SURVEYING BY AERODIST IN GUYANA

by Guenter Bellach O.L.S.

In the Spring and early Summer of 1967 I was fortunate to be able to participate in the first-order control survey of the Northerly portion of Guyana, South America. The project was carried out under the Canadian Foreign Aid Programme and consisted of the production of a series of topographic maps at the scale of 1:50,000 covering most of the country. The initial portion of the project dealt with the establishment and determination of positions of 21 control stations. The writer together with John Verhaegen O.L.S. and another member of the staff of Marshall, Macklin and Monaghan, Ontario Land Surveyors were seconded by that firm to Survair Ltd. of Ottawa, which firm together with Terra Surveys Ltd. of Ottawa had contracted this project from the Government of Guyana.

Guyana, a country of approximately the size of Southern Ontario, has a population of some 700,000. Formerly a British colony, Guyana became an independent nation on May 26, 1966, after experiencing repeated disturbances of a political and racial nature in recent years. The country has a colourful racial composition. The majority of the population is comprised of about equal parts Negroes and East Indians. The remainder, less than 10%, is made up by Amerindians, Europeans and other races. Dutch, French and British colonial rule have left their impression in the form of many place names in the coastal region like Beterverwagting, La Bonne Intention and Buxton, to name a few. Georgetown is the capital with a population of about 100,000. In this city, which was described to me as having been taken right out of a Somerset Maugham novel, are many picturesque wooden buildings exhibiting English, Dutch and East Indian influence.

This is a truly tropical country extending from 1 to 9 degrees North latitude. Nevertheless the climate is very pleasant, as particularly the coastal areas are almost continually fanned by the trade winds. Climatically the year is divided into two dry and two rainy seasons, the latter occurring around Christmas and around May to July. When it does rain it is nothing less than a tropical downpour generally followed in short order by sunshine. I remember one such downpour during which the streets of the capital city were covered, sidewalks and all, with about half a foot of water.

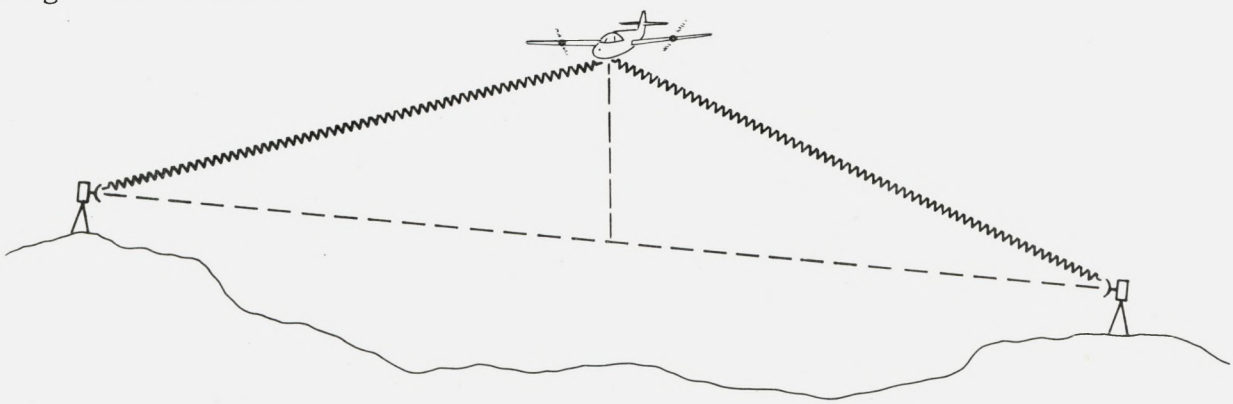
The coastal region exhibits an extremely flat topography, in fact, much of this area is below sea level and protected from the tides by an extensive system of dykes. The name "Guyana" is an Amerindian word and means "Land of Many Waters". The name could not have been chosen more fittingly. Several mighty rivers find their way to sea from the interior, many of them carrying large amounts of sedimentary material with them. Taking a trip on one of the two railways of the country from Georgetown Easterly to its terminus at Rosignol at the Berbice River, where it connects with the ferry to New Amsterdam, is like travelling across one giant lake, since much of the area is used for the cultivation of rice, which is produced in large enough quantities as to leave significant amounts for export. Other exports are diamonds, gold, manganese, bauxite and the products of sugar cane. The first three minerals are found in the Southwest central region; here the country rises to a maximum elevation of close to 10,000 feet at the top of Mount Roraima. At the Northern tip of this mountain the boundaries of Guyana, Venezuela and Brazil meet. The mountains in this area are almost without exception table mountains providing the conditions for many waterfalls. The highest of these is Kaieteur Falls with a sheer drop of 741 feet. This is the diamond country of Guyana. These are generally washed, often with the help of mechanical pumps, from the sediment of creeks and rivers. During my stay at Kamarang, a settlement in the centre of this area, a diamond worth about $200,000 in its raw state was brought in from the bush.

