B-47

STRATOJET:

BE A NUCLEAR DETERRENT TO THE NUCLEAR THREAT OF THE COLD WAR

Mission Complete

Louis Malucci

part of dirt, trees and rocks. In the vicinity of a thunderstorm, winds from the upcurrents and downdrafts and the wind spills against the ground can rapidly shift. That is why several airports now have wind shear detectors.

MOUNTAIN WAVE. This is only a relatively recently discovered phenomenon that has killed a lot of people, in particular in the lee, i.e., the downwind, side of the Rocky Mountains. Winds moving across the mountains rise, as in orthographic lifting. When it crosses the mountain, it produces down drafts. Many light airplanes have mysteriously crashed, for example, around Colorado.

I experienced it on at least one occasion, in a C-119. Flying over Virginia and Western North Carolina's Blue Ridge Mountains, we encountered the mountain wave. Despite pulling back on the control column, the plane continued to lose altitude. Not until we applied 2900 RPM takeoff power were we able to overcome the downdraft. On another mission I was on with this same pilot and we were struck by lightning. The cockpit filled with smoke and we got a dent in the nose. And dirty underwear. He wasn't my favorite pilot.

CELESTIAL NAVIGATION.

I always loved celestial navigation. To me it was a challenge and in every case with very successful results. One of these successes is elaborated on in great detail in the chapter entitled "First Perfect Navigator Check Ride," which had a memorable finish despite driving into an unexpected jet stream.

There was an incident which almost preempted even finishing the navigation school program. One requirement of night cel was several outdoor classes in the evening for "star identification." Here we studied the various constellations to help us locate the stars in the heavens that we were to shoot in flight. This was particularly important before we converted to the periscopic sextant. With the periscopic sextant, you could crank in the expected elevation of the star, allowing for the rising and falling that would occur before the shot, and also crank in the azimuth of the star. This way the star would virtually "drop" into your viewing lens. It should be added that if you shot a star in view, that was the wrong star, even though it appeared to be a half inch from the correct star, the results would put you off by hundreds of miles. Finding the right star was critical against the beautiful spectrum of the great Milky Way and the other galaxies in the beautiful panorama of the celestial dome.

However, with the hand-held sextant, it hung by a hook attached to the Plexiglas dome in the airplane. You had to swing it around until you found the correct star. You had to be able to recognize it by its position among other stars in the constellation. You had no azimuth help, though you still need to put in the anticipated elevation of the star.

Since we took the course in winter, we became most familiar with the winter constellations such as The Belt of Orion, Cassiopeia, the large and small dippers, the so-called "navigator's triangle, Spica, Deneb and Dube, the Seven Sisters of Pleiades, to name some. In fact, the favorite navigator three star fix was the infamous Dube, Deneb and Dallas. If you were flying over Texas and were totally lost and was near Dallas, you could always know where you were, but not because of any star fixing. Navigators would plot their position and "back in" the data from the stars which would give you that position, determined by "Big D" not Dube, Deneb...

etc. The irony was that it took even more proficiency to do the math calculations backwards to achieve that fix than to do it right the first time around. Working all those formulas for aircraft movement, star movement, atmospheric refraction, and adjusting for time, really took an innate understanding to accomplish that. I never heard of anyone failing for doing that. It demonstrated knowledge.

Now getting back to our getting in trouble: One night a fellow student and I had heavy dates on a night when star classes were being held. We got so wrapped up with our date, we forgot about it. When we finally remembered where we needed to be, we hustled over there quick-like, with one minor problem: It was an official formation, meaning we needed to be in uniform, but we weren't. So we got a little butt-chewing from the senior student, Lt. Ledbetter, our official leader. He had been commissioned years ago and served in another capacity before going to Nav School. We always considered him a "hard-ass" and he took his responsibility a little too seriously. But we did get past that one.

The techniques used in celestial navigation are elaborated in great detail in another chapter called, **"The Perfect Flight Check**." This demonstrated how accurate celestial could be, though it too was very labor and time intensive. Celestial navigation was used by the Phoenicians and the Polynesians centuries ago. The Polynesians used a coconut with three holes drilled into it, one hole was used to determine level, i.e., by keeping the water from leaking out and through the other two holes, they sighted the North Star. By keeping it in sight, they were able to maintain a constant east-west course, and then turning 90 degrees (I don't know how they knew when) to make landfall.

