"THE AMERICAS CUP

The design evolution of the pure racing yacht

Rory O' Connell

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"THE AMERICAS CUP" - THE DESIGN EVOLUTION OF THE PURE RACING YACHT 1850 - 1987.

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SUBMITTED BY

RORY O'CONNELL

DEPARTMENT OF INDUSTRIAL DESIGN

FACULTY OF DESIGN

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INTRODUCTION

I aim to trace the developments from the 1850's to the 1980's of what is a true thoroughbred racing yacht - The Americas Cup Yacht.

The Americas Cup has always been a game that is played by the rich and for high stakes. Over the past 136 years gentlemen have come to blows over it, fortunes have been lost through it and diplomatic relations have been strained over it. However underneath all of this the Americas cup is just a yacht race, a yacht race that may be compared to a formula one motor racing grand prix.

The Americas Cup boat has changed from being a floating home, in the 1850's that were raced for wagers, to being nothing more than a shell that floats. This shell is a test ground for any new and innovative ideas that may make a boat go faster.

Design has changed, it is no longer a piece of guess work, designers nowdays do not carve halve hulls and go by the saying "if it looks right it must be right". Design has taken massive leaps forward still using models, but towing and testing them under the many different conditions they may encounter in real life. Computers are being used to design sails , boats and to do all the complicated stress analysis and more.

Early on in the Americas Cup in the 1930's navel architects began to get involved with aeronautical engineers and designers. Now most syndicates and countries have used either an aircraft companies

design computer or aircraft manufacturing technology to aid them in their bid to capture the cup.

New materials are constantly being tried out for the sail and hull, materials that have often been developed for space technology.

All these developments are being linked together to form boats that are so technically advanced that they are suited to nothing else only racing.

THE HISTORY OF THE CUP

The Americas Cup is the oldest international sporting trophy of its kind. The Royal Yacht Squadron had planned a series of races off Cowes to celebrate the great exhibition of 1851, and an invitation had been sent by the Earl of Wilton to the New York Yacht Club to compete in these races.

The Americans took their task very seriously and they formed a syndicate to organise and race a boat in England. The syndicate were determind to show their one time rulers that the yachtsmen of independant America could sail rings around those of their former mother country.

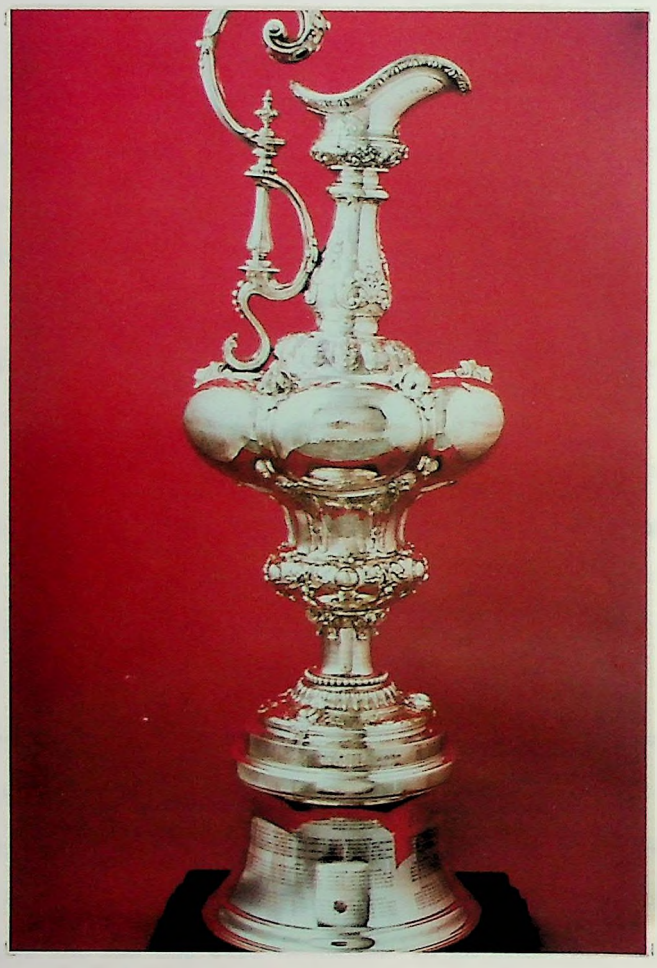
The American syndicate intended to recoup their costs on the building of the boat by wagering on the races. As in those days there was no system of handicapping, a winner could be picked easily and so a wager on the outcome of the races was always acceptable.

The syndicates yacht "America" set sail from America on 21st June 1851 with a crew of 13 bound for Europe. America made her first landfall in the French port of Le'Harve where she was pulled from the water and cleaned for the forthcoming races. The Americans then sent a message to the Royal Yacht Squadron giving the date of their expected arrival in Cowes. This polite move was nearly to cause the downfall of the syndicates plan to recoup their costs by wagering on the races. The British sent their fastest yacht out to welcome the yacht "America" and to escort her up the solent to Cowes. America easily beat the British yacht "Laverock" to Cowes. Immediately the news of the speed of the Americans boat circulated through the ranks of the British

yachtsmen, this news caused a total lack of interest in racing against "America" for money. Stevens the Americans syndicate leader offered to race any British boat for a purse of between 1,000 and 10,000 guineas, but he found no takers. This lack of interest and courage prompted the newspapers to write about the British sailors and yachtsmen relating to their lack of sportsmanship. These articles hit home to the yacht clubs and the yachtsmen of the Royal squadron. As the yacht club invited the yacht "America" to compete against a fleet of its yachts for an ordinary cup, a cup which was valued at 100 guineas and they were to race around the Isle of Wight.

On the appointed day of the race the 22nd August 1851, huge crowds turned out along the coastline to watch this historic race and a large fleet of spectators, over one hundred boats turned out to greet the competitors. Eighteen yachts entered the race, these yachts varied from schooners to cutters and ranged in weight from 47 tons to 393 tons. Three of these yachts dropped out before the start and the other fifteen rested along the start line at anchor. "America" crossed the starting line last, but one and half hours later "America" was reported to be in lead. There are no reports of the race until near the finish. It is reported that Queen Victoria sent the tender from the from the"Victoria and Albert" to see who was winning. Having returned and given the news that "America" was leading the Tender was sent to see who was coming second the reply was "Mam, there is no second". This sums up todays Americas Cup to a tee, the leading British boat had not yet come into sight. America won the race in ten hours and 37 minutes and the next boat home was "Aurora" which was nearly twenty minutes

(FIG 1)



The "Auld mug",the Americas cup the oldest sports trophy of its kind,a cup which gentlemen have come to blows over.

behind the Americans. The syndicate was presented with the cup which was to be known as the Americas Cup from then on.

After the race was finished the British yachtsmen came aboard "America" to try and find the secret of her speed. It is reported that the Marquis of Anglesy climbed out on the bow spirt of America to see her bow wave and concluded he had been sailing his yacht stern first for 20 years. Immediately discussions were started with designers to see what sort of a yacht could meet America on equal terms and defeat her. This was to be the start of the ongoing evolution of the Americas Cup boats.

The 1851 event set the seal on the cup as we see it today not only as in the challenge but for the controversy that usually surrounds the cup. For in the very first race a query followed the course taken by "America" had she taken a short cut by not going around the Nab Light and to this day recrimination between yacht clubs, millionaires and syndicates has become a hallmark of the event.