The most Southerly region of Guyana is taken up by the Rupununi Savannahs. Cattle breeding is the major enterprise here. Formerly cattle ready for slaughter were driven in herds some 300 miles through virgin jungle along the Rupununi Cattle Trail to the coast. Understandably when they arrived they were often only skeletons. Now the cattle are slaughtered in the area and the meat transported by air to the coast. This fact, perhaps more than anything else, demonstrates the complete lack of roads and other economical routes of transport in the area separating the savannahs from the coast. The Rupununi Cattle Trail is the only land route and has been traversed by jeep only a very few times, I was told. Although a number of large rivers flow through this area, these are often interrupted by rapids and falls making water transport lengthy, hazardous and uneconomical.

The need for roads brings us to the need for topographic maps, and the need for mapping to the need for primary survey control. The existing control prior to the commencement of this survey consisted of five stations, which are an average of 130 miles apart, established by the Interamerican Survey using the Hiran trilateration method. This method is similar to the Aerodist method described later. Other than this the country had been covered to a fairly high concentration with a system of fixes derived from local astronomical observations. These had been used for mapping to-date, but the geographic positions thus derived, not being tied to each other, were occasionaily in error by up to three miles. The object of the present survey was to densify the existing Hiran net so that the average distance between stations would be brought down to about 50 miles. For purposes of determining the position of these stations all distances up to a maximum of 160 miles were measured by Aerodist. As

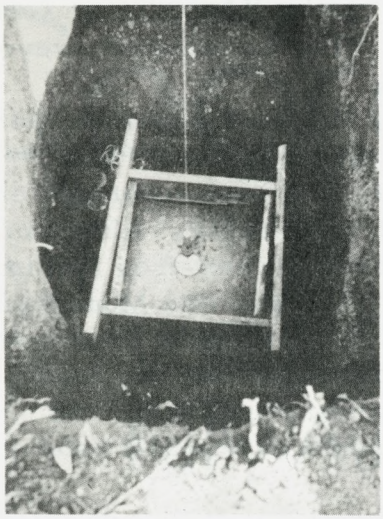
the shortest distance between adjacent stations was some 45 miles and the type of topography generally did not permit intervisibility between stations, measurement of horizontal angles was not attempted.

The aerodist is simply another adaptation of the Tellurometer. The master set is mounted in an airplane, a DC-3 was used in this instance, while two remote instruments are situated on the two particular ground stations between which the distance is to be obtained. The airplane, with the master continuously transmitting signals via a very wide beam antenna, flies approximately midway between the two ground stations and at right angles to the straight line connecting them, returning and passing over the line a number of times. The remote instruments, both tuned to the master, are directed along this connecting line and are responding continuously to the signal received from the master. At the master a continuous measurement is automatically recorded, which, of course, becomes longer or shorter, depending on how far the airplane with the master is away from the straight connecting line between the ground stations. The length of the measurement is also affected by the height of the airplane and by the meteorological conditions over the area through which the signals pass. The shortest measurement on each "line crossing" is the sum of the two hypothenuses of the two near-right triangles, while the sum of the two longer legs is the slope distance between the two ground stations.

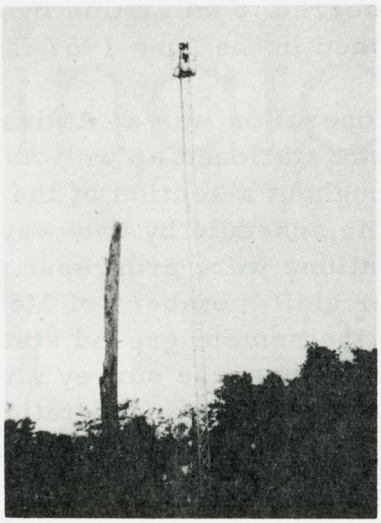


Each measurement consists of two or three individual measurements taken on different days with different weather conditions, and each of these consists of as many line crossings thought necessary under the prevailing conditions to ensure a sufficiently accurate result. Meteorological observations are taken continuously at the airplane and at the ground stations. Elevations are determined by barometer.