Going back to my subsequent navigational career in the reserves, while in the C-119, I volunteered to ferry a C-119 to the Nationalist China air force. I actually saw Generalissimo Chang Kai Shek on that trip. The loran petered out about halfway along the 2200 mile course between California and Hawaii, forcing me to use pressure pattern and DR during its absence. I recall a newly promoted full bird colonel, i.e., my pilot, who was a HAM operator, climbed up into A deck and changed the loran antenna coupler in order to get the loran going. We always carried a spare. It didn't help, so it became purely DR., celestial, and some pressure pattern navigation.

I was able to keep the low frequency radio tuned on a California station and the other ADF on Hilo in the Hawaiian Islands. However, this gave me a course but not a speed line. That is, I had no reliable information as to how far along course, other than that determined by DR from the forecast winds. We were running the risk of being far off our planned ETA to the ADIZ, the Air Defense Identification Zone, and having F-106 fighter planes come after us for a look-see. We were only allowed a window of 10 minutes of acceptable error.

At dusk, I asked the pilots to let me know when the stars came out. Finally, one replied, "I see a star." I said, "Thanks. Nice but I need more than one and they need to be ones I recognize and are in the reduction tables we carried." Eventually, it became dark so I pre-compted a three star fix and took the shots, adding Polaris which took no computation since it was circum-polar, fixed in the sky. When I plotted the fix, it fell exactly between the course lines of the two radio stations. I yelled "whoopee" something you don't do in a qui airplane, especially at night. The pilots turned startled and asked, "What's wrong?" I yelled back, "A perfect pi point fix!" They replied, "It certainly doesn't take much to turn a navigator on." Exactly one hour later, I repeated the process, and like the first fix, the intersection of the plotted lines of the four stars produced not th customary triangle, but all merged into a spot the size of the pencil mark. We had gone exactly 160 miles sinc the last fix and therefore calculated our ground speed as 160 knots and thus the ETA for the Hilo VORTAC, i.e. visual Omni range/Tactical navigation radio. After nearly an hour, one of the pilots reported "I have the Hi VORTAC locked on." I asked, "how far do we have to turn to get back on course?" They replied, "We don't." We were dead on course, and my calculated ETA was within 30 seconds. The moral of the story: If th Phoenicians and Polynesians can do it, why can't? The pilots on this mission were ones with whom I had no flown very much up until that time. I grew about 2 feet in their eyes. The rest of the mission went much th same way except we did not have to fly at night and I had to rely on day celestial from Hawaii to Midway, t Wake Island, to Guam and finally to Ping Tung South, Taiwan, a 60 hour flight, 43 over water. And with th skillful crew coordination with the flight engineer, between my calculations of optimum RPM for our changin weight, and his skillful manipulation of the mixture and torque controls, we landed with 1753 lbs. of fuel enough for about another 45 minutes of flight. It was the first time I ever kissed the ground. I will say, when w finally reached Taiwan and broke through the clouds, I muttered aloud, "I hope I have the right China."

I should add here that navigators had to be able to calculate the exact moment of sunset and sunrise Normally, just an academic exercise, this became important on a mission in Central America. Because of th hostile terrain and the relatively primitive navigation aids, we were not allowed to fly between official sunse and sunrise other than at Howard Air Base, Panama. In fact, some of these navigation radios were only turned o by native personnel climbing the mountain in South America on an animal and turning on them on. We were tasked to support the corps of engineers putting in a runway in Puerto Limper, Honduras. We were then asked t fly a mission into the interior to rescue stranded personnel in Madeira. Our expected time barely allowed us pick them up, return to Puerto Lempira and get off the ground before sunset. I quickly made the calculation and by miracle, got it exactly right. Just as we lined up at the end of the dirt runway, the giant fireball of the sun was flush on the horizon. The alternative: sleeping in a hot, humid, mosquito infested airplane until sunrise. Like my deodorant, it worked! However, the Spanish language newspapers described our mission there as "provocateurs."

GRID. And finally, there was "Grid navigation." That dreaded, grid. Most of us hated it. It was hard work, and took a different set of maps. Its purpose was for use in the upper latitudes because, as said, the difference between magnetic north and true north was exacerbated by the converging lines of longitude. If you were sitting directly over the North Pole and told the pilot "turn south" even the least astute pilot would get that right. Anywhere is south! Therefore, a grid map was used in which all the parallels and meridians formed right angles.