Six years after the cup had been won the surviving members of the "America" syndicate donated their prize to the New York Yacht Club on the understanding that any foreign yacht club be allowed to make a challenge for it. The conditions for a custodianship and challenges for the cup were contained in an elaborate deed of gift which read:

> "Any organised yacht club of a foreign country incorporated, patented or licenced by the Legistature Admiralty or other exclusive Department, having for its Annual Regatta an ocean water course on the sea or an arm of the sea or one which combines both, shall be entitled to the right of sailing a match

for this cup, with a yacht or vessel propelled by sails only and constructed in the country to which the challenge club belongs against a yacht or vessel constructed in the country of the club holding the Cup."

Parts of this deed still stand today, it was to be almost twenty years before the first challenge was to be mounted to regain the cup in 1870.

THE FIRST BOAT "AMERICA"

Up until the first invitation by the British to the Americans, racing yachts were fitted out below decks in the same way they left the launching bays. Here they had been originally designed to be a home away from home for the well off. The boats contained heavy victorian furniture, carpets and even potted plants. The sailors and yachtsmen were used to sailing in the manner in which they were used to living at home and so they paid little attention to trying to make the yachts lighter and faster by taking out some of the excess furniture carried aboard. The early yachtsmen did not bother to take their yachts out of the water to clena the undersides. So many of the early challenges had undersides that spawned weeds and barnecles, some of the early challenges were even grain swollen.

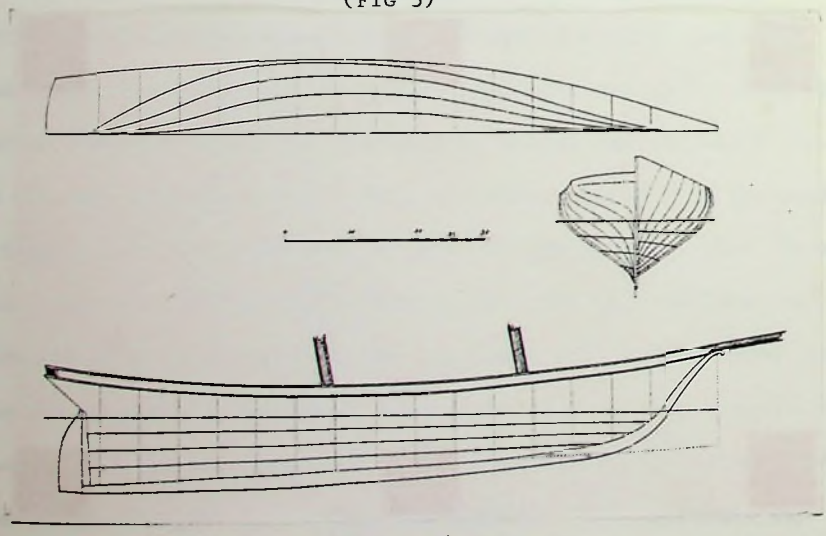
This was all to be changed by the challenge the Americans were mounting. The American syndicate wanted so badly to beat their old motherland they decided to build a boat specialy for the race, a boat which was to be specificaly designed for the conditions she was going to race in, yet she was still to have her luxury interior.

The yacht was to be built by William Brown a shipbuilder at East River and twelft at New York. The designer was George Stevens who presented himself as being the best designer around at the time. Stevens worked for Brown at the time, and the two of them got so involved in the challenge that Brown agreed to build the boat for $30,000 and that if the boat was not the fastest boat in New York the syndicate need not worry about paying him. The contract was signed and it was promised that the yacht "America" would be

(FIG 2)

A replica of the schooner "America" seen off Cowes in 1969,her raked stern and her long bow spirt may be clearly seen.

(FIG 3)



"AMERICAS" lines

launched by the 1st April 1851. But it was not until the 17th of May that she was ready for her first trials , she was tried against "Maria" a centre board sloop which was renowned for her speed in sheltered waters, but was said to be unsafe in the open sea. It was not surprising that "America" was well beaten by "Maria" so a new price of $20,000 was agreed.

"Americas" lines were never offically recorded though her certificate of registry included the fact that she was over one hundred and seventy tons. She is said to have been 93feet and 6 inches long, to have had a beam of 22 feet 6 inches, a mast that was 81 feet a foremast of 79 feet and she was able to carry 5263 square feet of sail.

The yacht "America" was startingly different in design to the British yachts which until this challenge had been considered to be the best in the world in both appearance and performance. The hull of "America" was based on the design of a pilot boat, she had a low sleek hull with a steeply raked bow and hull. This long hollow bow, for which "America" was to become famous, was built on the wave line principal. This had been derived by a Scottish Scientist John Scott Russell in 1848 for the 50 ton cutter "Mosquito" which was the fastest boat in her class. The hull of "America" also differed from other boats as she was built with a long fixed keel. She was rigged with two masts which were said to have been raked backwards at an alarming angle. On these two masts the Americans had better designed sails than the British. The Amercians had chosen a tightly woven sail cloth which was lashed taught to her

booms and masts, while the British still favoured loose woven sail cloth made of flax which were loose fitting at the booms and masts leaving wind through which meant the British boats were unable to point as high into the wind as the Americans. So big was the difference in the sails that one writer described the British sails as being "made by the sons of tent makers."

The British yachtsmen after being defeated looked for excuses and were unwilling to admit that they had been beaten by a better design. They said it was her iron hull or her suit of sails that gave her the speed, but there was no way they would admit that it was her hull shape that gave "America" her uncanny speed. This was to be the start of a design battle which still rages on to this day.

50 YEARS OF THE BIG BOATS

From 1870 to the 1890's the Americas Cup racing continued with the Americans consistantly winning. The challengers came and were defeated. At this stage of yacht racing a yacht was still a floating home and all that the owner would remove before racing was any loose object, like plants that may have broken during a race. Nobody could see the need to adopt what we would call today a more professional attitude towards the cup.

Around 1880, Watson, a designer is said to have read a paper at a navel architecture exhibition in Glasgow, from what he said then we may see how many of his ideas were correct. And we may even see that some of these ideas are still in use. Watson said "when we do arrive at the perfection of shape we can set to then and look out for better materials, the frames and beams then of my ideal ship shall be of aluminium the plating below the waterline of manganese bronze and the topsides of Aluminium, while I think it will be well to deck her too, with that lightest of metals as good yellow pine will soon be seen only in museums."

Watson was obviously aware of the importance of the use of new materials into yacht designs and his main thoughts centre around lightness, strength and speed. He is said to have looked at yacht design from what he called a flying fish point of view, a hull shape that would skim over the water rather than plough through it was bound to go faster.

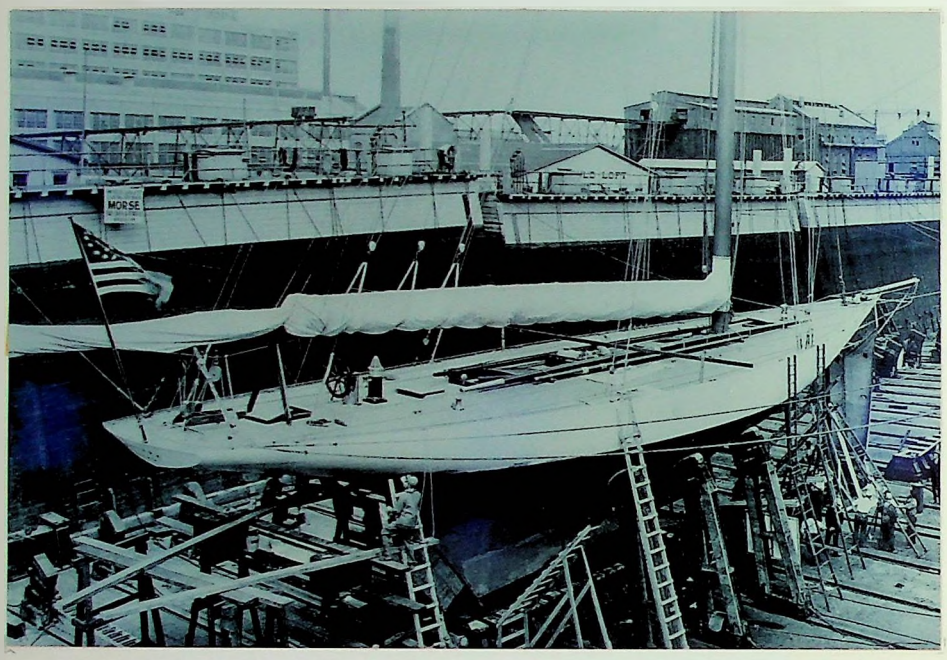
Another great designer of this era was Nathanial Green Herreshoff, a navel architect, shipbuilder and marine engineer. He along with

his brother formed Herreshoff Manufacturing and between them they devised a new way of building the boats. They started to build their boats upside down over moulds and used double skins stitched together with iron floors and knees.

