement of the fluid in which it is immersed. If the force applied be that of wind and the structure a square one, the vessel will move in only one direction that of the wind. If the vessel be a boat or ship lying with her side to the wind and her sails spread on the appropriate side she will be moved in two directions, first directly from the wind with a broadside motion, but slowly, on account the great resistance; next, forward in the line of her keel or that of least resistance, the wedge shaped bow cutting the way through the fluid. Should the force come more from the bow than the stern, the forward motion would continue provided the sails were properly adjusted and the bow not nearer than 45° of the wind. Ships sail fast or slow, make headway or leeway according to the construction of the hull,

the form and fit of the sails and the force of the propelling power. If the ship be broad of beam and have a comparatively flat bottom so that she will float lightly she will make much leeway. The resistance on the broadside will not be sufficient to keep her in her course; if narrow of beam and the immersed part be sharp and deep, she will make a little leeway, however close to the wind she may sail. Such vessels can virtually sail against the window as shown in the illustrations.

Displacement

Displacement is the weight of the water which a vessel displaces when launched. In a merchant vessel it includes the weight of rigging and load when ready for service.

To make a vessel sail well she must have breadth in proportion to her length; something in the rates of 5 or 6 to 1. To cut her way through the water she must have a sharp bow below the waterline. The hollow wedge is the nearest form. She must also have clean lines aft, be cut away as the lines approach the stern. To carry sufficient canvas for fast sailing she must have either breath of beam or depth of hull. The vessel with broad beam and shallow Hull will sell fast before a strong wind, but to sail on a wind, must have a false keel or centre board to prevent careering and making great leeway.

This model is called a sloop contrasted with the deep hull and narrow beam, called a cutter. In the illustrations of the dictionaries the sloop and cutter appear exactly alike. Each has one mast and, ordinarily four sails. We now call the American model a sloop and English model a cutter. But it must be understood that the American model of hull, may be Schooner in rig. The illustration on the board represents cross sections of the two models. Both have the same displacement, the one in depth, the other in breadth.

Of the two models, the sloop model has the greatest stability but is necessarily a quick, jerky boat; the metacentre rises and falls rapidly as the boat careens; she rights herself suddenly at the least slacking of the wind, and is therefore not well adapted to a heavy or short sea. The Cutter, on the other hand, owing to the slight degree of change of the metacentre, is necessarily a much easier sea going boat. She will go almost on to her beams and with safety, and return easily and gradually, as soon as the squall slackens or the vessel is headed to the wind; hence the English cutter is admirably adapted for the short choppy seas and sudden squalls of English waters, while the sloop model, with the movable centre-board is as well adapted to American waters.

Sails.

In the early history of sail making the principle of construction that governed was the theory that the propelling power of the wind lay in the part of the sail that bagged, or, as sailors say, bellied. The more a sail presented the appearance of an inflated bag the more effective was it in driving power. Fore and aft sails were therefore made with the seams of the canvas broader at the bottom than the top, and the ropes of the luff were sewed on tightly while those of the leach were put on slack. The foot of those sails was also curved so that they hung lower in the centre than at clew or tack. The greatest peculiarity was the

cut of the jib, the luff or stay part of which was curved outward with the centre of the arc nearly opposite the clew. When roping the the sailmaker gathered in all the slack of the curve till the rope and sail were reduced to a straight line not longer than one drawn from the top of the sail to the tack, before it was roped.

Experience taught American seamen that the theory was fallacious; that when a vessel was sailing side to wind, the propelling power lay in the impingement of the wind on the flat surface of the sail. The swifter wind thus drawing, rather than driving the ship along. Another advantage derived from the flat sail was the ability of the vessel to sail with her head closer to the wind. The bellying jib would shake and spill the wind when near to it, while the flat jib continued to propel, when the vessel was one or two points nearer.

