THE GRAND OLD MAN OF NAVIGATION

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If the captain of the ships in which Saint Paul was wrecked on Malta had come back to earth in 1730 he would have felt very much at home. Navigation methods would have scarcely changed in 1650 years. Had he come back half a century later, however, the art and science of navigation would have changed out of all recognition. The marine sextant, unchanged in its essentials today, was demonstrated in 1731. Just two centuries ago the Nautical Almanac was first published, giving sea captains the means, together with their sextants, of doing serious celestial navigation. By 1770 the Harrison chronometer was in use. In the first third of the 19th century the Sumner method of plotting celestial position lines was introduced. Except for minor details, marine navigation, and to a very large extent air navigation as well, remained the same from then until the Nineteen-Thirties.

The Thirties began a period of revolutionary changes in navigation. Foremost among those responsible for these improvements is Captain Philip Van Horn Weems, U.S. Navy (Retired). Weems, born in 1889 and orphaned as a child, grew up on a Tennessee farm, with his six brothers and one sister worked themselves after their widowed mother died. In 1908, after a year at a prep school, he entered the U.S. Naval Academy, where he sailed on the last cruise of the Navy's square-rigged sailing ship Hartford. During his student days he began his love affair with the stars which lasted the rest of his life. After he graduated in 1912, he specialized in navigation, especially celestial navigation, practicing it at sea and instructing midshipmen in Annapolis classrooms.

When Weems first used his "hambone" sextant aboard the ships of the pre-World-War-I fleet, he used the American Nautical Almanac, which still contained tables for the solution of longitude by means of lunar distances. First published in 1757, these tables allowed navigators to calculate their longitude even without an accurate chronometer, but the observations were so difficult, and the method of reducing the observations so complicated and lengthy, that Weems had never met a navigator who knew a navigator who ever made practical use of the technique.

The Nautical Almanac still tabulated the positions of the heavenly bodies using hours and minutes of Right Ascension. Celestial observations were still worked out by most navigators by solving the celestial spherical triangle by means of logarithms, the biggest improvement here during the previous century being the adoption of the Marcq St. Hilaire azimuth intercept method, coupled with improved haversine tables devised by Percy L.H. Davis. (The big advantage of haversines is that they are always positive, and obviate blunders from giving quantities the wrong signs). Solving a celestial sight, however, was a long process that required a lot of arithmetic, although with eight-knot ships nobody was in much of a hurry.

By the time Weems had been in the navigation business for ten years, however, he had begun to do a very un-expert-like thing -- he was trying to simplify matters. Ordinarily, people who become experts have a vested interest in keeping things complicated, since this makes their expertise more valuable. Weems, however, had begun to interest himself in

aviation, and particularly air navigation, where the ten-fold increase in speed meant that the navigator wais always in a hurry. The old ways, hallowed by centuries of use aboard ships, were no longer fast enough for those who had to cope with the winds aloft.

By 1928 Weems was well enough known in navigation circles to take a month's leave to teach celestial navigation to Charles A. Lindbergh, who was well known as being the 105th man to fly the Atlantic, as well as the third man to fly it non-stop, and the first to fly it solo. While taking sun-sights for practice, Major Tom Lanphier, U.S. Army Air Corps, at Selfridge Field, Michigan, pointed out the weaknesses in transferring a sun-line ahead for an hour to get a running fix, as had been done for decades aboard ship. This set Weems to thinking that a fix obtained from sights on the sun and also the moon would provide an accurate fix, the difficulty being that reducing the moon observation was fearsomely complicated.

Weems turned the matter over in his mind, until one morning at 4:00 AM a partial solution occurred to him, which he forthwith suggested to the Naval Observatory superintendent. Solving sights involved adding or subtracting longitude, which is recorded in degrees, from right ascension, which was then recorded in hours (at fifteen degrees per hour). After receiving suggestions from several other navigators, Weems in 1929 came up with his "Lunar Ephemeris for Aviators," which tabulated the moon's Greenwich Hour Angle in degrees of arc against ten minute intervals of Greenwich mean time. This was an enormous simplification from the practice followed by the Nautical Almanac, and is essentially the same as that used today by the Air Almanac, and also the Nautical Almanac (though here the periods are hourly), The idea was so good that Weems extended it to stars, planets, and the sun, coming up with his "Air Almanac" in 1933.