Herreshoff was 42 when he designed "Gloriana" the first real racing yacht with radical design changes from her predecessors. "Gloriana" was not built for the Americas Cup but more as a prototype for the cup boats. This was the first time that a boat had been used as a test boat for new ideas before building a real challenger. "Gloraia" had a fin keel a relativly new development having only been used on one boat before this occasion. She had a short waterline length with a huge sail area and a very long overhanging bow and counter which were to become winning features on many winning yachts. Herreshoff after abolishing the straight stems and long keels was the first to recognise that just by increasing the sail area and using a fin keel was not going to maximise the speed of boats. Herreshoff designed the boats to be lighter and also looked into the way boats were built. He noticed what the effect of the rough hewn planks, which often caused fouling had on the speed of the boats.

Herreshoff decided that his ideal boat would have less displacement, less resistance and a more stable hull, along with this, to get rid of heavy wood decking and steel frames and dispose of all the interior comforts that were not necessary for racing. He would then increase the effeciency of the blocks and tackle, put more sail area on the yacht and then the boat was bound to be faster than any before he concluded.

(FIG 4)



"Resolute" one of the last of the big boats,seen here in dry dock,being fitted out before her sea trials.

In 1895 Herreshoff designed "Defender" for the Americas Cup defence. "Defender" was 133 feet in length with a waterline length of 80 feet. She had a draft of nearly 20 feet. Herreshoff had the hull below the waterline built of bronze plate while all the topsides were of aluminium. He had now built the boat he thought would move much faster. The "Challenger" was heavier and over 6 feet longer.

This was one of the first real large boats but not the largest, this honour goes to "Reliance" the 1903 defender of the cup. "Reliance" was also designed by Herreshoff with the aid of a model. The initial model was actualy based on "Defender" and Herreshoff carved a half model for "Reliance" and this he used to judge if anything was wrong with the shape by the feel of the model, in fact he used to do what a computer in a modern towing tank does today. "Reliance" was based on the same waterline and draft length but was over 10 feet longer measuring a massive 148 feet long. The hull was built entirly out of steel and had topplates that were said to have been only half the thickness of modern 12 metre yachts. She carried a mast that was over 200 feet tall.

These were the days when rigs got bigger and bigger, designers were cramming more and more sail area onto boats then ever before. These rigs were positivly dangerous as people did not know how much stress they could take. The harnessing of wind power became the designers nightmare as only a few of these machines were able to sail anything other than calm inshore waters.

Leading up to the 1920's the gaff rig was to give way to the Bermudan rig, this new rig had a taller mast which required a

(FIG 5)

The Gaff rig seen in the background was to give way to the Bermudan or Marconi rig in the 1920s. The Marconi rig in the foreground got its name from its complicated rigging system.

rigging system, which made the mast look like a marconi radio wireless station. So these rigs were nicknamed Marconi rigs. These taller masts meant a higher aspect sail plan could be developed which in turn lead to a shorter boom. The shorter the booms got meant a permenant backstay could be erected which lead to easier handling of the yachts and this in turn meant that less crew were needed.

As in all aspects of life the application of what was then modern technology caused unemployment as the boats no longer needed a crew of fifty or sixty sailors.

THE J CLASS BOATS

Following the First World War the big boats had become too expensive to race and the deed of gift was altered to suit the slightly smaller sized boats of the J class. This was first put into force in 1930 when all yachts competing had to conform to Lloyds scantling rules. This meant that for the first time since in the history of the cup, both the challenger and the defender would be built to conform to the same rules.

The J class was a universal American sailing rule, it was for boats between 76 feet and 87 feet at the waterline. This rating had nothing to do with the actual waterline, but was derived from an equation as are the boat lengths today. The J class yachts were huge, being up to a 120 feet long and carrying masts that were up to 20 stories high and needed 20 to 30 men to crew them. The racing was also changed from New York harbour to New Port, Rhode Island where it is held to this day.

The first of the J class clashes was in 1930 between the American "Enterprise" and the Northern Island "Shamrock V". "Shamrock V" had no real new innovations when compared to "Enterprise".

"Enterprise" had three new innovations. The first of these was the manager Harold S. Vanderbilt. He treated the competition in a manner more suited to todays competition then a competition in the 1930's. The whole "Enterprise" show was one of complete professionlism. So much so that it is said that he made the British boat look like a team of talented amateurs.

(FIG 6)

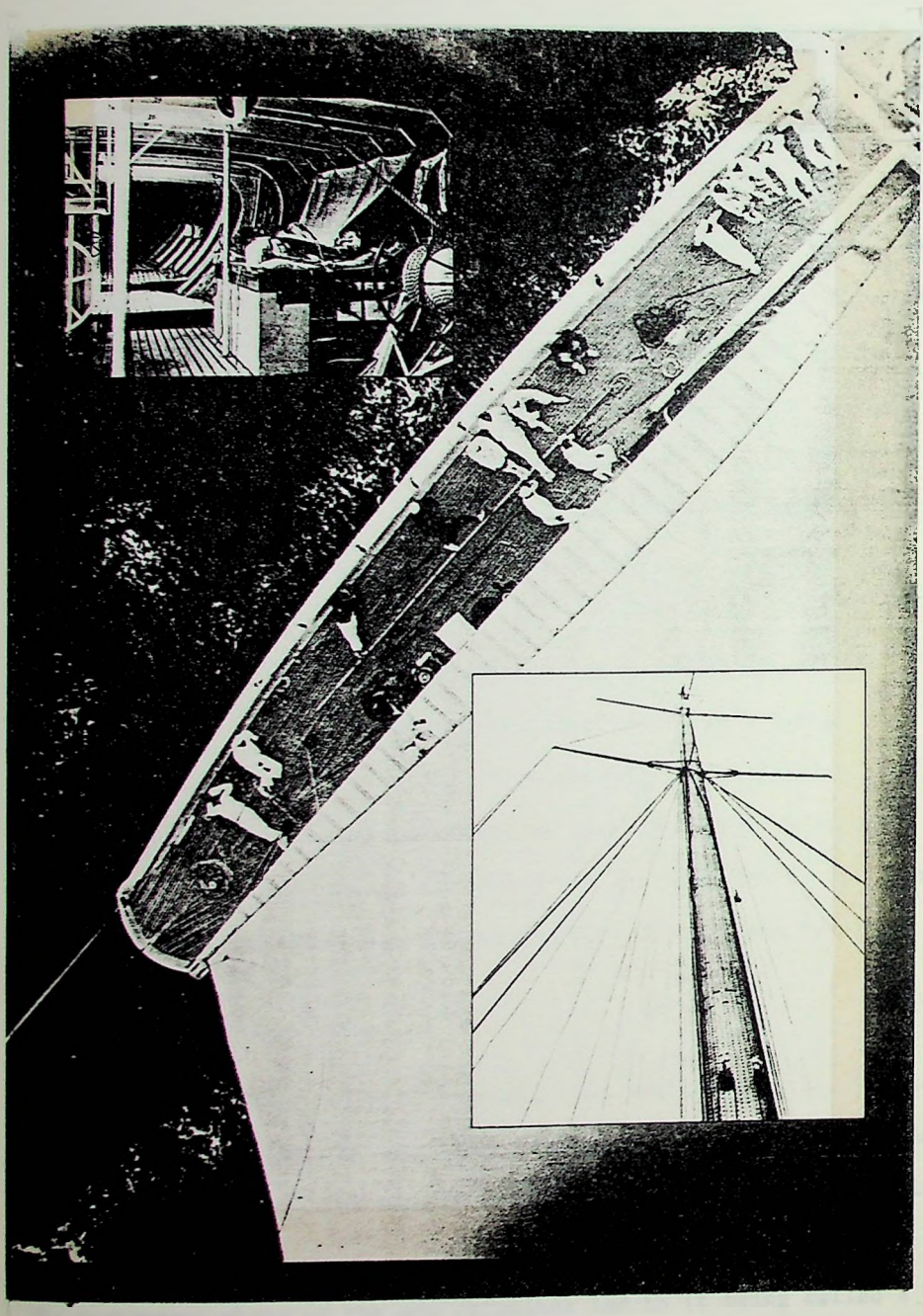
The J class boat "Shamrock V" (foreground)seen racing in the Solent.

