OCEANIC NAVIGATION
OVER 30 YEARS

BY BILL COMPTON, ANCHORAGE, ALASKA

My first oceanic trip was in 1975, a round trip in my N35 between Cold Bay, Alaska, and Honolulu. Over the years, I made four more trips to Hawaii, once from Australia in an A36TC via Guadalcanal and Tarawa. There were also four trips to Europe, two in a B55 and two in my current V35TC. I always preferred the Bonanzas; I like generous fuel reserves.

In 1975 there was no GPS. Loran C was available, but involved a large radio set with an oscilloscope, reminding one of the old shoe-store X-ray machine. The navigator lined up master and slave traces on the scope, read the time difference, tracked one or two other slaves against the master, then went to a chart showing time difference lines to obtain a fix. This would not do in a single-pilot Bonanza. The microprocessor-driven Lorans were yet to come. Omega, inertial and VLF were up and coming but not practical for a Bonanza.

Professional ferry pilots were mostly using dead reckoning for long over-water trips. The oceanic flight plan divides the route into legs by wind forecasts, true course, distance and variation, then ground speed and drift are solved with an E6B to get magnetic heading and time en route for each leg. The pilot flew the legs by the planned headings and times, watching the ADF, transponder and VOR needles for the first confirmation of the approaching destination. Position reports were simply read-backs of the flight plan.

Astronavigation

The airlines used professional navigators expert in astronavigation and Loran. I was curious, so I picked up a surplus hand-held bubble sextant. The whole process of "sight reduction" seemed unfathomable until a retired Japan Air Lines navigator simplified it so even I could understand it.

Looking out the cockpit after takeoff on the leg from Honolulu, Hawaii to Bellingham, Washington.

Think of this: If you are at the North Pole and Polaris is almost directly overhead, the "altitude" of Polaris, or angle with the horizon, is about 90°, which is your latitude. That works anywhere in the Northern Hemisphere.

The same logic applies to 57 navigational stars whose place in the sky is catalogued in an almanac called HO 249. For any assumed latitude/longitude and Zulu time, the almanac gives the angle and bearing of seven prominent stars visible from that position. The difference between the predicted angle and the observed angle is your distance from the assumed position on that bearing.

How did a vertical angle become a distance? Each degree of angle is 60 nm and each minute of angle is one nm, just as each minute of latitude is one nm.

A nautical sextant measures the angle of a heavenly body with the sea horizon. The aeronautical sextant instead uses a bubble to define the horizon; the navigator adjusts his view and his indexing knob so that the body centers in the bubble and the bubble centers in the optical field. Still, this is not good enough, as the aircraft is not steady. So a timer averages the reading over two minutes, while the navigator earnestly keeps it all lined up by rolling the indexer back and forth.

While standing in the yard on a clear night, I did consistent fixes within 3 miles. In flight, sights were tougher. Night fixes were done with sights on three stars, timed four minutes apart. Since the earth rotates one degree every four minutes, that simplified the numbers. The three lines of position were plotted on a chart. The smaller the plotted triangle, the better the fix.

Changes in drift and groundspeed detected by the fix were used to adjust heading and time to the next estimated fix according to the navigator's confidence in the sights. Without Left/Right guidance it was unlikely to cross that precise fix. Instead, at about that ETA, one plotted another fix and reported *that* position, with another, later-to-be-bypassed fix again estimated. In this way the flight hopscotched back and forth, bracketing the course line.

Astronavigation actually worked well for me, not necessarily every hour, but often enough to confirm appropriate progress.

Upgrade to modern navigation

Loran followed later by GPS changed that for my flights, just as inertial nav changed that for the airlines and made flight navigators obsolete. With the computerized systems, the flight stayed on centerline, actually flew *over* the next fix and gave constant awareness of groundspeed and track. One hardly fussed about true vs. magnetic. It was easier than flying Victor airways.

My first experience with this was in 1985 when I had a Northstar Loran on a flight from Cold Bay to Kauai. I took an occasional celestial fix but Loran was obviously the new Top Dog.

Guess what? It ruined the fun! Navigating became almost effortless, and little was left to do but just sit there and hallucinate. Gone was that eager watch for land ahead that my sights said should be there. Instead, it seemed a certainty.

I quit going on those long ocean trips, but not to Europe, which didn't need a cabin tank. Just grab a passport and go. Short legs (for a tip-tanked Bo), exotic locations, great scenery—and sometimes we could just camp out under the airplane. I even went to Hawaii a few times on the airlines.

V35TC

In 1981 I traded my N35 for a 1966 V35TC that my son Steve and I still own. Initially, flying it rich of peak EGT, we were pulling too many cylinders. So in the mid-'90s we switched to lean of peak (LOP) operations and have had no more of those problems.

The N35 had an injected 470 engine with 8.6:1 compression, which would yield about 149 hp at 10 gph if LOP, while our V35TC with a 520 engine and 7.5:1 compression would only yield 137 hp at that fuel flow when LOP. On the other hand, we had run the older Bo rich of peak, and running the turbo model LOP would make up on efficiency.

To go LOP, you don't just pull the red knob a little more. Articles by George Braly and John Deakin were digested and slowly we became confident with LOP ops. Same cruise speed on less fuel flow and lower CHTs has a certain charm. LOP ops mesh beautifully with the V35TC's turbocharging.

Approaching the Washington coastline on return leg.

I had done Honolulu to Anchorage direct twice, but not the other way, as Kodiak was a closer alternate only for the northbound trip. With more efficient LOP ops, I started thinking the southbound leg might be done safely with the 225 gallons of fuel I could carry. I was also aware that my long-range flights lacked a logical cruise control strategy. The old itch was returning.

