FAIREY SURVEYS

Newsletter

January 1969

I

News of developments in the world of surveying and mapping

Published by Fairey Surveys Ltd of Maidenhead Berkshire England. Telephone Maidenhead 21371

One-inch contours?

Something of a breakthrough has been made recently in the field of contouring from aerial photographs. Using a sortie flown over an area of airfield runway, a standard error in photogrammetric heighting of less than 0.5 inches was achieved on an overlap containing 100 check points, four of which had been used as control. This result has created considerable interest among engineers and others concerned with such problems as surface deformation, drainage, earth movements and engineering structures of all types. A programme of test and experiment is continuing.

How has this remarkable result been achieved? By helicopter photography from an altitude of 250 feet, the long-standing problems of vibration having at last been solved by the use of silicone-damped spring Faireymounts, similar to those now in use on many Royal Air Force long range reconnaissance

Continued on page 2, col. 3

Air or ground?

Until only a few years ago, air survey was not considered accurate enough as a means of producing large scale plans. The position has now changed and air photography is regularly used for the production of engineering plans to scales of 1 : 500 and larger. For large areas, the aerial approach often offers the only economic solution but this does not mean that air survey is necessarily the fastest and most economic solution for the mapping of all types of areas.

Professional survey companies are continually called upon to offer advice to clients as to the best means of producing maps for their particular project.

For certain types of work, pure ground survey may offer distinct advantages. Such work may include property and site surveys in both urban and rural areas, some forms of topographical work and other types of surveying required for building or engineering projects.

During recent years, availability of modern distance measuring equipment, automatic levels, self-reducing tachyometers and the possibility of automatic plotting of field observations, has added a new dimension to ground surveys.

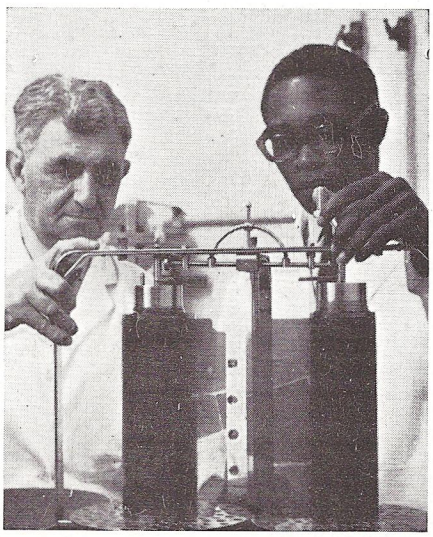
In the United Kingdom, other additional factors which must be taken into account in assessing the two alternative systems are photographic weather conditions, traffic congestion and tree cover and growing crops which occasionally make it more economic to employ a ground survey method.

We propose to discuss this subject in more depth in later issues. For the moment we would simply emphasise the desirability for a survey organisation to have the ability to undertake all types of survey in order that a proper professional judgement may be exercised in deciding whether to do a survey from the air, from the ground or by a combination of both.

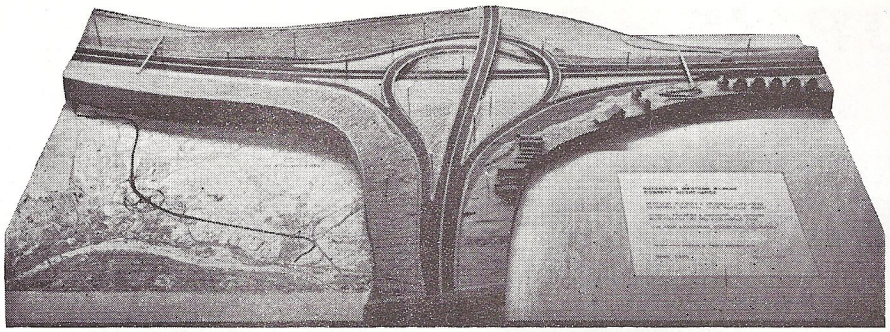
Kenya candidate for training

Kenya is the latest country to send one of its young surveyors to Fairey Surveys for training. He is Mr Frank Oyuga, 23, from the Department of Survey in Nairobi. He trained as a qualified ground surveyor and was selected from over 400 applicants to become qualified as the Department's first indigenous air photographer. During his six weeks training at Maidenhead, Mr Oyuga operated the Wild R.C. 5A and R.C.8 cameras with their associated equipment and was instructed in flight planning, the principles of navigation, and the processing and printing of aerial films.