A prophet, however, has no honor in his own country, and the Air Almanac was discontinued in 1934. In 1936 the idea was suggested to the British, who grasped it enthusiastically, and have published it every year since 1937 in a book whose cover bears a design of an Elizabethan seaman shooting the sun with a cross-staff, together with the slogan "Man Is Not Lost."

The United States began publishing the American version of the Air Almanac in 1941, and then shortly after the war the United Kingdom and the United States began publishing it jointly. Her Majesty's Stationery Office, as a mark of respect to Capt. Weems, provided him with advance copies free of charge; the United States provides him with as many copies as he wishes to pay for. The Nautical Almanac was also re-designed to bring it into line with the streamlined methods which had worked out well in the air.

Meanwhile Weems was progressing further in his endeavor to simplify celestial navigation in the air. Working out celestial sights by logarithms was still popular at sea, but "short" methods were gaining favor. "Short" tables (which air navigators paradoxically thought were long ones) short-circuited the logarithm route by tabulating certain values (which were, indeed, often logarithms themselves) which, when added and subtracted according to a set of rules, arrived at a star azimuth to plot (i.e., the direction to look to see the star) and also a tabulated height (i.e., the altitude at which the star would appear if the navigation were actually located at the navigator's assumed position). Almost always these tables relied on the principle that splitting any spherical triangle into two right-angle triangles by dropping a perpendicular from the apex to one side wouldl make the solution easier. The calculations and table-searches for "short" tables were easier than they were when using logarithms, but they were still rather lengthy and vulnerable to error, especially when the navigator was in a

hurry, which he usually was aboard an aircraft. There were a myriad of short methods, including Ageton's, Ogura's, Dreisonstok's, Smart and Shearme, and Comrie's tables, to name only a few.

The big advantage of short methods were that they were usually contained in a small book. Their chief competitor was the pre-computed table, which did all the computational work beforehand and then tabulated the actual altitude and azimuth for any combination of even degrees of latitude and hour-angle, combined with the declination of the body being observed. Examples of these tables were the British Air Navigation Tables and HO 218, first used during the Second World War, HO 214 widely used for surface navigation, and HO 249, the simplified and improved version published since the early 50's. These tables were convenient and faster than the short methods, but they required a large number of books.

Weems pondered the matter at length and came up with a method which depended on the fact that circles of equal altitude (really the position-circles which the navigator wishes to plot) ring the sub-stellar point of each star (the point on the earth's surface immediately beneath the star) like the circular ripples around a stone dropped in the water. This family of circles travels around the world at the same speed as the rotation of the earth. The longitude of any portion of this set of concentric circles depends on the hour-angle of the star (i.e., the difference in longitude between the sub-stellar point of the star and the aircraft). Weems, with immense labor, selected a number of pairs of stars whose families of circles intersected at convenient angles (i.e., gave a good "cut") and plotted them for given bands of latitude and hour-angle. The navigator had only to pick the right page for his latitude and longitude, observe the two stars plus Polaris for a latitude-line, change his Greenwich Mean Time to hour-angle, and enter the star-altitude tables like a graph to obtain his fix.

Weems, who had retired in 1933 with the rank of Commander, published the famous Star-Altitude Curves, sinking most of his personal funds into the enterprise. The Navy, however, was not too interested. The U.S. Army Corps on the other hand was, and gave him a small contract for his tables. Before the war was over he had received, as the President of Weems System of Navigation , a contract for a million dollar's worth -- for which he gave a discount of 80%.

