

Mayday in December

“Mayday mayday.” This message of a pilot in distress on radio three days before Christmas 1978 is heard by Auckland ATC. The saga of how Jay Prochnow was finally located by the innovative navigational techniques of Captain Gordon Vette aided by Malcolm Forsyth both of Air New Zealand, Auckland ATC, Norfolk Island and the crew of the Royal New Zealand Air Force (RNZAF) Orion is made into a Brain Game. The Penrod, a towed oil rig with running lights, served as a beacon which enabled Captain Vette to rendezvous with Jay Prochnow.

The Sun reached its highest ascension 21 December 1978 at the winter solstice (summer in the Southern Hemisphere) and the very next day Jay Prochnow (a former U.S. Navy pilot), piloting a Cessna 188 AgWagon found himself lost. He was ferrying the Cessna from Pago Pago to Norfolk Island. With a failed ADF and an overdue ETA, he was deeply worried.

Prochnow began an expanding square pattern hoping to find Norfolk Island before the fuel ran out. Capt. Gordon Vette in command of an Air New Zealand DC-10 (equipped with three inertial navigation systems), believed to be near the Cessna, was enlisted by Auckland ATC to help locate the lost Cessna. Vette, a qualified navigator, contacted Prochnow and asked him to head toward the Sun and to report his magnetic heading. Prochnow pointed the Cessna to magnetic heading 274 degrees as Vette steered his DC-10 toward the Sun and read his magnetic heading as 270 degrees. Next Vette instructed Prochnow to determine the elevation angle of the Sun above the horizon using his partially outstretched arm and fingers as a sextant. Prochnow established the elevation of the Sun as four fingers as Vette measured the elevation of the Sun as two fingers. Vette estimated the Cessna was about 240-250 nmi (each finger was slightly more than 2 degrees with each degree worth 60 nmi) from the DC-10. Vette was then able to get within VHF boxing range of Prochnow in 7 or 8 minutes. Prochnow was directed to fly east toward the DC-10. The Sun began to set. Norfolk Island and Prochnow were both instructed to note the time that the upper limb of the Sun sank below the horizon. With this information, the results of VHF radio reception (contact/loss) and the time of sunset comparison observed at Norfolk Island and the Cessna, the Cessna's position was determined to be within 290 miles of its destination. Rendezvous over a towed ocean rig refined the position and Prochnow was directed to a heading to intercept Norfolk Island. We may conclude that the Cessna was:

- a. Northeast of the DC-10 initially and located by using sunset tables adjusted for altitude and VHF reception
- b. Southeast of the DC-10 initially and located by using sunset tables unadjusted for altitude and VHF reception
- c. Southwest of the DC-10 initially and located by using sunset tables adjusted for altitude and VHF reception
- d. Northwest of the DC-10 initially and located by using sunset and declination tables adjusted for altitude and VHF reception

The answer is:

In constructing this Brain Game certain liberties were taken regarding details of air-to-ground-to-air coordination. However, the concepts of location finding portrayed are based on the valid techniques employed by the DC-10, Norfolk Island, Auckland ATC and the Cessna.

Space limits including all the details of the crisis confronted by Prochnow and all the refinements employed in the search. Since the heading of the Cessna to the Sun was 274 degrees it was greater than the 270-degree heading of the DC-10, that meant that the Cessna was south of the DC-10 as shown in Figure 20 . Since the elevation angle of the Sun measured by Prochnow was higher than that established by Vette, the Cessna was closer to the Sun or west of the DC-10 as shown in Figure 21 . Thus, the Cessna was southwest of the DC-10.

Vette recognized that the VHF communication link could be exploited to locate the Cessna. He requested that the Cessna orbit as he raced through the VHF range circle which had a radius of about 200 nmi as depicted in Figure 22 . A map of the region, courses, and events is depicted in Figure 23 .