The most important design development the Americans had was in their mast. "Enterprise" had started off the season with a normal hollow mast which weighed in the region of around 6000 lbs and rose to a height of 150 feet above deck level. This mast would have been the same type that the challenger "Shamrock V" used. At the start of the season "Enterprise" did not fare to well at a few regattas. This prompted the owners to do some further design work on the boat. Starling Burgess, the designer, the son of Edward Burgess an accomplished aircraft designer, asked his brother Charles who was a designer for 12 years in the Airship Design section of the Navy, to design him a light weight mast. Here Charles was able to apply mathematical theories developed for designing aircraft structures to the design of masts and spars for yachts.

The mast he came up with was twelve sided and was made of two shells of duralumin which were held together by no fewer than 80,000 rivits. The great bonus was that this mast weighed only 4000 lbs. A full 2000 lbs lighter than "Shamrock V's " mast. To give the mast sufficent play it was stepped in a quicksilver type liquid. The mast was often referred to as a miracle mast, a miracle that it stayed up, but stay up it did and from the moment the mast was stepped in the boat her performance was improved and she began to win races.

The development of the duralumin mast represented a step forward in yacht design that has been used and furthered to this day. It was the first liason between yacht designers and aircraft designers. As fast as yacht design developed so did aircraft design, so much so that yacht designers are aided by space technology today.

(FIG 7)



The park avenue boom as seen from the top of the mast of "Enterprise"

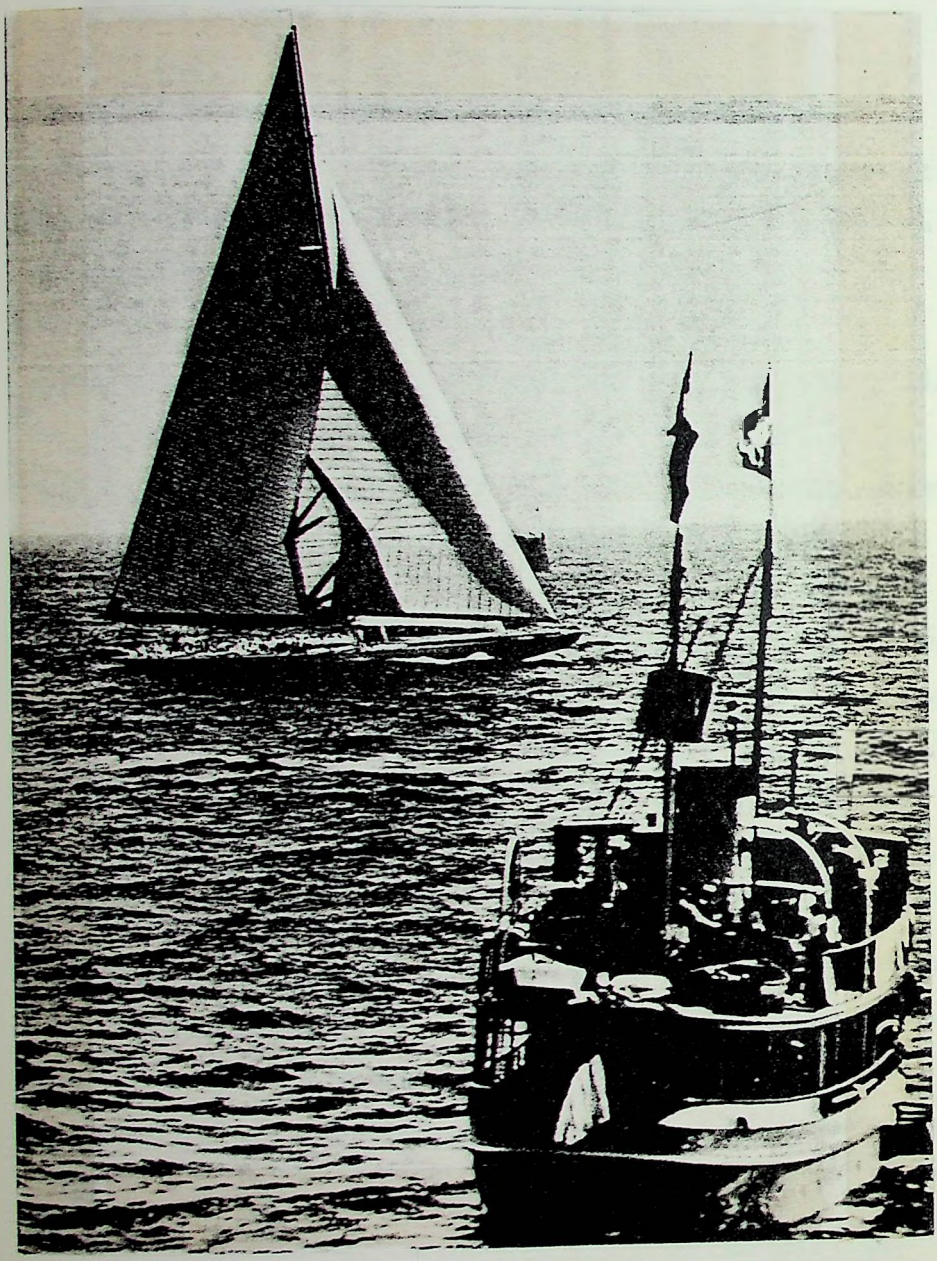
(FIG 8)(insert) The Duralumin mast which was held together by 80,000 rivits

The other development "Enterprise" had over "Shamrock V" was her boom. "Enterprise" sported a boom triangular in section which was 4 feet wide at its widest point. This boom enabled the foot of the main sail to be altered by a series of transverse tracks which could be moved to form an efficient camber by adjusting the stops on the slides. The holes and stops on the tracks were then coloured so that the most efficient camber for different wind conditions could be recorded and set with ease the next time those same conditions arose. This piece of huge ungainly, but very useful, equipment got named the Park Avenue Boom from the fact that two men could quite comfortably link arms and walk down the length of the boom side by side.

In 1934 it was Vanderbilts "Rainbow" against Sopwiths "Endeavour". "Endeavour" was one of the first boats that was to be totally stripped out below decks to race. Upon arrival in the States Sopwith ordered much to the amazement of his crew, everything that was not necessary for racing, including his own bathtub, to be taken out of the boat. He had also copied the Park Avenue Boom for this challenge.