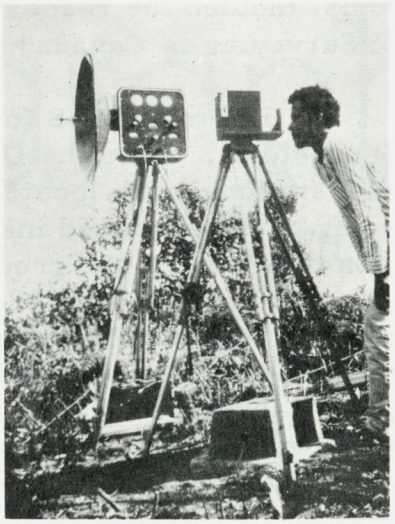
Adjustment and checks on the barometer heights are carried out by two methods. On each station a "heighting" is taken where the airplane makes an overhead pass over the station taking a vertical aerodist measurement which serves to calibrate the various barometers in use against each other. As it is almost impossible to aim an airplane to pass directly overhead a particular ground position this measurement can only be a near-vertical measurement. The angular deviation from the vertical is observed on a very simple sighting device called a "zeni-flub". The airplane is observed as it passes through a system of circles that is projected concentric to the zenith, each circle representing a particular angular zenith distance. The shortest measurement taken is matched to the angular value of the closest ring to the centre touched during each pass. Another check on barometric height determinations is afforded by the Airborne Profile Recorder. This is a sounding device where signals sent from the airplane are simply bounced off the earth's surface. "A.P.R." lines are flown in from the sea surface to various ground stations supplying an elevation profile of the line traversed. The precision of Aerodist measurements is in the 1:100,000 range, with the resolution of an individual measurement lying around three feet. Modulation chan-



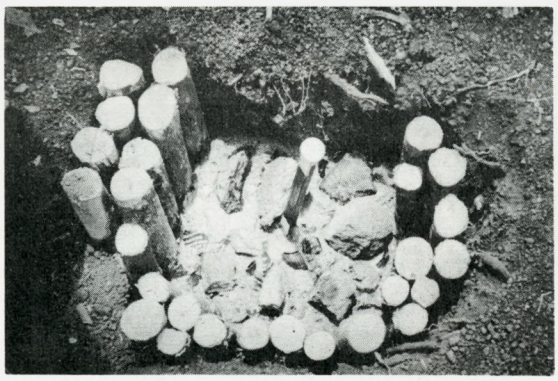
Finished lower portion of main monument at station "Tiger"



Observation tower at station "Lion"



Aerodist, zeni-flub and main monument at "Holitipu".



Reference monument at station "Tiger" partly poured. Note the upkeep of old surveyors tradition in "re-inforcing" the monument with (broken) beer bottles.

Completed reference monument at "Tiger"

Campsite at station "Tiger"

Aerodist and view from station "Maurugaru"

ges are effected by an automatic mechanism. Ground swing (reflection of stray rays, introducing erroneous components into the measurement) is controlled by varying the altitude of the airplane for each line crossing. For a more detailed description of the Aerodist method the reader is referred to an article by A.C. Tuttle: "Aerodist in Geodetic Surveying in Canada" published in the June 1967 issue of "The Canadian Surveyor".

The main base for the operation was at Atkinson Air Field, the main airport of Georgetown. Here the DC-3 was stationed as well as the computing staff. Six ground stations were located throughout a section of the country and were informed each morning of the proposed measuring schedule by two-way short wave radio. After completion of a section the ground stations were progressively moved in leap-frog fashion to adjacent areas. I and the other staff members of Marshall, Macklin and Monaghan were each responsible for one of the remote ground stations. One station's crew comprised generally one Canadian, one Guyanese survey student assistant and two local helpers (labourer and cook). Weather and transportation situation permitting, the measuring schedule included between two and seven measurements of one half hour each per day.