Capt. Vette reasoned that if he marked the points at which he established and lost contact with the Cessna, he could find the location of the Cessna. He knew the diameter of the VHF range circle was 400 nmi. He flew his DC-10 along track 1-2 as depicted in Figure 24. He acquired VHF contact at point 1 and lost VHF contact from the Cessna at point 2 (marking the point) at which time he turned 90 degrees left and began his aural box pattern. After flying on this new leg for a reasonable period, he turned 90 degrees left for a short period followed by another 90 degree turn to the left and at point 3 he regained VHF contact with the Cessna (as he marked his map). He continued through point 4 where he lost VHF contact with the Cessna. Using the intersection of the perpendicular bisectors to the two chords flown within the VHF range circle, Capt. Vette established the center and the location of the Cessna. The Cessna, however, was not immediately found. Earlier, the DC-10 had dumped fuel to leave a trail which was not seen by Prochnow. Capt. Vette recognized that one can determine the difference of longitude between Norfolk Island and the Cessna by noting the GMT of sunset at the two locations. Norfolk's local time was 1900 for this event. The Cessna's time was reduced to sea level (as Prochnow would see sunset later owing to his altitude and his eastward displacement from Norfolk Island). The difference between the times in GMT for sunset at the two observations was 22.5 minutes which corresponds to 5.6° longitude (a degree is equal to 4 minutes in time). Norfolk's coordinates were latitude 30°S , longitude 168°E . This would place the Cessna at longitude of 173.6°E , 291 nmi east of Norfolk ($5.6^\circ \times 60 \text{ nmi/deg} \times \cos 30^\circ$). Prochnow was directed to fly northwest during this interlude as he was regarded as being southeast of Norfolk Island. A RNZAF Orion was dispatched to help find the Cessna which had been airborne for 20.5 hours and now had minimum fuel remaining. Continued plotting by the navigators showed that the Cessna was approximately at 30°S , 171°E . Prochnow soon saw a light on the water's surface. Prochnow found an oil rig under tow whose coordinates (31°S , $170^\circ 21'\text{E}$) were relayed to the DC-10 and enabled a rendezvous with the Cessna. The Cessna was less than 150 nmi from Norfolk and was given a steering direction by Vette of 294° magnetic heading to Norfolk Island. The Cessna landed safely after being airborne 23 hours and 5 minutes arriving at close to midnight 8 hours beyond its 1600 ETA. Prochnow had stretched the Cessna's twenty-two hours of fuel by 5 percent through cruise control.