Sopwith had also done a lot of research into sail designs and produced no fewer than two types of new sails. He produced a parachute spinniker, which was a more full round symetrical sail than the already existing triangular spinniker and this proved much better on downwind legs. The curvateous shape of the new spinniker led to it being called a "Mae West" sail. The second new sail that Sopwith introduced was the Quadrilaterial Jib. This was a Jib (foresail) with four sides as opposed to the normal triangular jib. This let more sail area to be

(FIG 9)



The Quadrilateral jib (foresail) was one of Sopwiths new sail designs.

set and still remain relativly easy to control.

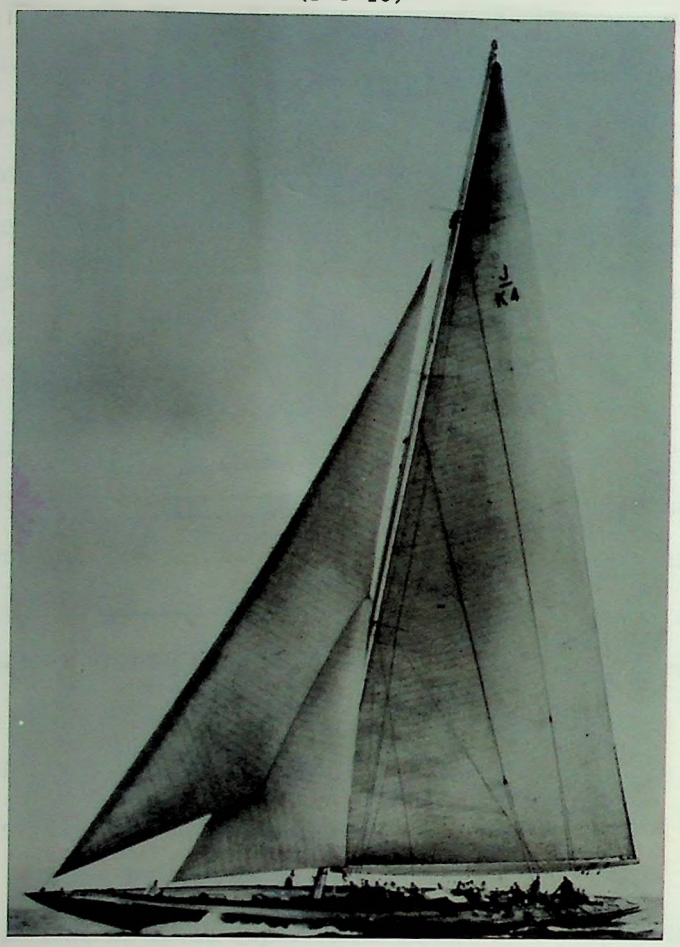
Instruments and guages other than compass were introduced for the first time by Sopwith. "Endeavour" had five jib topsails which all had strain gauges fitted on deck so that the crew could keep an eye on overloading of the masts and sails.

Sopwith also built his hull from steel plate on 74 ring frames, this was one of the reasons the Americans gave for losing the first two races on the 1934 series.The American defender was basically a newer version of "Enterprise" with very few modifications.

The 1937 series, which was to be the last of the J class racing series, was raced between "Endeavour" and "Ranger". By this time yacht design was no longer a seat of the pants affair. Designers had started using towing tanks. Tanks had been used before but the methods required very large expensive models and the results were not relied upon by the designer of the time. New tank testing methods using smaller models were being developed by Professor Kenneth Davidson. This method was proving cheaper and more reliable. The new method enabled lateral forces of different wind strengths to be applied to the model, in addition to the normal forward thrust, resulting in different angles of heel. Davidson also was the first to compare results of new boat designs with older designs. He used models of "Rainbow" and "Endeavour" against models of new boat designs.

The Americans had now two designers working on their new boat, Burgess and Stevens. They tank tested four models and picked one, this was

(FIG 10)



"Endeavour" one of the first yachts to win a race

(FIG 11)

The hull of "Endeavour" just after being launched.Her sheer size may be clearly seen in relation to the people on board.

to be "Ranger". "Ranger" was a very ugly looking boat compared to existing boats, she a very ugly bulbous bow and a flattened stern features that were to be a major contribution to her incredible speed. The two designers worked to try and improve the appearance of "Ranger" without affecting her performance. Even though "Ranger" was often described as an ugly ship her speed left little doubt that she was in her own time a state of the art design.

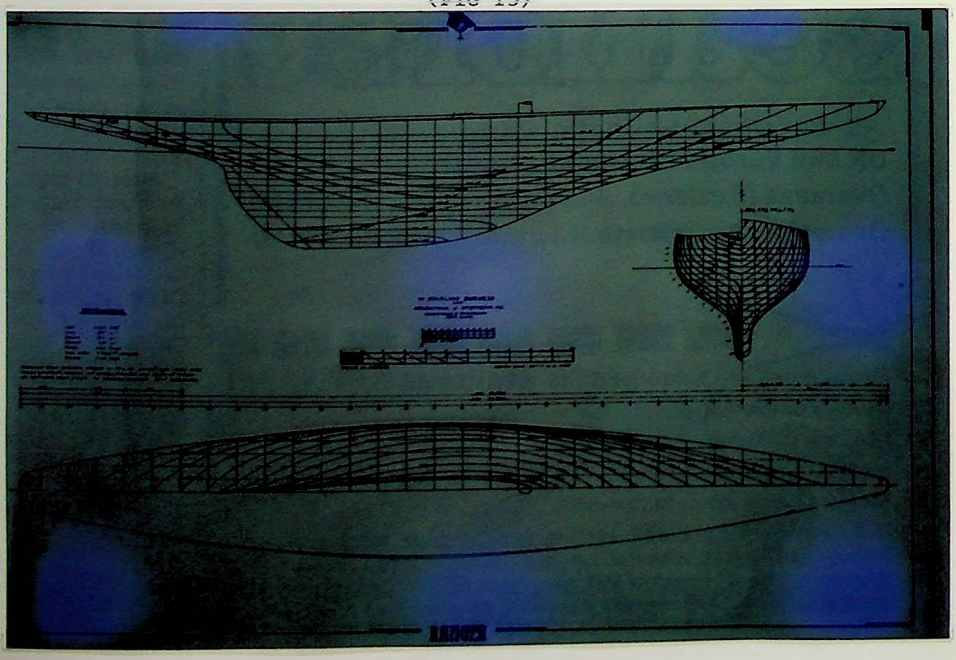
The hull of "Ranger" was constructed entirely of steel plate which were flush rivited by the Bath Iron Works in Maine. The mast, the boom and the spinniker pole were all made in Duralumin and had bar riggings. These spars lightened the boat considerably. "Ranger" also pioneered a new sail cloth for her sails, using a lightweight cotton canvas for all of her 7,546 square feet of sail. These features along with Oiln Stevens and his brother Rod aboard in the aft guard made "Ranger" unbeatable.

Three of four of these magnificent yachts have been refurbished and are seen sailing today. One may say that these were the last giants of sail and indeed one of the giant steps forward in the design of pure racing yachts.

(FIG 12)

"Ranger" under going her sea trials

(FIG 13)



"Rangers" lines

THE INTRODUCTION OF 12m YACHTS

After the Second World War by which time the majority of the J class had been melted down or left to rot away, the New York Yacht Club elected to choose a new class of boat to sail for the cup. Many classes were looked at and rejected. The 12m class was chosen many say because when viewed from a respectable distance the twelves looked as glamorous as the J class and the older classes.

The twelve metre was a class that was already in existance, a boat had been developed from a rule to encourage inexpensive yacht racing for the less well off. However the introduction of the twelves to the Americas Cup was soon to put an end to this inexpensive yacht racing.