Weems' interest in Star Altitude Curves did not stop him from retaining a concern for the more traditional methods. While he was an instructor at the U.S. Naval Academy, he was explaining the use of tables to determine the azimuth of a heavenly body to a class of students. One of the students, a Lieutenant Ageton, contended that if a set of tables could be used to compute azimuth, which it did by solving the celestial triangle, it could be used to solve for altitude as well. Nobody had thought of this before. Weems encouraged the young officer, and before long Ageton's tables (HO 211) were in use as possibly the most compact set of "short" tables in existence. Getting the new concept into print, however, was a harrowing experience; from several authorities, Weems and Ageton received nothing but obstruction, on the ground that the old ways were perfectly good enough.

Weems was recalled after the outbreak of the war, as a Convoy Commodore (the senior naval officer with a convoy, one of whose main tasks is to keep the merchant ships from bumping into each other). In the interim, however, he had not been idle. He had published his epoch making book, Air Navigation and came up with the device which is associated most closely with his name -- the Weems Plotter. This combination protractor, straightedge and parallel rule has appeared in dozens of sizes, guises and modifications, and was the

standard plotter for the U.S. Air Force.

Another of Weems' inventions was the second-setting watch. At sea, celestial sights had to be taken with the aid of a hack watch which was set to the ship's chronometer. It was difficult, however, to set the watch exactly, which meant that it differed slightly from the chronometer, which in turn differed from Greenwich Mean Time. Weems reasoned that the difficulty in setting the watch came from the fact that at the time it was almost impossible to set the second hand exactly. However, if the second hand could not be set to match the dial perfectly, it might be possible to make the dial movable, so that the dial and the second hand were synchronized at the right time. The fact that Weems' father-in-law was a patent attorney helped him considerably in getting the idea patented, but patent it he did, and he had dozens of claims based on the second -setting watch patent.

Weems was also the author of the Line of Position Book which was originally published by the United States Naval Institute, plus some fifteen other books on the various aspects of navigation. He, and his company, pioneered and developed a variety of devices, including a complete celestial navigation system, a sunset-sunrise computer, the celestial coordinator invented by Wyatt, and a method of using altitudes between two stars, without a visible horizon, developed by an Australian named Burton, and Precomp Navigation, which was a super short tabular method.

Weems cotninued working on sea and air navigation, but space navigation had not escaped his attention. In 1961, at the age of 72, he was recalled to service to work with four clever ensigns to develop a system of space navigation. This indeed they did, using Weems' constant companion of half a century, a sextant. During this effort, Weems and his colleagues picked up another four or five patents.

During his career Weems met most of the great and near-great of navigation and aviation. One of them was Orville Wright. In his files, also, he has a copy of an invoice for $10.00, sent to Wrong-Way Corrigan. Corrigan always insisted that he flew the Atlantic from New York to Ireland back in 1938 in a light plane strictly by mistake, since he planned to fly to Los Angeles and misread his compass. However, the invoice records that the information and charts he wanted from Weems were all about the North Atlantic. Possibly he studied the wrong area by mistake, also.

Weems flew to the North Pole, when it was far from the routine matter it is today, in 1948, and flew around the world in 1950, both times keeping detailed and accurate logs and charts and being intimately concerned with the navigation. He also navigated a light plane, flown by his son, the late Cdr. George T. Weems, USN, from London to Alice Springs in Central Australia. In the early Thirties Admiral Richard Byrd invited him to accompany him to the South Pole, and Weems was sorely tempted to go, but he was about to establish his own business, and the two years he would have had to spend in the Antarctic would have set him back seriously. Regretfully he declined.