American sails are therefore cut to fit more accurately. The mainsail, with its foot straight from the tack to clew and sold with seems of uniform breath. When finished it is set with three sides firmly fixed; the head bent to the gaff, the forward leach fast to the hoops of the mast and the foot lashed to the boom. When fully set it is therefore flat as a board. The foresail is made to fit in the same way, and with a boom attached to the foot when necessary. While the luff of the jib is cut with the least curve consistent with its girding from clew to luff, it is often further improved by having the cloth along the foot correspond with the straight cloth of the leach, which gives strength to the centre while it aids in making the jib a flat sail, that kind of cuts will be seen in one of the reviews we have of the Gloriana. It is now known that it was the American cut of sail, rather than the hull and centreboard which enabled the schooner America to carry off the Queen's Cup.

Square sails do not require special cutting. But it may be stated that much importance is attached to fore and aft sails of the square rigged vessel. On the clipper ships we find many jibs because they are powerful under the propelling force in giving headway, with little influence in careening the ship. Like the raking masts, they are also claimed to exert a lifting power when the ship is under press of canvas and are the most effective sails in the maneuver of tacking. The number of jibs on a clipper ship is accounted for when it is considered that larger ones could not be firmly set and would be more difficult to furl or take in.

Sailing Against The Wind – Tacking

Tacking is the art of advancing by a series of angles toward the direction from which the wind blows. To accomplish that in the best manner the vessel must be sharp and deep at the bows, have a good hold on the water, yet cut through it easily and make little leeway. The English cutter and the American sloop or yacht with a centreboard possess these requisites. The former with her deep hull will hold well to the wind while the latter with her flat sails and centreboard will be nearest to it.

The average nearness is four points. Reference to the compass shows that a point separates eleven and one fourth degrees. Assuming that a vessel sails within four points to the wind she will make an angle with it of forty-five degrees. Changing her course, or tacking on the other stretch, she will then make a right angle, as shown by the illustration.

The distance that she will have to sail to reach a given point to windward is a simple calculation of the square root. A yacht three and a half points from the wind will traverse thirteen miles to make ten miles to windward, one sailing four points, will traverse the fourteen , one sailing four and a half points will traverse sixteen miles to make ten to windward.

Yachts

The yacht was originally used for state purposes, in transporting from place to place ambassadors and other officers of state. When not engaged in that service, yachts, like those of today, were used for purposes of recreation and pleasure. As such, laws have been enacted for the convenience of the owners, exempting the boats from custom-house entry. Until about the year 1870 the New York Club was the only one in which any pretensions were made to own and sail first class yachts. Then, there were some twenty steamers, one hundred schooner yachts and about three hundred sloops - - say 400 vessels and all. In 1884 there were one hundred and fifthy steam and yachts, two hundred and fifty schooners and four hundred sloops, with a host of small craft, making in all, about two thousand vessels. The official report of the present year gives 3891 yachts of the various clubs that join in the annual regattas in search of cups.

A marked improvement has taken place in the designing and construction of yachts, the drafting of sails, and in plans for spars and for ballesting. What was the result of the old rule of thumb and guesswork in the construction of the improved clippers and early yachts, is now in the achievement of engineering calculations. The ideas embodied in foreign models have all been tried and tested, and only those features adopted which have been found of mutual advantage. Take the American yacht, a vessel peculiarly fitted to the requirements of our large bays and shallow waters and, yet embodying in her design and rigging some of the best features of the English racing boat. True, the shallow hull, called by the English skippers “a skimming dish” has had to yield many points, till now, the racer presents the appearance of a happy medium between the broad and shallow boat of earlier years, and the deep cutter, which continues to be the favorite of the English yachtsmen.