Then in 1956 the United States supreme court allowed changes in the 1887 Deed of Gift of the cup, the changes included the reduction of the waterline from 85 feet to 45 feet and more importantly it no longer required the challenger to cross the Atlantic by her own power. This enabled the already existing twelves to be shipped out rather than be fitted out for transatlantic voyages, thus all these boats needed to be were bare hulls.

The first challenge after the war was in 1958 and it was again between America and England. The first challenge lacked the glamour of the big boats, the glamour of the backdrop and skyscrapers and also the large spectator fleet that used to be seen before.

In 1958 the British challenger, a wooden hulled 12m, faced "Columbia", a brand new 12m, owned by the New York yacht club commodore Henry Sears. 12m boats were very evenly matched at this time so much so that the New York yacht club had to keep its selection trail going much longer than they had expected in order for "Columbia" to beat "Vim" a 12m that was almost 20 years old.

The main innovation the Americans had over the British was in materials, sailcloth. The Americans had developed a new material called Dacron, which enabled the Americans to build lighter stronger sails. These sails were able to hold a much smoother camber in light winds and they had one more very important factor, they were much more water resistant than canvas sails. This very important factor meant no sagging of the sail so they held a better shape in wet conditions, without gaining much weight during a race. These sails helped the Americans to a 4/0 win in this series.

The English boat "Sceptre" had one new design innovation, a huge open cockpit at the centre of the boat. This enabled the sailors and the winchs to be kept at a much lower level and thus be used as ballast. This was later to be outlawed by a rule change as it was considered dangerous.

In 1962 another country entered the race, in a bid to win the cup from the Americans, Australia. The Australians took a very serious approach to their attempts to lift the cup from its pedestal in the New York Yacht Club.

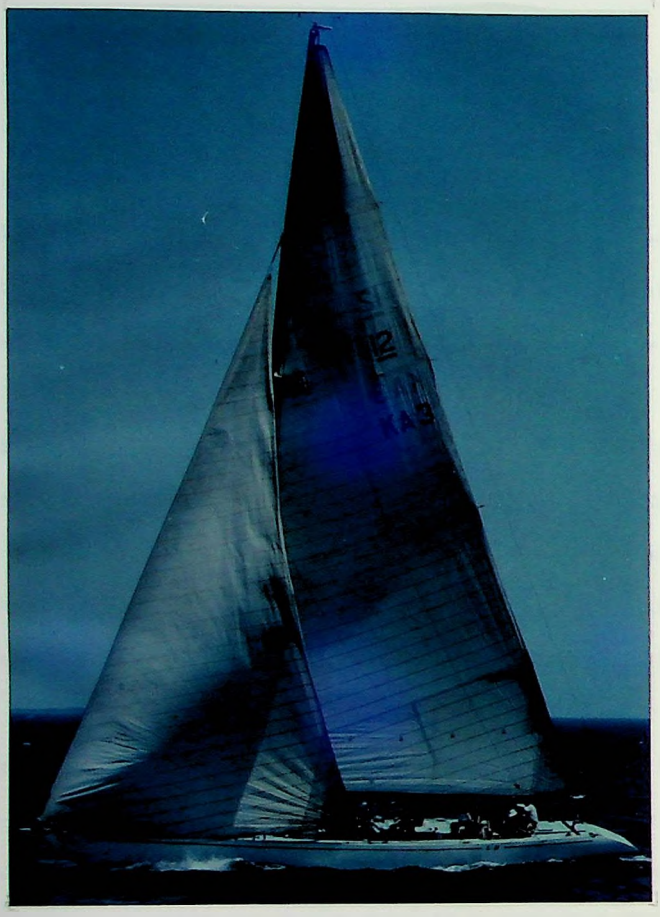
They had learned early on from the Americans the values of racing against existing boats . They trained their crew in existing boats like "Vim" while Navel architects were busy working at the testtank. This was one of the first times a true attack was to be made on the cup. It also meant the crew could be trained before the boat was even ready, providing an added time bonus.

The Americans keen to bring the competition back to its pre-war success seemed to be bending over backwards to help the Australians. The New York Yacht Club bent the rules to allow some material and equipment to be used although manufactured outside of Australia. They even let them import the best Honduras mahogeny along with some spar extrusion from the United States. These extrusions were then welded and tapered to exactness by De Havilland the Australian Aircraft company.

As a result of all this cooperation the Australians "Gretal" was tank tested against the defender "Weatherly" she was found to be faster in a breeze. The Australians also had an innovation which enabled them to tack their boat much faster. "Gretal" had a linked set of coffee grinder winches. This consisted of the two main drum winchs being connected to a central pedestal, this could be worked by two or four men which enabled the sails to be winched in much faster. With these new innovations the Australians won one of the races, the first time since the 1930's.

Soon after this defense the Americans changed the Deed of Gift to block any further cooperation from the Americans, this effectivly blocked sail technology, deck equipment, all were outlawed to any challengers. This rule change proved important in the evolution of

(FIG 14)



"Gretal"

Navel architecture and technology as it meant that challenging countries had to develope their own technology in order to remain competitive. The Americans now decided also to only accept challenges every 3 years.

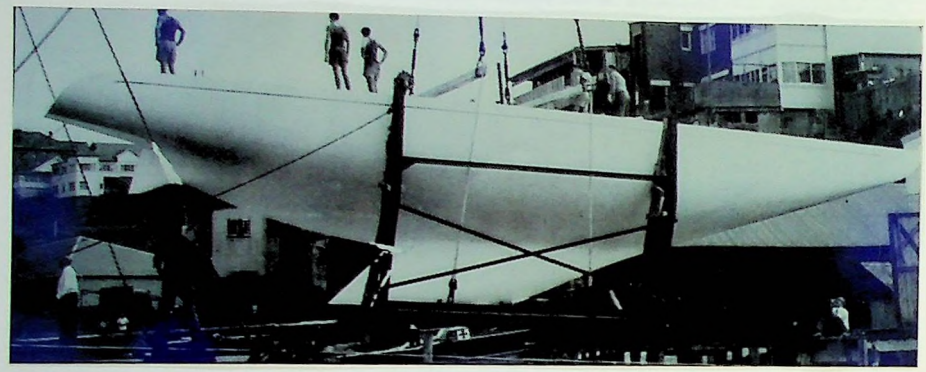
It was in 1964 that De Saix, a navel architect found that by attaching pieces of thread to the underside of his hulls for tank testing he could study the laminar flow and the under water bustle. Watching these pieces of thread he was able to chop and change models until the best results were found. His designs of 1964 had fuller aft sections which minimised the disturbance of laminar flow.

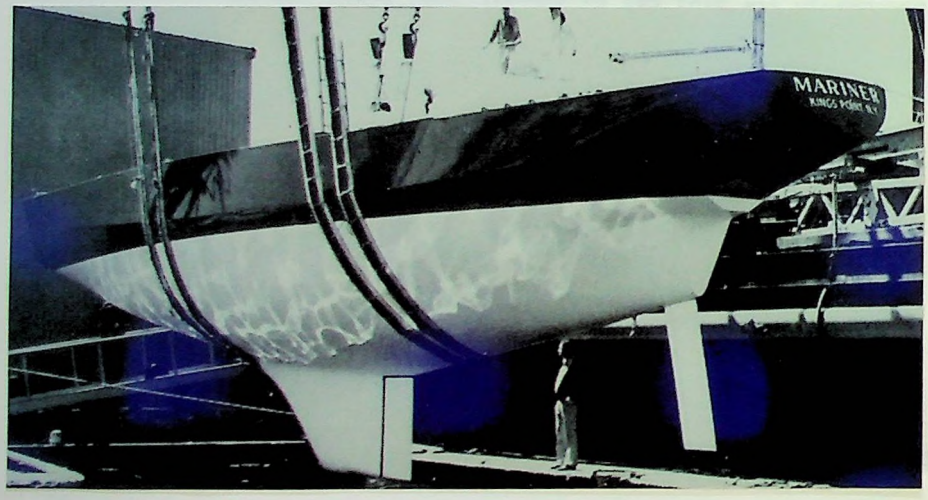
The next major design change was in 1967, the hull sported a seperate rudder and keel. This was supposed to give greater lateral resistance and it also allowed an additional rudder or trim tab to be fitted on the keel. This is a design feature and area into which much design work was soon to concentrated.