Weems retired again at the end of the Second World War, but kept as busy as ever. One of his achievements, in his spare time, was to join with two friends of his, likewise interested in navigation, to establish the U.S. Institute of Navigation in 1945. Because of Weems' reputation and knowledge, Col. Charles Blair sought him out, as Lindbergh had done earlier, for instruction in celestial navigation when Blair planned to fly over the North Pole, from Norway to Point Barrow in his modified P-51 Mustang single-seat fighter in 1951. Weems

settled on a totally pre-computed solution for Blair, which involved plotting his flight in advance, and working out the altitude of the sun for a number of points along the path. These sun-altitudes were then joined to form a graph. In flight, all Blair had to do was to take a sight and compare his observation with the predicted altitude from the graph. The difference between the two values indicated how for he was off track or off schedule. Weems and Blair carried out the computations four times, in case Blair had to delay his take-off by a day and also to allow for having to delay the hour of take-off from noon to one o'clock. Everything worked as planned, with Blair not having to lay pencil to paper after he passed Spitzbergen on the Norwegian side of the pole. He made his landfall at Point Barrow one minute ahead of his ETA.

Weems, however, overheard Blair saying, "It was nothing", to an engineer when queried about his navigation. "Don't say that!" said Weems. "That kind of navigation is still fairly complicated, and if you tell people there's nothing to it, they'll try to fly over the pole in ignorance of all the ins and outs of celestial, and kill themselves!" Blair agreed, and toned down his navigational modesty.

Weems lived in Randall House, a historic 30 room building, built in 1717 and bought by him in 1939. Its position is 38 degrees 58.8 minutes North latitude, 76 degrees 29.4 minutes West longitude. Weems had to know this, since he was constantly trying out new techniques which involved observing the sun and the stars from his front porch with a marine sextant or a bubble sextant. Visitors who were interested in the art were always invited to take a few sights, which Weems carefully entered into the log he kept for many years. Weems affection for his house was not diminished by the fact that it layed exactly eight-tenths of a minute of longitude West of the Maine Mast at the U.S. Naval Academy, from which he graduated 57 years ago.

Weems had several other distinctions besides his achievements in aviation. He was on the Olympic wrestling team in Antwerp in 1920, he was an All-American center with the Navy football team, he won the South Atlantic amateur light-heavyweight wrestling championship in 1925 when he was 30, he was a proficient skin-diver and in 1959 he joined an expedition to explore Port Royal in Jamaica, where the pirates of the Spanish Main had their capital two centuries ago.

In December 1968 Weems was presented with the gold John Oliver la Gorce Medal by the National Geographic Society, in token of his life's work in air, sea and space navigation, rather than in appreciation of any specific achievement. Quite a different acknowledgment of Weems' contribution to navigation was paid by Ben Carlin, the author of the book Half- Safe who says:

"Of all the professions, trades that are shrouded by their professional practitioners in an aura of self-protective bull, celestial navigation just about takes the cake.

'Well it is rather complex, old man - you wouldn't understand - y'really need forty years at sea for this sort of thing.' Thanks largely to air navigators, the Hydrographic Office of the U.S. Navy, and Commander Weems, this primeval veil has been ripped away in recent years. It's not a matter of mathematical proficiency - I can't count to twenty with my shoes on; the fantastic ease with which, given a modicum of elementary understanding, the correct time, an almanac, a book of tables, a sextant and a patch of clear sky, one can determine osition within a mile or so anywhere on the earth's surface,

never fails to fascinate me. Let no one interested flinch from tackling it - but on the right lines. No, I have never met Commander Weems or corresponded with him in any way."

His life, however, has not to be unmarred by tragedy. Both his sons met untimely deaths, Major Philip Van Horn Jr. being killed in the Southwest Pacific in 1943, and Lt. Cmdr. George Thrackray (Weems always referred to him as "Bee") being killed at 30 in 1951 testing an aircraft. Weems and his wife Margaret had a married daughter, Margaret Dodds, who had three children.

Other people may be impressed by Weems' accomplishments, but Weems himself was not. He was at all times completely approachable, polite and pleasant. Letters to him were always answered promptly, and sometimes in his own handwriting. Those who met him always found him a thorough gentleman. Captain Weems died June 2, 1979 at the age of ninety and will always be remembered as one of the great navigators of the Twentieth Century. In memory and in honor of Weem's significant contributions to navigation, The Institute of Navigation created an award given annually to an outstanding individual "For Continuing Contributions to the Art and Science of Navigation."