He is not the first surveyor from the developing countries to be trained by Fairey Surveys. Many other African nations have sent their technical teams to Maidenhead for instruction while in Iran Fairey Surveys set up a complete training establishment. In addition, the Company makes available comprehensive consultancy and training programmes to meet whatever needs a country may have. International training centres are already available in the Netherlands and Switzerland but whereas the emphasis there is on theoretical work, at Fairey Surveys the trainees have an opportunity of becoming thoroughly immersed in every aspect of practical work as well.



Right: Mr Frank Oyuga with his instructor, Mr John Rushton, at Maidenhead examining film after processing.



Model of the Consett Interchange—Gateshead By-pass made for Ove Arup and Partners from expanded polyurethane, on the new Fairey Modelling Machine, direct from a 1 : 500 contour plan with 1 foot vertical interval contours.

Precision models direct from maps and drawings

Three dimensional models accurate to five thousandths of an inch can now be made direct from contour maps or plans by Fairey Surveys. The light-weight models are carved from solid blocks of close-grained rigid polyurethane by a new precision modelling machine, and are directly comparable in accuracy with the original base map or drawing. A section of mountainous terrain, a boat hull, a model township or the ground contours of a proposed motorway or reservoir are equally suitable subjects for the machine.
The instrument maintains a high standard of planimetric accuracy over a large working area with vertical tolerances of ± 0·005in. The models are supplied from single polyurethane blocks for sizes up to 4ft square. Larger models can be manufactured in sections and then assembled.
Fairey Surveys are offering a model making service based on this instrument to architects, engineers, local and central government departments, railways, river boards and other similar professional users.
The machine itself comprises two tables, one for tracing and the other for modelling. The modelling table is capable of extremely accurate vertical movement measured by dial gauge and under the control of a hand wheel and gearing mechanism. A master guide bar between the two tables controls the precision carriage which is stabilised at each end, and which carries both the tracer and the cutting bit. The cutter is powered by a 230/250 volt A.C. electric motor.
The drawings from which the models are made can have been prepared by conventional engineering drawing methods or can be the result of three dimensional photogrammetry which is already offered by Fairey Surveys as a service to industry and the professions.

Simulating earthquakes

A laboratory in which earthquake conditions can be simulated has been set up in Japan. The equipment comprises a Fairey electrohydraulic vibration actuator coupled to a horizontal platform. To reproduce earthquake vibrations of any magnitude up to severe, an input signal is sent to the vibration actuator by computer, magnetic tape, programmer, special wave form generator or from a simple electronic oscillator. The resultant vibration enables scale model buildings, made from either miniature bricks and mortar or girder framework with flooring, to be tested under earthquake conditions simulated with remarkable accuracy.
Apart from seismic surveys, vibration generators are being increasingly employed in other branches of what might be broadly termed ' earth sciences.' They are being used to test the strength, impact and wearing characteristics of roads, to evaluate the dynamic qualities of concrete and soil samples, to detect in bridge structures any weakening through fatigue well before failure occurs, and to conduct seismic surveys of underground geological structures. They are also able to provide quality control in the construction of motorways because the dynamic characteristics of a well-made road are very different from those of one which has been built on poor foundations.

Tours of Inspection

A feature of most Fridays throughout the year at Maidenhead is the party of visitors being conducted through the premises. One such party comprised 21 Councillors and 3 Officers of the Surrey County Council, led by the County Engineer Mr W. C. Hall, C.Eng., M.I.C.E., A.M.I.Struct.E.
An introductory lecture with slides, was followed by a tour of the technical departments and it was obvious from the level of interest shown and the penetrating questions discussed, that this two-way exchange of views and needs, had proved of benefit.