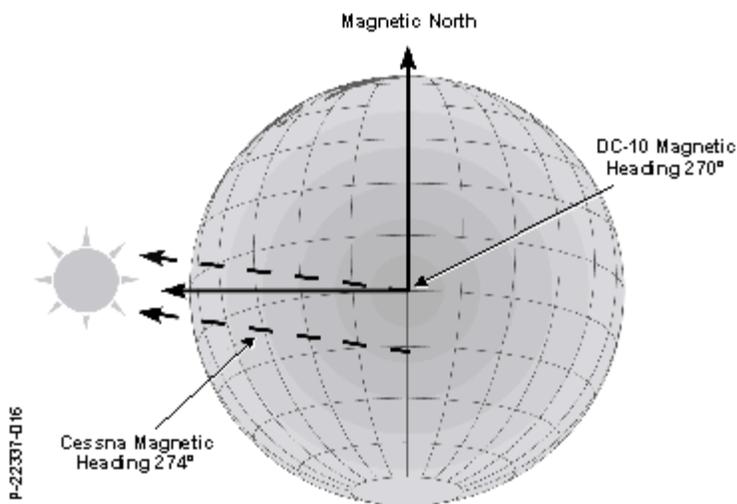


Figure 20. Cessna South of the DC-10

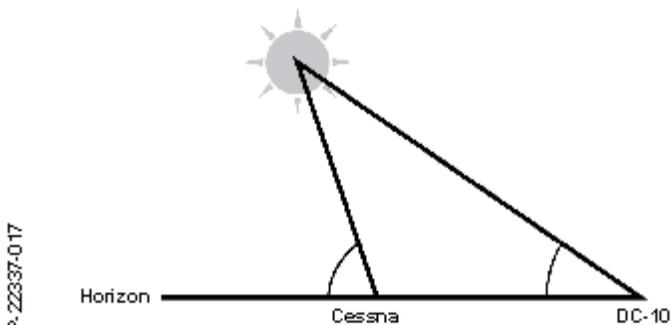


Figure 21. Cessna Must Be West of the DC-10

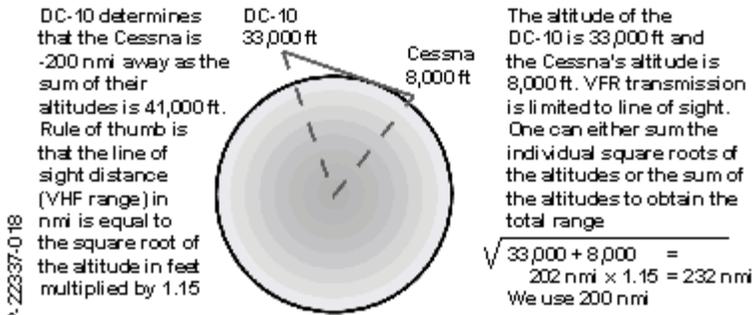


Figure 22. VHF range

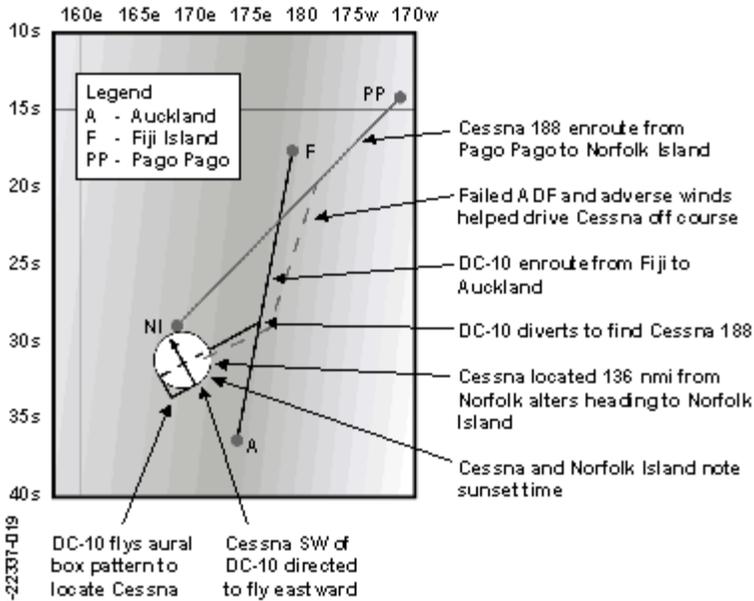


Figure 23. Map of Mayday in December

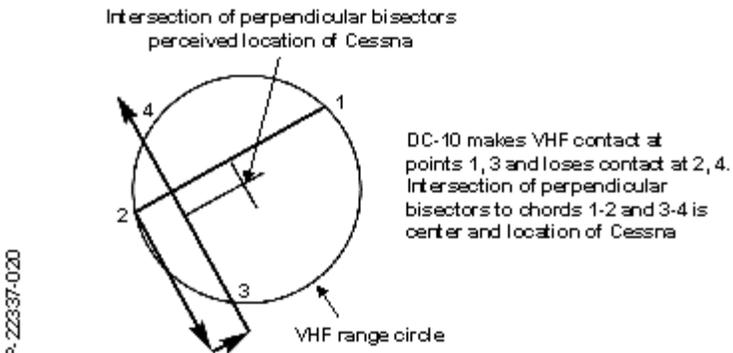


Figure 24. Flying the Aural Box Pattern into the VHF Range Circle

Sources of error

Aural boxing. Depends on continuous transmission on VHF otherwise a silence can be construed as loss of contact. To be accurate the acquisition and loss of Prochnow's VHF transmissions would have to be accurately noted. There could be timing errors in this procedure in noting these events (30 seconds error in the same direction on each end contributes to 10 nmi error at 600 knots ground speed).

Sunset observation. Accurate determination of longitude by observing time of sunset requires knowledge of latitude by observing sunset and noting the time in GMT one may determine longitude by assuming a latitude of the site.

The Local Mean Time of sunset changes 13 min/5° latitude in this region of 30° latitude. Therefore, an error of one degree latitude contributes to 2.6 minutes in time error which is 2.6 min x 1°/4 min or 0.65° of longitude uncertainty or

$0.65^\circ \times 60 \text{ nmi}/^\circ \times \cos 30^\circ$ or $0.65 \times 60 \times 0.866 = 33.8$ nmi error in longitude which demonstrates that determining longitude by assuming a latitude is very sensitive to the latitude assumption.

Afterword

Captain Vette had dumped fuel when he thought he was within visual contact of the Cessna. He believes that the Cessna's opaque canopy prevented Prochnow from sighting the DC-10. Vette concluded that his dump position was behind the Cessna as verified from his inertial navigation coordinates and an HF line of position.