THE PERFECT FLIGHT

The nightmare experience with the infamous gold dust twins, Ollie and Stan, very likely accelerated my departure from active duty in the minimum time to satisfy the contractual agreement resulting from my ROTC commissioning. My entire outlook on the Air Force, and the B-47 was a pretty grim one. The pressure, the mission, the great number of fatal accidents, the discomfort flying in this beast had taken its toll and, frankly, I wanted out, as soon as possible. However, my outlook took on a very positive turn when I was assigned two excellent pilots as my next crew mates following that temporary assignment as acting squadron navigator. The aircraft commander came from a B-57 assignment and the copilot directly from pilot school. They were refreshing personalities after the dismal experience with "Ollie and Stan." And they were both extremely capable pilots. After several weeks of training flights with Jack & Jim, the crew was ready for its combat ready flight check.

INFLIGHT REFUELING

The flight began routinely, with a rendezvous with a tanker, which by this time, were mostly KC-135s. This tactic is described in more detail in the chapter on refueling. As usual, the tanker transmitted its APN-76 pre-established identification code which appeared on my radar scope. I switched the control switch on my radar control panel to "Beacon" function and found the code for his tanker on the screen of my MA6/MA7, 10 inch diameter radar screen. From here on, everything went as planned, despite a more than moderate turbulence in the area, approaching the tanker which was in the preplanned orbit at the pre-briefed refueling altitude. When the radar image of the code, a series of narrow and wide strips, not unlike a bar code, closed to 80 NM, we descended from cruise altitude at 2500 feet per minute to a point 1,000 feet below the assigned refueling altitude. I continued to announce our distance from the tanker until the tanker was 50 miles away. After reaching a point 12 miles behind the tanker, I "walked" the bomber in one mile increments through the 12 and 6 mile ranges at which point, the tanker departed the orbit to the refueling track. By this time the pilots had visual contact with the tanker and I continued to count off the range. At 2 NM, the bomber slowed to mach .78 and at 1 mile to .72, i.e. about 280 knots, eventually slowing to .68 or 255 knots for the actual hook-up. We lowered flaps to 20% to give greater stability to the plane while hooked up to the boom. Final hook up was made and the 60,000 lbs. of fuel were transferred from tanker to bomber. So far, so good.

CELESTIAL NAVIGATION

Then the two aircraft separated and I directed the bomber to Bagnell dam on the Lake of the Ozarks, the departure fix for the celestial navigation leg. Because takeoffs on schedule were so critical, it was easy to pre-comp, i.e., precompute the data for the celestial fixing because you knew exactly when you were going to take off, virtually to the second. This precomping procedure was time consuming and the primary rule was that anything that could be done on the ground should be, and was.

What follows immediately here will be greatly detailed minutia which many readers will find to be difficult to understand and pose the question, why bother me? Let us address this first, pointing out that in the more than forty years which have passed since that check ride, the results of the procedures and efforts are produced in an instant with GPS, Ground Positioning Satellite. Computers as we know them now did not exist. Even in the MA6/MA7 navigation system, which cost a good part of a million dollars, a sophisticated development in its time, by today's standards, was pretty rudimentary. The emphasis here, and will be reiterated later, is that all this takes time. Lots of it.

I should interject here, that although the Phoenicians and the Polynesians used celestial navigation thousands of years ago, I suspect this isn't the same technique they used. On the other hand, they were not en route to a hostile nation to drop a nuclear weapon, and although this was only a training flight, they would not have been required to be within 32 miles of destination at the end of the celestial leg, in order to pass some exam.

It is relevant to understand the crisis that I faced in the midst of this flight evaluation and how to deal with the consequences that arose to salvage the mission. Keep in mind the disastrous previous flight check with Frick and Freck, i.e., Ollie & Stan, the Gold Dust twins. The crew, including me, failed that flight exam putting an additional pressure on this one. The conditions encountered on this flight to a large degree compounded the challenges of the mission.

The first step in the process of obtaining a "fix" by celestial means is to establish fix time and estimated position at that time. This was accomplished using DR, i.e., dead reckoning, using the best known wind to calculate ground speed and heading. Next the navigator entered the air almanac to determine the exact position of the "first point of Aries", a theoretical star which in fact had burned out billions of years ago. This reading is in degrees and minutes of arc. The navigator then selects the coordinates of the longitude of the estimated position and reduces the minutes of arc to match those of the GHA previously extracted from the almanac in order to produce an even number to enter the HO-249 sight reduction tables which were listed in even degrees. Subtracting the GHA from the longitude produces an LHA, the Longitudinal Hour Angle, also an even number. To reiterate, these details are very much esoteric, i.e., only comprehended by a select few. The message to the rest of the world is, "golly, this is complicated," even in the best of conditions and we were not encountering the best of conditions.