A party of 34 students from the International Institute for Aerial Survey and Earth Sciences, Delft, Netherlands, was welcomed to Maidenhead by Mr W. P. Smith, Joint Managing Director. The student party was completely international in cross-section with students from North and South America, Japan, Australia, all parts of Africa and the Middle East as well as Continental Europe. The emphasis in these bi-annual visits is on the practical applications of fully developed photogrammetric techniques, which adds a valuable rider to their academic studies in Holland. Fortunately for the students, cloud base was low over the UK on the day of the visit and they were able to visit our aircraft fleet grounded at White Waltham Aerodrome and see the practical tools of the air photographer: aerial cameras, anti-vibration mountings and navigational aids.

Continued from page 1

cameras. The pictures are remarkable for their sharpness and since the Aviogon lens employed has resolution up to 50 lines per millimetre it is not difficult to imagine the fine detail which can be interpreted.
The test area chosen was a paved area of hard standing at White Waltham Aerodrome, Berkshire.
The camera used was a Wild R.C.8 with a 6 inch focal length Aviogon lens. Ground control points were co-ordinated in plan and height; checked height points were surveyed to an average density of 100 per stereoscopic overlap of photography. The photogrammetric measurement of the check height points revealed a standard of less than 0·5 inch from 1 : 500 scale photography.
Many interesting fields of application have been opened up by this new tool . . . traffic counts and car flow pattern, car parking analysis and agricultural analysis being among them. We will keep our readers informed and would be pleased to hear from those who feel that we may be able to help in any particular problem.

M4 survey

For most motorists, a motorway is a rapid means of getting from one place to another. Usually too, motorways are easy to drive on, without the pedestrians, cyclists, dogs and other hazards, normally met with on our other roads. Perhaps for this reason the motorist is more intolerant of, irritated by, and less prepared for, hazards on a motorway. The road maintenance unit, an accident, even fog perhaps, are all seen as intolerable incursions on his freedom to tear along at high speed.
Fairey Surveys are working on a survey contract connected with the widening of part of the M4 Motorway and our surveyors soon realised that they were intruders in an alien world. Running a precise traverse along the central reservation with traffic roaring past at 70 mph can be a frightening business. Despite the resplendent fluorescent jackets the men wear, the margin for error seems slight when even to cross the road requires a high degree of agility and judgement.
The senior surveyor on the job asks how surveying in a concrete jungle like this can be called Land Survey and says he would rather have the solitude of the desert any time.

Infra-red sensing

An amusing sidelight on aerial reconnaissance came to light recently when one of Fairey Surveys' aircraft was making an experimental run over the South of England using an infra-red sensing device. The output from the instrument revealed three small circles of white stones similar to prehistoric monuments. Curiously, one circle of white marks was much lighter than the other two. Investigation on the ground revealed that no prehistory was involved. They were three circles of chicken houses, the lightness of the one circle compared with the other two being due to the fact that it contained the younger and presumably more hotblooded chicks.

Frontier in the Andes

Settling international frontier disputes rapidly, accurately and without acrimony might be thought an impossibility in the world climate of the 1960's. In fact, Britain recently acted as arbitrator in a dispute of long-standing between Argentina and Chile which provided an excellent example of international co-operation. In both countries there is a justifiable feeling of pride in the standard they have established in the settlement of international disputes.

This article, a summary of a paper prepared by Major W. D. Rushworth, R.E., Directorate of Military Survey, and Mr W. P. Smith of Fairey Surveys Ltd, describes the contribution made by photogrammetry and ground and aerial survey to the demarcation of the frontier between the two countries, adjudicated by the Court of Arbitration appointed by the British Government. The mapping method adopted provides an excellent example of how a good topographic map can be made from limited ground control, using the full range of photogrammetric techniques and airborne aids available.

