A Christmas Story about Celestial Navigation - December, 2008

Before accurate electronic compasses were installed in aircraft, shortly after WWII, navigators depended on celestial navigation to check the accuracy of the magnetic compass. This was very important when flying in the Arctic, especially in areas within a thousand miles of the magnetic pole where magnetic compasses are not dependable. In the 1930s and 40s, crews of aircraft like the DC-4 (C-54 military), long range patrol aircraft and bombers of WWII, and the Pan Am Clippers used a device called an astrocompass. Later, in the 1950's, pressurized aircraft like the DC-6 and the Superconstellation were equipped with periscopic sextants with mounting devices which included a compass rose to check direction. The principle of the astrocompass can be explained by an example. Suppose you are flying at morning twilight on March 21st, the first day of Spring, where the sun comes up due east for everyone on planet Earth. When dawn breaks over the horizon you notice that you are pointed directly at the sun. Your true heading is 90 degrees, or due east. Another example: suppose you are in another aircraft at the same time and location and you have a device which measures the angle between your aircraft and the sun and that angle is 60 degrees right. Your true heading is 30 degrees (90 minus 60). An astrocompass works basically the same. It is usable with stars, planets, the moon, and the sun, provided the navigator has the skill to use it. On ocean crossings, when depending on the old magnetic compass, a good practice by aerial navigators was to mount the astrocompass early in the flight and check the accuracy of the compass. If the compass is in error by only 2 or 3 degrees and the flight proceeds with no correction, the aircraft will be hundreds of miles from course over a two thousand mile flight.

The way it was: Imagine that you are a Civil Engineer, specializing in construction of runways, hangars, fuel storage tanks, water supplies, sewage systems and all the facilities that are present on a big airbase. It's the Cold War, and you have been assigned to plan details for the construction of a U. S. Air Force Base in northern Greenland. On April 25th, 1951, even though the ice surrounding northern Greenland is much too thick for cargo ships to reach that area, it is not too early to plan for construction to begin in late June or July. You are accompanied by Colonel Bernt Balchen, USAF, (Admiral Byrd's pilot when they flew over the south Pole in 1929). The two of you manage to find a military C-54 on a resupply flight to the tiny weather station at Thule, in far northern Greenland, just where you are headed. You hitch a ride and by the time the transport reaches the Royal Canadian Air Force Base at Goose Bay, Labrador, you have become acquainted with each other and the crew and they have invited you forward to observe. Its much more interesting than staring at tied down cargo in the cabin.

After a briefing on the northern bases at RCAF Goose, the C-54 is airborne late, about 4 p.m. local, headed for Frobisher Bay on the southeast end of Baffin Island, Northwest Territories, Canada.

Its less than three hours to the RCAF base at Frobisher and Thule is another five hours north but the pilot has informed you there is no aviation fuel at Thule. That means stopping at Frobisher to tank up because the return trip will be made with gasoline in the tanks arriving at Thule. The weather is cold but clear northbound and from 6,000 feet you catch glances at the snow covered terrain below. The trees, which covered the land around Goose Bay, become sparse then disappear before you leave northern Labrador. Even though the crew is tracking by reference to the ground, the navigator has been checking the heading of the aircraft by using the astrocompass with the sun every few minutes. The plane is equipped with an ordinary magnetic compass but the navigator has been checking the pilots manually set, vacuum powered, directional gyros. He explains that, when they get farther north, the directional gyros might be all that they have in case they can not see a celestial body and the magnetic compass becomes unreliable. He shows you that, approaching Baffin Island, the compass is already erratic. Even the slightest ripple in the air or a shallow bank causes the compass to spin like a top. After the compass is disturbed, the aircraft must be in perfectly smooth air for several minutes before it settles down. As the northward progress continues, the compass grows even more unsatisfactory. However, after only two hours of working with the astrocompass the navigator has plotted a graph on each cockpit directional gyro. The pilot's precessed (drifted) about 8 degrees clockwise and the copilot's precessed about 6 degrees clockwise per hour. That's good enough to use for direction for several hours if nothing else is available.