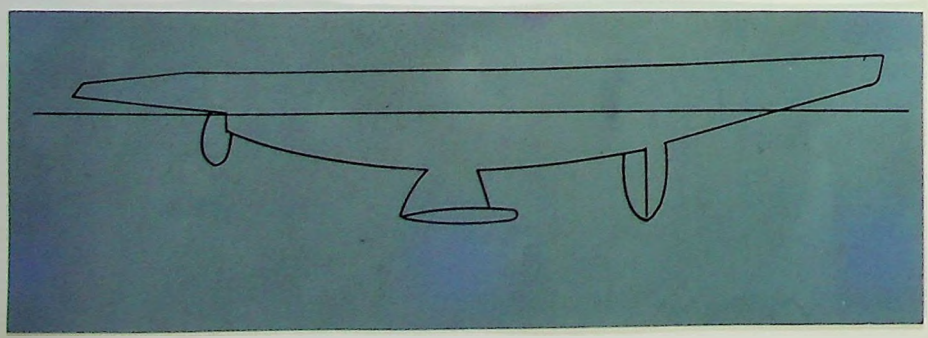
The British attempted to find sail cloth similar to dacron and came up with a fabric called "Kadron", which after initial laboratory tests seemed to be as effective if not more effective than dacron. However as soon as sails were cut from it and tested it showed to be totally useless.

Over the next few years there were no major design changes or innovations until the rules were altered to allow the twelves to be made out of aluminium. This enabled the hulls to be made up to 15% lighter and also much stiffer which allowed them to travel faster.

(FIG 15)







The evolution of the hull shape to today

The 15% weight that was lost by using aluminium could then be added to the ballast without receiving any penalty as the boat would still conform to the twelve metre rule.

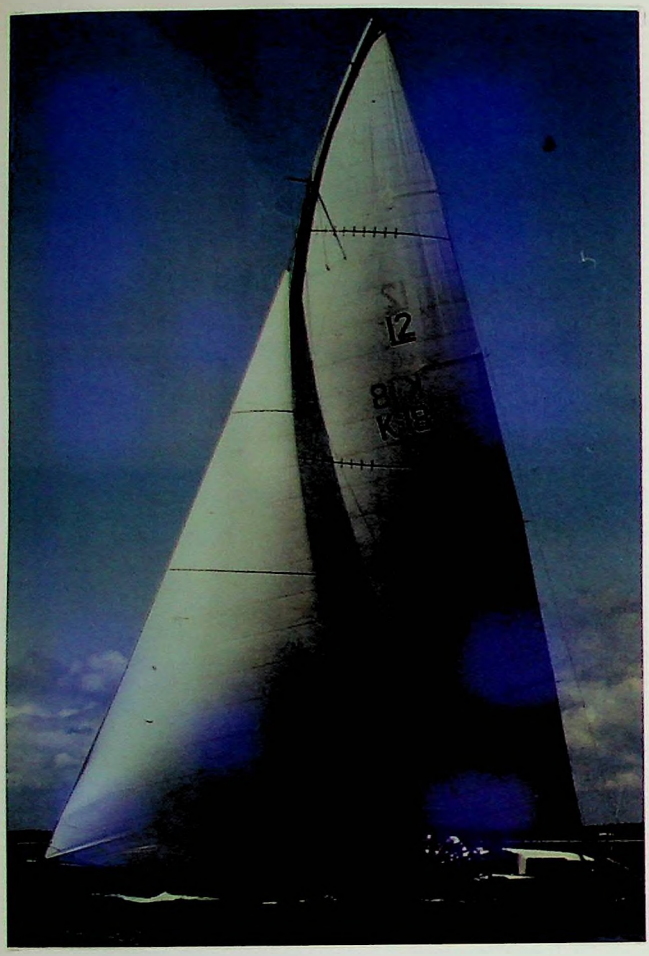
Throughout the seventies on-board computers started to surface on many of the boats. These were there to aid the tactitians. The computers could have the tidal and current affect programmed into them, then along with the information received from the log (speed and distance), the elapsed time, tacking angles, etc. The computer could calculate the optimum sailing angles, lay lines to marks and even suggest possible tactics based on other match race situations.

By 1977 the rules had again been changed to say that all winchs had to be on the deck and not below with a lower centre of gravity as they had been before.

1980-87 A QUANTUM LEAP

In the 1980 Americas Cup challenge, the challengers were starting to grow with four boats fighting for the challengers position. At this stage the challengers could take one of two philosophies to win the cup. They could opt for an evolutionary yacht or a revolutionary yacht. Taking the evolutionary line one opts for a conventional yacht, say a previous winner with some very small alterations done to it. This is what the Australians had done along with Ben Lexcen, a designer soon to become famous, modifying the yachts underwater configurations.

The British on the otherhand eager as ever to retrieve the cup choose the revolutionary line. The British syndicate, led by Tony Boyden developed along with Procter, a revolutionary new mast. Reading heavily into the rules they had found an area which left a gap wide open for them. According to the rule the mast height is measured by a straight vertical line from the deck upwards. The British developed a bendy top mast and by having a permanent bend at the top of the mast "Lion Heart" gained sail area ahead of this vertical line, added to this the sail area aft of the mast had a large curve of sail to give even more sail area. This larger sail should have given more potential speed. However any advantage the British had was outweighed by in camp arguments and shortage of funds. When Australia won the right to challenge for the cup they decided to copy the bendy top mast idea. Lexcen and the designers of the Australian syndicate worked frantically to prepare a bendy top mast for Australia. They were to be rewarded, they narrowly missed winning an early ract when the time limit elapsed and they



(FIG 16) The British developed a new bendy topped mast which enabled them to set more sail without any penalty.

(FIG 17)Masts may now only be bent by the pressure exerted by hydraulic backstay.

succeeded in winning another. The mast had proved its point, and was seen as a race winner. The New York Yacht Club, the rule makers, legistated against such a mast and so they are not seen around today. One may see however straight masts bent in a curve by Hydraulic Pressure on the backstay.

In 1981 Ben Lexcen, Australias designer went to Holland with the permission of the New York Yacht Club to test some ideas using the facilities of the Netherlands ship model basin. This was to prove a vital testing ground for Lexcen, as here he was able to test models up to 24 feet in length as opposed to 8 feet models and this enabled him to get much more accurate results. He tested a rather conventional boat first and then with time to spare Lexcen was able to test a variety of his winged keels. The tests proved spectacular. The winged keel was devised after studying the performance of the Lear Executive Jet Plane. What Lexcen had done was to build a light boat and put the ballast that gives boats there stability, where it was most effective - right down low at the bottom of the keel in the form of lead wings. As the keel of a yacht works in water the same as sails do in air, creating lift and also stability, Lexcens keel was unique in that it provided more lift and more stability for the same weight than a conventional keel. This keel also made the yacht more manoverable, along with getting rid of some of the turbulence caused by a conventional keel. Maybe the most important and overlooked factor was that the news of the keel may have caused the Americans to panic and lose the cup.