The area that was in dispute lies in Patagonia between latitudes 43 deg. and 44 deg. South, on the eastern slopes of the Andes. It is a country of rugged snow-covered mountains up to 2,000 metres high, intersected by steep and deep river valleys which are heavily wooded. The climate, even in summer, is not particularly attractive since although the area is protected from the worst of the Pacific storms, the rainfall is heavy and the winds of Patagonia are famous for their ferocity. The valleys in the northern part of the area have been partly cleared of trees by burning, and the burnt trees lie where they fell or in many cases still stand as stark sentinels, somehow in keeping with the grey landscape. The scattered inhabitants of these valleys live by raising sheep and cattle, with a few crops for home consumption. Occasionally, for a short period, the clouds lift, the wind drops and the sun shines. Then the full majesty and unspoilt beauty of the Andine scenery is revealed.

The section of interest lies between the two gaps in the Andes made by Lake General Paz and by the River Palena which flows from Lake General Paz first eastwards and then westwards to the Pacific.

The origins of the dispute really date from 1855 when Argentina and Chile agreed that the two countries should retain the territories which they possessed in 1810, when they separated from Spain. Unfortunately the boundary description adopted, '*the line of the highest peaks which divides the waters*' was a classically bad one since it was incapable of a literal interpretation. The swift west-flowing rivers had cut back eastwards into the mountains towards the pampas with the result that the watershed and the line of the highest peaks were many miles apart. In 1898 both countries submitted the dispute to Queen Victoria, who appointed an Arbitration Tribunal which reported in 1902. Subsequent exploration of the area proved this judgement to be unsatisfactory for one part of the boundary, so that in 1964 the British Government was again asked to act as Arbitrator.

The available mapping of the area was of varying scales and quality, the best being some 1 : 50 000 maps prepared by the Argentine/Chile Mixed Commission. Unfortunately these did not cover the full area in dispute and were, for reasons connected with their method of compilation, not acceptable to both Parties. The Court therefore decided to have air photographs taken of 8,000 square kilometres to assist it in its work and with a view to having a map made of some or all the area photographed. The weather records of the area showed the cloud-free periods were very infrequent but January and February were selected as the best months for air photography and for a Field Mission to visit the area. The time available for air photography and making the map was very limited if the whole of the Court's proceedings were not to be delayed by the surveyors. An A.P.R.* solution that required a minimum of ground control was therefore selected. The map was required at 1 : 50 000 scale with a contour interval of 50 metres. The results of the Welsh A.P.R. tests in 1962 indicated that accuracies of 2·7 metres in X, 4·4 metres in Y and 2 metres in Z could be achieved in a similarly sized area using only four ground control points, provided these points were adequately pre-marked.

Fortunately there were about 20 stations of the Mixed Commission triangulation in a chain down the centre of the area to be photographed. Of these, 14 were recovered and pre-marked, before the arrival of the survey aircraft. It was fortunate that the Parties provided light aircraft for reconnaissance and helicopters for visiting the stations, as without these it would not have been possible to complete this marking in the time available. The pre-marks were crosses, each arm being 23 metres by 2 metres.

At lower points locally abundant timber was collected to form a cross, whilst elsewhere either the bare rocks were cleared or stones were laid out. In all cases the cross was painted white. The difficulties were mainly concerned with the weather as there were unusually late falls of snow. The local inhabitants regarded it as somewhat eccentric to sweep snow off hills in order to paint them white. In one case the background rocks provided insufficient contrast with the white cross. The difficulty was overcome by standing stones on edge round the cross to provide shadow as a contrast. Contrast of texture is most important for a good pre-mark. This was achieved in some cases by laying brushwood round the wooden marks.