Fortunately, experts developed the HO-249 tables which reduced the amount of calculation required to shoot the stars or else the navigator would have to use the same technique as used in shooting the sun or planets which took several extra steps.

The celestial leg on any routine training flight or on a flight exam was a minimum of two hours duration with a dog-leg of some unspecified angle and each leg should be at least an hour long. Optimal time of the entire celestial portion of the flight would be approximately two hours and fifteen or twenty minutes. Because takeoff times in SAC were sacrosanct and because to be successful in any aircraft, you had to stay ahead of the aircraft.

the precomputation for the first fix could and should be accomplished on the ground. Normally, the first fix would be approximately 45 minutes down track on the first leg. This would give the copilot time to take the shots, and then give the navigator time to plot the fix, DR, i.e., dead reckon, that is using the wind information to calculate the heading and time and distance ahead to the turning point.

So I did exactly that. I plotted the fix, calculated the heading and ETA to the turning point and notified the pilot that exactly at the expiration of the ETA, he was to assume the new heading without my having to give it to him. It should be noted here that even the radius of turn had to be taken into consideration when plotting the heading to the final destination. The radius of the turn at 425 knots TAS was approximately 32 miles in a "standard" turn, i.e., 30 degree bank. Having given these instructions to the pilot, as was the custom and product of the training, I immediately began plotting the assumed position of the next fix after the turn and also to precomp the celestial information.

It should be noted here that each shot took four minutes. The actual observation and measurement of the elevation of the star took two minutes. The sextant had a built in timer that closed exactly two minutes after being activated, and checking this timer was a pre-flight check item. The actual time of the shot was the midpoint of the two minute shot. It would take about two minutes to record the observation on the work sheet and enter the information for the next star into the sextant, therefore the four minutes between shots. Three star shots were the standard, which ideally resulted in a small triangle, the size of the triangle often dependent on the consistency of the observer in keeping the star within the illuminated bubble in the reticule. It also depended on the skills of the pilot to give as perfectly level a shooting platform as was possible.

So, up until the first turning point, the mission, including the air refueling, went as planned. I gave the ETA to the turning point, and using the track from departure fix to the celestial fix, with true airspeed and true heading, determined the in-flight wind from which to calculate the heading and ETA to the turning point. After giving these to pilot asking him to turn on his own time hack, I began to precomp the second fix. The plan was to begin shooting the second fix immediately upon roll-out on the new heading to destination.

Ideally, the spacing should allow time for two evenly spaced fixes between the turning point and the final destination. By regulation, the navigator must make his final course correction and announce the ETA to destination to the flight examiner a minimum of five minutes before that ETA. This too became a critical factor in what happened later.

When plotting the "fix," the navigator had to take into consideration the effect the refraction of the atmosphere had on the observation. If the celestial body were nearly vertically overhead, you would be looking through a relatively thin atmosphere with minimum refraction, i.e., bending or distorting the measured elevation of the body. If the body were low in the sky, it would be like looking through a glass sideways through the curved glass, distorting the image. The lower the star on the horizon, the more correction was required, as derived from a table in the HO-249.

You also had to consider that the star is "moving" during the shooting period, i.e., a star in the West is descending and a star in the East is rising, at approximately 2 ½ degrees every four minutes. And you also had to measure the speed of the aircraft towards the relative motion of the star. A star off the wing rose slower than a star off the nose, and vice versa for a star behind you. Simple thing, right? Oh, those Phoenicians didn't realize how easy they had it! As said in the chapter on navigation school, navigation is basically solving math problems. And most calculations are ratios, distance pro-rated over time. Since you could not do this on your fingers, the previously discussed E6B, the circular slide rule was the critical instrument. Most table values were expressed per four minute time periods. If the shot were 12 minutes before fix time, you had to resolved that by extrapolating the movement over 12 minutes, or 8 or 4, for subsequent shots. Fortunately, my math acuity allowed me to do a lot of the ratios in my head, saving lots of time.

NOT TO PANIC

After the pilot assumed his new heading following the turn, I began my series of shots for the second of the three fixes. I recorded the data from each and plotted the fix. Good grief, Miss Agnes! Something was drastically wrong. It was a nice triangle to be sure, but instead of plotting approximately 40 minutes from destination, it plotted only 10 minutes away. If this were accurate, I had only 4 minutes to precomp, do all the math, shoot, plot and announce the new heading and ETA to the flight evaluator to conform with the requirement of announcing such 5 minutes prior. Keep in mind all the steps iterated above.