This boat "Australia Two" became the new bench mark of 1983 and in the 1986 series all but one of the seventeen boats were to carry a variation of the winged keel.

(FIG 18)

"Australia II" was to set the design evolution rolling again when her winged keel was unvieled.

In the plans to regain the Americas Cup the challenging syndicate enlisted such names as Boeing, Ciba Gigy, Grumann, NASA and the University of Maryland to name but a few. This list of names sounded more like a design team for a star wars project than an Americas Cup Challenge. The 1986 Americas Cup challange had many innovative and new concepts.

The English had both a conservative yacht and a revolutionary challenger. The British had chosen David Hollom who specialises in model yacht design, to design a boat. The boat "White Horse" challenge is basicaly the same above deck as a conventional twelve metre but her shape beneath the water is radically different. She has a bulbous underneath shape which lead to the boat being called the "Hippo". After the trials she was left behind maybe because the crew did not know how to sail this boat at its best.

The most innovative and daring of all the challenges was "U.S.A." by Blackaller. Her slender body did not carry a version of Lexcens winged keel, but had instead a torpedo shaped bulb suspended from a slender strut and was known as the Geek. Because of this shaped keel she had very little latheral resistance so the designers of "U.S.A." had added a forward "fin" which acted like a combination rudder and centre board.

The radical keel shape and steering mechanism made it very hard for Blackallar to keep the boat tracking all the time and so "U.S.A." tended to go in fits and starts. The explanation was that in the heavy lumpy seas off Freemantle, whenever the bow raised up over a wave a

(FIG 19)

(FIG 20)

Hippo the British designed revolutionary boat.

substantial part of the forward fin/rudder was lifted clear of the water and the little latheral resistance the boat had was gone. This caused the boat to lurch sideways by as much as 3 or 4 feet at a time. Before the semi finals they thought they had cured the problem as Lockheed had fitted a new steering mechanism. This however did not solve the problem.

Alterations and radical changes during the competition were to become common place. "Heart of America" seemed to have an original keel, for throughout the competition, the wing expanded with the additions of winglets, then smaller winglets and finally tiplets on top of these winglets. Other boats had bow chopped off and rebuilt over night.

The two French syndicates used a French government backed Aerospace report from a research programme to develope their own new sail cloths. This cloth had originally been developed in the research for a space probe. Kevlar another new sail cloth was begining to be used on most sails, however if the sails were left to flap they became useless. Some sailmakers developed a lattice pattern of reinforcement across the stress lines to limit the fibre deterioration caused by the continous flexing on the material. These sails almost mirrored the three dimensional stress analysis maps which were now being generated on computer.

Along with the sail development each syndicate spent hours trying to find the optimum shape for each type of wind speed. Matching that shape exactly, the next time those conditions prevailed.

(FIG 21)

"U.S.A" The most radical design innovations since the winged keel.Her forward rudder/fin may be seen through the water.

Kevin Parrys taskforce of '87 developed a unique digitised system of video cameras to provide a continous record of sail shape. There were four cameras, one at the mast head, two set at either side of the hounds and the other sealed into the deck of the boat. These cameras were focused on three broad black "shape" strips which traversed each sail horizontaly. By analysing the test data they were able to build up a data base of optimum shapes which could be stored in graph form within the computer on board. These images could be called up to provide a visible overlay to the live video pictures in the cockpit and the sail trimmers were able to match up the black lines.

The other new departure in this series was the New Zealand yacht "Kiwi Magic KZ7". This yacht designed by Ron Holland, Laurie Davidson and Bruce Farr. Most of these designers were at home with fibre glass and New Zealands boat builders are renowned for their expertise in fibre glass boat building techniques.

The designers from New Zealand said that most other 12m designers did not have fibre glass experience, yet it was natural for Farr, Holland and Davidson to design the boats in Fibre glass. The advantages to be seen in making the hull in fibre glass were,a much fairer hull shape could be moulded which would not dent and more importantly it would not flex as much as an aluminium hull going through the water. It remains the shape moulded.

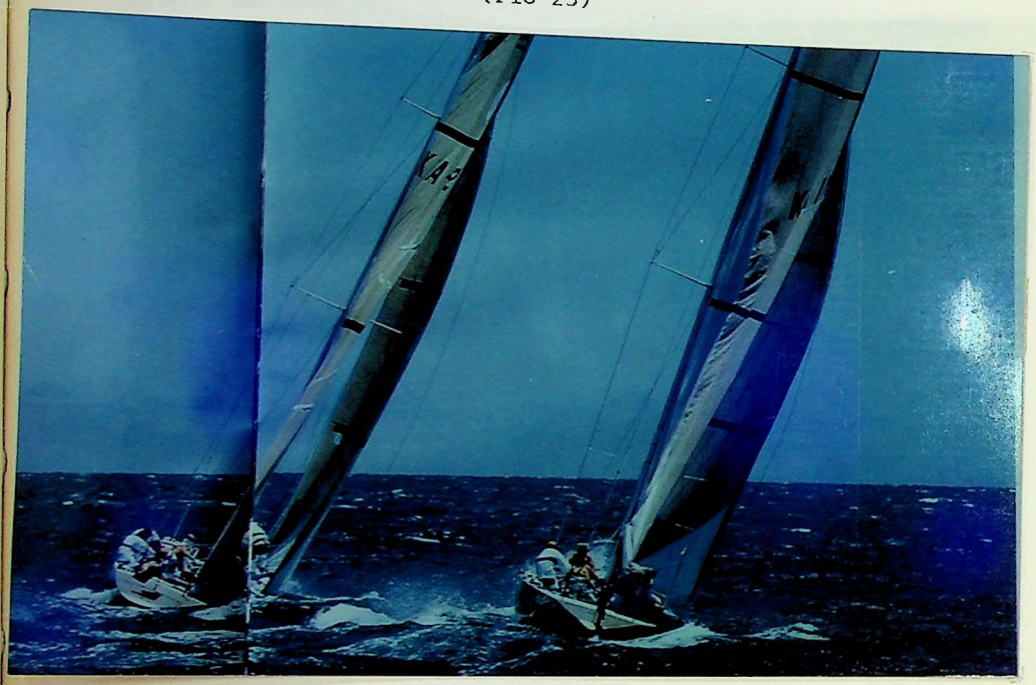
The boats still had to comply with Lloyds scantling rules. A Lloyds surveyor was on hand to supervise all the laminating to ensure no corners were cut. This new boat had to be perfect as it was bound to cause some up roar - but that is the Americas Cup !

(FIG 22)

Tape sails

The use of tape along the strees line in sails may be clearly seen in the photograph. These tape sails often looked the exact same as the computer generated strees analysis.

(FIG 23)



Kevin Parrys syndicate used a system of digitised video cameras focused on a set of black "shape" lines to record and set optimum sail shapes.

WHERE TO NEXT

The amount of technology and money that was spent on the defence of the cup in 1986,over $200 million,made it seem like a nautical arms race.The amount of money needed to campaign a boat for the cup will not stop developments as the Americas cup has developed into a massive publicity platform.The Americas cup has reached a stage,with so much development and technology,that people are wondering when it is going to become not just a yacht race.Today with the involvment of so many aircraft companies,space agencies and computer companies,it is starting to slip away from being just a yacht race.All this aircraft technology has lead to boats becomming more difficult to steer and keep in the groove,so much so that it lead Tommy Blackaller to compare steering his boat "U.S.A" to flying his plane.

Is it all eventually going to lead to a computer battle.boats and equipment are being designed by computer,sails are being set with the aid of a computer,tactics are being decided by a computer,and the helmsman is being advised by computers.Is this all going to lead to the Americas cup being fought out on a computer battle ground ?

With all these developments tafing place one wonders where this is leading to or where it is going to stop.

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