Air photography

The survey aircraft, a DC-3, arrived at Esquel on 13th January 1966, having flown from the Fairey base at Maidenhead, England, by the South Atlantic route. On arrival, the airborne profile recorder and photographic equipment were installed and there began a wait of 10 days without a break in the cloud-laden skies. On the morning of 24th January, 1966, the clouds started to clear and some photography was completed. The next day and the following morning were ideal for photography, but thereafter the clouds closed in again. This was the longest cloud-free break during the Field Mission's visit and during it all the air photography was completed. The scale was nominally 1 : 42 000, from a flying

**Airborne Profile Recorder, a radar altimeter system for topographical surveying.*

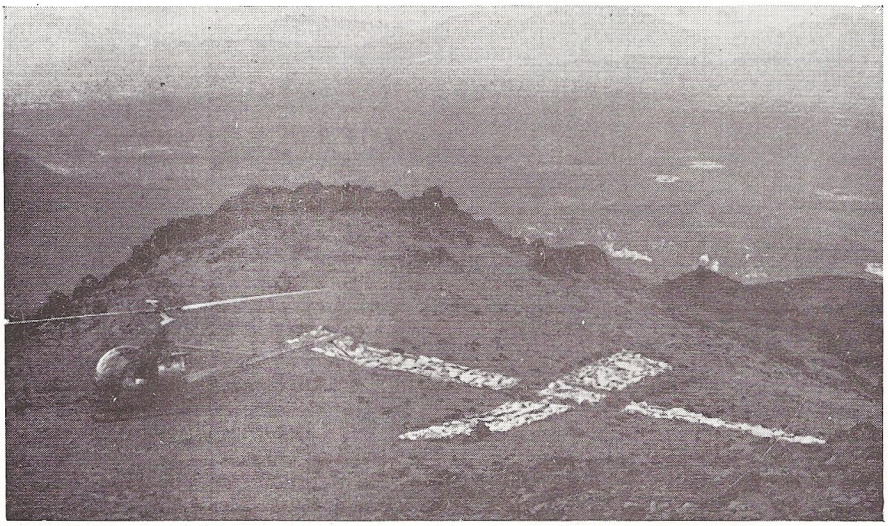
height of 26,000ft. above sea level and there were twelve main strips and five tie strips. All the strips were accompanied by A.P.R. centre-line profiles, totalling 1880 profile miles. The camera was a Wild RC5A with 152 mm focal length lens. Because of the relief, lateral overlap was increased to 30 per cent and fore and aft overlap to 80 per cent. Exposure was difficult to assess because of rapid changes in tonal values between the white snow on the summits and the dark green of the deep-forested valleys, which were often in shadow. All sorties began and ended over Lake General Paz whose water level was determined, during December 1965, in relation to the triangulation.

Two sets of field prints were provided for the use of the Field Mission during its inspection of the ground. These proved invaluable in the study of the complicated drainage of the area, a subject that was of great importance in the Case. The air photographs were also used to make a sketch map of the area for the collection of topographic names and route classification. The sketch map was considered to be a more positive method of collecting names than the usual method of collecting on air photographs. Name collection was complicated by the two Parties having different names for most features and because the people providing the names were generally lawyers unfamiliar with air photographs. The sketch map was controlled by enlarged copies of existing maps. It was drawn in Palena and copies were printed in Santiago and Buenos Aires by the Military Geographic Institutes of the two Parties.

After the return of the Field Mission to England the two Parties completed their cases for submission to the Court of Arbitration and work began on the plotting of the 1 : 50 000 map of a selected area within the photographed area.

Considerable difficulty was experienced in reading the A.P.R. charts due to the extreme relief. It was frequently impossible to distinguish between instrument 'steps' and topographical 'peaks' so a lot of careful backward and forward reading was necessary in many cases. Fortunately the subsequent photogrammetry provided a fail-safe system and easily resolved any stepping

errors, which only occur in multiples of 500 feet. The transfer of trigonometrical points and minor control also presented special difficulty because of vast height differences along the lateral overlaps. Similarly, special care was necessary to select A.P.R. ground points along flat valley bottoms or flat hill tops, as both were extremely rare in most of the area. Despite these difficulties the heights obtained from the A.P.R. adjustment, using only one known height as control, agreed well with the remaining stations used as checks, the mean square error begin $\pm$ 3 metres.



Marking of a control station in progress, prior to aerial photography. Helicopters were used extensively for the transport of men and materials to mountain summits.