There certainly was no time to review neither my precomp data nor the plotting in a search for errors. I had to act and act now and had to assume that the precomp and shots as well as the plotting were all accurate. The wind calculated from this fix came out to 300 degrees at 170 knots, a monstrous deviation from the flight plan wind of 240 degrees at 45 knots. I had no choice to buy it. It meant we had driven into an unforecasted jet stream, right on the tail. This meant that instead of the expected ground speed of about 425 knots or about 7 miles per minute, we had a ground speed of nearly 600 knots, or 10 miles per minute. And we were only 100 miles from destination, i.e., about 10 minutes out. Keep in mind, shooting three stars alone took 12 minutes, irrespective of the time to plot and calculate the next heading and ETA.

I instructed the copilot, who did the shooting, to set the azimuth to 000 (the azimuth of Polaris is usually 000 except when Cassiopeia appeared to the right of Polaris making the true bearing 001 or to the left which made it 359), and to shoot Polaris on the next even minute on his watch. Polaris is circum-polar and therefore does not rise or fall. The elevation of Polaris is always exactly equal to the geographical latitude. I then proceeded to give him the estimated elevation to find the star in the reticule. I then begged the pilot to keep the aircraft as steady as absolutely possible.

In the meantime, I quickly went to the tables and calculated just one star, one that gave me a 90 degree cut to Polaris to obtain a two star fix. Not as reliable as the three star, but it had to suffice because there was no time for the customary two minute observation straddling the shot time. This was to be an instantaneous shot, not an average. We were going for broke.

Jim, the copilot quickly called out the results of the shot and I rapidly plotted the fix and measured the track and calculated ETA to destination, the bridge in the center of Green Bay, Wisconsin. I then quickly turned and announced the ETA to the flight examiner as 5 and a half minutes away.

The evaluator reached down and turned up the gain on the radar set which had been turned down to give a blank radar scope. This part of the mission was to be celestial and celestial alone. A big smile crossed the examiners face, discernable only as a gleam in the eyes protruding above the oxygen mask on his face. There on the radar, right on center line of the heading marker, exactly 10 miles away with one minute remaining on the ETA. A 00 mile deviation from actual. A perfect score. Acceptable limits for a celestial mission was 32 miles, and I had gotten a perfect score. And under the most unfavorable conditions imaginable.

LOW LEVEL NAVIGATION

The celestial part of the check ride was exciting, to say the least, with extraordinary success. But the mission was far from over. Equally challenging, if not more so, was the low level navigation and ensuing bomb run yet ahead of us. Now the crews turned towards Traverse City, Michigan, descending to 1,000 feet above the ground, at night, and proceeded on the low level navigation leg, using only the radar and the MA6A/7A computer. Anyone who has ever watched a television weather station showing the returns on a stormy night, knows that the ground clutter consumes most of the picture. This was not far removed from what the navigator sees on his screen at high speed, low level navigation. Precise navigation required finding every discernable radar image that was identifiable and pecking away fix by fix, in an aircraft shuddering with the normal turbulence found this close to the ground, especially at an indicated airspeed of 360 knots. The aircraft did not normally fly that fast that close to the ground except on strike missions or simulated strike missions which we were now experiencing. At least one B-47 had disappeared over the Great Lakes on similar missions as these.

Contrary to what might normally be expected, the navigator does not find a ground return and attempt to identify it. Rather, he has to look at his charts, and using DR, i.e. dead reckoning, look ahead for selected prominent, identifiable returns, a river bend, a bridge, a town or some other identifiable isolated return and then try to find that corresponding return on his scope. He did get some help from the computer system in tracking his current position. However, this system was pre-Doppler, i.e., the wind was not automatically calculated by the system but rather had to be determined by the navigator.

"KILLING THE WIND"

The MA6/MA7 computer on the B-47 was state of the art. For that era, well before GPS. It worked on the "delta" methodology, the delta being the changed value. Before takeoff and at various times in flight, the navigator had to manually set the true airspeed in the system. He also had to pre-set the pre-flight, forecasted, wind components in, manually, using the tracking handle to drive the dials to the forecasted ground speed and drift angles. Once in flight, the navigator updated the wind. To repeat the procedure from an earlier chapter, this was done by placing the selector switch to "Sector" scan, placing the cross hairs on a clearly defined ground