Moderate beam and increased depth seem to be the present tendency of the American yacht. The results of study are also apparent in minor details. In ballesting for instance; paving stones and scrap iron have been replaced by lead and iron keels or, for inside ballast, iron or lead cast in forms to fit the framework of the bottom. Thus the centre of gravity has been lowered, making provision for an increased spread of canvas. Wire has superseded rope for standing rigging, giving to the masts greater stability and the stays increased rigidity. Various means have been resorted to tending to flatten the sails, when in use. Canvas is also specially manufactured, narrow in the web and for ordinary purposes, lighter than heretofore. Then, experience has taught the naval engineer that neither the idea that boat could fly over the water more easily than through it, nor its converse is entirely true. Experience has also shown that though a Baltimore clipper schooner may carry off an international prize in British waters, the deep cutter, is better adapted for the choppy seas of the Irish sea, St. Georges or the English channel.

Members of the club recollect reading of contest between Galatea an English, and the Mayflower, an American yacht and the victory achieved by the latter. The drawing shows a midship section of each and the extreme features of each type of racers. The vessels are nearly of the same length, the Mayflower being two feet the shorter, but in breadth of beam the difference is far more noticeable. Being broader of beam and constructed with a centre board she carries more sail for her length than her rival, and was therefore handicapped in the race by her being obliged to give the Galatea the inside track and a start of 38 seconds. The Galatea's lines show the conventional cutter, but not the curved keel which enables her to turn more quickly. But builders of both sides of the Atlantic seemed to agree more closely regarding certain features in the construction of racing boats. Among the most distinguished was the late Edward Burgess. The others are Fife of Scotland, Paine of Boston and Herreshoffs of Rhode Island, the designers and builders of the now famous yacht Gloriana. The following table will show how closely they came together.

Races compared

Of these boats the Gloriana carries the Palm. She is largely a new departure. Abnormal in length over all, yet normal in length of water line. The 25 feet of difference is divided between bow and stern, and is known as overhang, that at the stern being the greater and, in strict technical language the overhang.

The elongation of the hull necessitated new lines of structure with full and flaring bilge, thus increasing the carrying capacity; more ballast, more sail. Below the water, her lines are like the common type, easy and sharp; above them, there is no common resemblance. Your essayist has not seen this remarkable naval structure, nor could he procure drawings of the hull. However a fair conception can be had of the vessel by an examination of the photographs representing her under sail.

The chief points that have attracted attention seemed to be
1st The flaring sides which easily dispose of the water displaced by her hull.
2nd Increased length occasioned by immersion of the hull when careening under press of sail and a consequent increase of speed.

3d Immunity from deck-washing when in a heavy sea, the overhang giving her great buoyancy in such situations, and, as the surface water is less disturbed by the movement, her speed is increased.
4th Certainty insured to the action of the rudder when running free or before the wind, the formation of the bow not admitting of the displacement of much water, which in boats of the normal type thrusts the lee bow windward and necessitates a weather helm and consequent diminution of speed.
5th Promptness and ease in responding to the helm under all circumstances.
6th Facility in taking in sail, the result of the overhang which needs neither lengthy boom nor bowsprit, admits of the operations of making, taking in sail, reefing and furling to be performed with greater ease and safety.
7th Greater living space insured for officers and men and the combination of guests.
8th Increased safety in stormy weather.

From the hull, attention is directed to the rig and the sails; the mast has a graceful rake, the bowsprit and main boom little projection. The sails almost as flat as if board surfaces, the mainsail taut on the gaff, up in the throat and firmly lashed to the boom. The gaff topsail as firmly spread, the jib with its American cut, and diagonal seam from clew to stay, and a new attachment substituting a boom at the foot for completeness of spread, the jib topsail also firmly set to the breeze and a foresail with its right angled clew and its surface as flat as a floor.

It has been said that the present perfection of the world's naval merchant Marine is without doubt the outgrowth of experiences gained in the construction and handling of yachts, imagine the gain to shipbuilding and commerce from the improvements made in this yacht alone; In the Gloriana we have the swiftest of the sailors, the most graceful of sailing vessels and, the safest of yachts. In construction she is the glory of American naval architects and yachtsmen, and the most brilliant achievement in the history of shipbuilding and the evolution of the sailing vessel.

Richard Nelson

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