In the past I had cruised at constant power, 50° ROP and 12 gph, a poor choice for several reasons. Studying, I found that best range performance is achieved by flying a constant angle of attack at L/D max (best lift over drag speed). This results in an indicated airspeed (IAS) for best range, Vbr, which decreases as aircraft weight decreases with fuel burn. As the aircraft lightens, specific range—defined as nautical air miles/gallon of fuel—increases. So the assumption that one power setting gives a predictable airspeed for an entire trip was discarded, and this table was proposed (see table on the previous page).

LONG-RANGE CRUISE PROFILE N411EG w/ 225 gallons, cruise 20 LOP at 12,000' density altitude

ET	fuel flow/tas	fuel burn	air miles	acft wgt	nam/gal
0000	Takeoff 32 gph			3803	
0020	12000' TOC	10.5/10.5	36/36	3740	3.4
0200	12.5 gph 152kt	20.9/31.4	253/289	3614	12.1/9.2
0400	12.5 gph, 155kt	25/56.4	310/599	3464	12.4/10.8
0600	11.5 gph 145kt	23/79.4	290/889	3326	12.6/11.2
0800	11gph 145kt	22/101.4	290/1179	3197	13.2/11.6
1000	10.8 gph 144kt	21.6/123	288/1467	3065	13.3/11.9
1200	10.5 142kt	21/144	284/1751	2940	13.5/12.2
1400	10.2 140kt	20.4/164.4	280/2031	2816	13.7/12.4
1600	9.5 143kt	19/183.4	286/2317	2702	15/12.6
1800	9 gph 135kt	18/201.4	270/2587	2594	15/12.8
2030	9 gph 140kt	22.5/223.9	350/2937	2460	15.6/13.1

TOC = top of climb
Desired reserve on arriving Honolulu (PHNL): 3 hours cruise, 1 hour hold=39 gallons
Takeoff to TOC at 12,000': 11 gallons, 36 miles
Kodiak to Honolulu is 2,237 nm, leaving 2,201 nm on 175 gal for the cruise segment, and requires an average cruise specific range of 12.6 nm/ gal of fuel.

To come up with this, I determined Vbr for one weight of the airplane, then computed Vbr for other weights, added 5-10% to those indicated airspeeds, and used flight-tested numbers and estimates to find the fuel flows to hold those airspeeds. The logic was that speeds slightly higher than Vbr could be used with minimal loss of range. True airspeeds also would be higher at higher altitudes. At 20° LOP EGT, maximum power and thrust would be obtained for a given fuel flow. I had to give all this a try!

Alaska to Honolulu

When departure day came, winds were unfavorable, so Kodiak was back in the plan. I launched out of there in early evening, reaching PHNL in 16 hours 56 minutes using 185 gallons of gas and one pint of oil. The engine was happy at 2200 down to 2125 rpm, 26" mp, fuel flow 12 gph down to 10 gph by the end of the flight.

Did I fly the planned profile? Sort of. Once into headwinds, lower altitude was better. But the basic strategy to cruise LOP a little faster than best-range IAS worked just as well down low, though true airspeed was less. It took a bit longer, but I landed with the reserve fuel I had wanted.

What about astronavigation? When the stars were out, I was too busy to use the sextant, what with HF problems, spontaneous autopilot disconnects, watching for traffic (tiny joke), etc. Black-of-night IFR can be hard work—and GPS is so easy.

In contrast to memories of old, there was a lot to do, and it was still lots of fun. I made it back home via Bellingham, Washington—but that's another story.

RISK MANAGEMENT

Flight beyond gliding distance from land brings risk of landing in the water, mandating provision for raft, survival suit and EPIRB (Emergency Position Indicating Radio Beacon). Reflection is needed on ditch procedures, egress for pilot and gear, and raft entry. Then attention can turn to minimizing the risk of ditching.

GPS lessens but does not eliminate risk of navigational error. A backup, battery-powered GPS is good. A digital fuel flow meter helps with fuel tank sequencing and awareness of fuel consumed vs. flight progress.

Failure of a well-maintained engine is unlikely, but one can lower that risk. Knowing the engine's history from first break-in flight onward is reassuring, more so with digital download of engine settings and temperatures every 6 seconds onto a computer.

Reviewing flights, one looks for any temperatures beyond limits, including excessive cooling rates on descent, or at top of climb before cowl flap closure or leaning. This data yields insight on best practices to minimize engine stresses and heat cycles. Lean-of-peak operations reduce intra-cylinder pressures and cylinder head temperatures. Oil analysis, compression testing and borescoping can provide additional reassurance.

Having done all I know to minimize risk, I find my concerns about ditching are not burdensome.

WHAT'S WRONG?

BY ADRIAN EICHHORN & RON TIMMERMANS

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This photo shows the steering idler arm removed from the shaft in the nose gear well. Notice that the idler arm includes iolite bushing (yellow arrow) that rides on the steel shaft shown in the previous photo. As forces are transferred to the idler arm during taxi, takeoff and landing movements, this bushing will wear. The idler arm eventually becomes loose where it is mounted on the steel shaft, resulting in the loss of that precise steering response you've come to expect in your Beechcraft.

To check whether the bushing on your aircraft is worn, reach into the nose gear well, grasp the idler arm and move it side to side. Side-to-side play tells you the bushing is worn and needs a new bushing installed. While your mechanic is changing the bushing, have him install a grease fitting (the zerk shown in this picture). This will allow lubrication of the bushing and extend its service life. This is a minor modification and a simple airframe logbook entry is sufficient.

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