Its cold at the RCAF base Frobisher, minus 40 degrees. Spring may be more than a month old in the USA but it arrives here late. Frobisher is almost on the Arctic Circle. The pilot requests enough fuel to make the trip to Thule and return plus flying on to Goose Bay in case Frobisher is unsuitable for landing. The transport is airborne after two hours ground time. It is still daylight. The navigator reports the sun's declination is more than 13 degrees north today. If the sun sets enroute to Thule it will not be much below the horizon. Twilight is only a matter of minutes in the USA but it lasts for hours in the Arctic in Spring and Fall.

The pilot climbs to 11,000 feet in this unpressurized transport because of terrain on Baffin Island. Charts mark the highest peaks as plus or minus 8,500 but a note on the chart warns "exact elevations unknown". The temperature at 11,000 is minus 45 degrees Celsius so our altitude is 1,500 feet below indicated, or 9,500 feet, The clearance between us and "the rocks" is a mere 1,000 feet. After level off, instead of the clear air which prevailed approaching Frobisher we are in a "whiteout" condition. This phenomenon is strange. There are no clouds and no

precipitation prevails but we can only see straight down. The horizon has gradually disappeared and the sun is obscured from view. What we can see of Baffin Island looks cold. Very deep snow and the only land visible is the steep cliffs, which can not hold snow, as we pass overhead. The condition lasts for about two hours. The foresight of the navigator pays off. The pilots had set their directional gyros before take off when lined up with the known runway heading. From time to time, the navigator advises the pilots to correct the gyros according to his graph of precession rate gathered on the previous flight. It will have to do because the magnetic compass is dancing wildly. We are way too close to the north magnetic pole for the compass and it is useless.

About halfway to Thule the whiteout condition slowly clears up. The plane must be past Baffin Island and over Baffin Bay because the surface is covered by ice and snow and very flat. Whiteout conditions aloft are often caused by strong winds blowing over snow covered mountains similar to Baffin‘s. The winds swirls the blowing snow into fine crystals and there is so much light reflecting off the snow crystals, that a person cannot recognize anything. Now that we are in clear air, the navigator's job is to find a celestial body to check our gyros and the heading. It is twilight and the sun is below the horizon but there is too much light for the stars to be visible. This navigator has been airborne often in the past few weeks and he is aware that Jupiter, a very bright planet, is above the horizon in evening twilight. He refers to the Air Almanac and his Hydrographic publications and sets the astrocompass to the data he has calculated for Jupiter. Sure enough, when he sights thru the astrocompass, mounted in the astrodome, there is a pinpoint of light which must be Jupiter. It is just behind the left wing and about 12 degrees in elevation. He lines up Jupiter accurately and reads the aircraft's heading on the astrocompass scale. The copilot's gyro is closest. It is only 4 degrees off. The pilots reset their gyros and correct heading. The navigator removes the astrocompass mount and sights Jupiter with his sextant to find a line of position. Combined with dead reckoning, this is not an exact position but it is the best they can do. As they fly north the sky actually becomes brighter.

After 4 hours twenty minutes the northwest cliffs of Greenland come into view slightly off to the right. Thule is nearly at 77 degrees north latitude and with the sun's declination more than 13 degrees north, the sun will be just on the horizon at midnight local. From 11,000 feet altitude and 80 miles south of the weather station, the sun's direction can be seen. It is just below the northern horizon.

Thirty minutes later the pilot sets the C-54 down on the 4,500 foot gravel strip. Its "warm" at Thule. It actually is warmer than Frobisher, about minus 30. The weather guys at the station tell you the bay ice "warms" the area along the coast. They jokingly call Thule "the banana belt" of Greenland.

After your restful sleep in a Nisson Hut, warmed by an oil heater, you venture out on the ice with Col Balchen and a guy from the weather station. He has an augur which he asks you to turn to measure the ice thickness. After 45 minutes turning the augur (you take turns) you finally bore thru the ice. It is just under six feet thick. Something tells you those cargo ships, with the materials to build the new Dewline Base, are not going to reach Thule for at least two months. The C-54 is on its way back to Frobisher but you have some surveying to do and have to find a table or desk in a warm place to work. After that you will catch the next flight south in a few days. You hope the navigator is as sharp at polar navigation as the one on this last crew. You have learned that knowing what direction you are flying is even more important than knowing your location.

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