The remote station operator had to construct a system of main and reference monuments and obtain distances and astronomical directions of the lines connecting reference and main monuments. For the latter I found the sun the most convenient to use, as completely cloudless days and particularly nights are quite rare in the tropics. It is a lot easier to get a short peek at the sun than to hunt for a star amongst the clouds. Polaris was to be seen just barely over the horizon, where the cloud concentration, as the eye sees it, is the heaviest. The Southern Cross can be seen in these latitudes quite high above the horizon at the proper time of the night. The sun provides quite accurate directional results, as it passes almost directly overhead and changes in azimuth only very slightly, being in the morning almost due East and in the afternoon almost due West. The main monument consisted of two concrete columns 14" square and 24" high with brass cap both buried and positioned one vertically above the other and separated by six inches of soil. Four reference monuments were also placed, sized 10" square and 24" long. On rock outcrops reference monuments and the lower portion of the main monument consisted of brass caps cemented into holes drilled into the rock. The upper portion of the main monument was a 6" high square concrete column anchored firmly onto the rock by slanting steel rods which were cemented into drill holes.

Most of the country is heavily forested, although the soil in the interior is often marginal. On about half the stations an observation tower was necessary to obtain clearance above the tree tops. The highest tower was 130 feet at station Baramita. Ordinary 12-volt car batteries provided power supply for aerodist and short wave radio. Each station was supplied with a small, portable Honda generator for keeping the batteries charged.

Helicopters were almost exclusively used for the final stage transport of equipment and crew to the remote stations, as these were mostly in otherwise inaccessible country on jungle, hill or mountain top locations. The station operator was requested to take on the initial trip all food, equipment, etc., necessary for about four weeks, e.g., until work at this station was completed. Weather conditions, particularly during the rainy season, and helicopter break-down rendered this service very unreliable. On one occasion I was left stranded on a station with rice and dried fish the only food remaining and worse than that, no books to read. The first sound of the

helicopter approaching with mail, reading material and food in the form of fresh eggs, fruit and meat was a very welcome sound indeed after six weeks.

Each crew was supplied with one shotgun, but local game was rather sketchy. My crew was able to bag one tapir (a piglike animal locally called "bushcow"), a good number of "powis" (a black well tasting bird somewhat larger than a pheasant) on one station, while nothing could be obtained at any of the other stations. We also caught two of the ill-famed, voracious piranhas, locally called perai. Apparently these fish are only plentiful and really dangerous in the months of August and September. In March we were able to bathe in the same location, close to shore of course, without any harm. If you like baboon meat (a small monkey) there were plenty of them around always, making quite a racket at sunrise. It seemed they held meetings around this time. Their communal howling sounds much like the howling of wolves in Northern Canada. Iguanas were plentiful at one station on the coast, but the Canadian party chief there could not be persuaded by his local staff to taste the meat of this large lizard. It bears locally the name "green fowl", which is supposed to be descriptive of it's taste. Astonishing to me in the beginning was the preference of the local inhabitants for fat food. In the first two weeks I did not feel the desire for much food at all in that warm climate, but later I developed a voracious appetite and similar preferences for fat food. Indeed, in our crew rice was had at least once a day and Indian curry flavoured our meals at least twice a week. A very tasty concoction prepared by our cook was "bakes", balls of dough raised with baking power, fried in boiling fat and eaten with plain sugar. The favourite national dish seems to be "cook-up", a rather heavy mixture of rice, fat pork(pig tails) and black-eyed beans. All non-alcholic beverages are called tea, like cocoa-tea, coffee-tea or just plain tea-tea. Of the other type rum is the universal favourite. Plain drinking water presented no problems in the bush, although it had to be carried sometimes up to one mile to the camp. If it was flowing water it could be consumed without boiling or other treatment.

My participation in this project was an extremely rewarding experience. I shall never forget the magnificent, panoramic view which we enjoyed on each clear day from our station on Mount Holitipu with the perfect cylindrical top of Mount Eluwarima about 40 miles to our Southeast and the mountains of the Pakaraima Range including Roraima stretching into the Southeastern horizon. Unforgettable also is the experience of being in the midst of a thunderstorm at cloud level on the top of a sheer rock face at the station on Mount Maurugaru. Last not least I shall always remember the warm companionship I enjoyed with my local assistant and helpers.

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THE MAIL BAG

On Safari

The Editor:

All the best from 'darkest Africa'. We're on a hunting safari in Tanzania -- even have an electric plant in camp. Got a good sable yesterday. Regards to all.

Bill Wildman

(Good hunting Bill! But what about those Masai gals? - The Editor.)