The arbitration

The Court of Arbitration sat for five weeks in September and October 1966 and heard the political and geographical arguments for the two claimed lines. Both Parties employed cartographic experts and cartographic evidence extensively and both had models made of the area in order to help the Court understand the topographical and geomorphological points involved. Mosaics and enlargements of the air photography were also extensively used, though mosaics were only possible in the relatively flat eastern area. In the precipitous west they proved to be impossible by normal methods and would have taxed the ability of an orthophotoscope had one been available. The Court reported to the British Government on their findings and recommended a line for the boundary. On 9th December, 1966, Her Majesty the Queen made the 1966 Award based on the Court's report. Argentina obtained three-quarters of the disputed area, but Chile acquired the mainly-Chilean settlers in California, so that both Parties expressed themselves well satisfied with the Award. The delimitation consisted of ten key points marked on enlargements of the air photography. The course of the boundary between them was defined in terms of river courses, water-partings and straight lines. This has great advantages over either textual descriptions or the use of a map to define a point, since the photograph 'cannot lie' or at least not as much as we all know that maps can. Textual descriptions of points are very liabe to ambiguities. There is a temptation to define the whole line of the boundary by a line on an air photograph, but this could be dangerous if, for example, a water-parting is chosen as the most suitable boundary. The drawing of a water-parting on an air photograph, even in a first-order plotter, is not always easy and any divergence between the line on the photograph and the actual water-parting would lead to increased confusion.

Anticipatory preparations were made for demarcation before the December 1966 Award as it was considered desirable to complete the case during the 1966–7 southern summer if possible. The Award made the Director of Military Survey responsible for demarcation and he organised the Demarcation Mission.

Twenty-one Boundary Posts were erected by the Mission. The B.P.s are angle-iron pylons about 3 metres high, set in concrete, surmounted by a cast-iron plaque with the names of the two countries on opposite sides. Their positions were determined trigonometrically in relation to the existing Mixed Commission triangulation to third-order accuracy. This work was mainly achieved by Tellurometer and Distomat traverses, but four triangles were measured by classical methods. In order that the trigonometrical work could be completed quickly, stations were sited as far as possible where helicopters could land and on low ground, so that observations could take place when the mountains were in cloud. Most of the B.P.s were on water-partings and thus on hills above the tree line. This made them relatively easy to incorporate in a traverse. However, some B.P.s were at the bottom of very steep-sided and heavily wooded twisting valleys. It was quite difficult to get two rays from these points to accessible hills and it was only made possible by large forest clearance programmes and by accepting very steep lines, in one case 20°.

The location of the B.P.s and trigonometrical points were plotted by their co-ordinates on the map, a severe test of accuracy which it passed with flying colours. The line of the boundary between the B.P.s was plotted on the map and was readily located in most places. At the pass between the Arroyo Siberia and the Valle Hondo the drainage on the Court map disagreed with the Mixed Commission map, due to the difficulty in following streams under the tree cover. Compass traverses showed the Court map to be correct.

This map was printed in quantity for distribution to the authorities concerned and in addition a very limited number was printed on silk as mementoes of the occasion. Her Majesty the Queen was pleased to accept a copy of this map in silk from Fairey Surveys, other copies being presented to members of the Court and the Ambassadors of Argentina and Chile in London.

So ended an interesting survey; the second major boundary survey to be undertaken by Fairey Surveys Limited. Their first was to measure and record a section of the frontier between India and East Pakistan in 1951. This followed the centre-line of the River Ganges, a far cry indeed from the flat and intensely cultivated land of Bengal to the wind-swept slopes of the Patagonian Andes'.

The original article was published in "The Photogrammetric Record" Vol. VI No. 32

Tripod-mounted drawing pen

A recent development to come out of Fairey Surveys cartographic drawing office is a drawing pen mounted in a perspex tripod platform with either a single or a double head.

So effective is this new instrument that trainee draughtsmen are ready for full production work within a four week training period instead of the 4 to 5 months spent on training in the past. Even experienced draughtsmen are finding that they can work faster using the new tripod mounted pens.

The price of the single drawing head instrument is three guineas and for the double pen instrument, particularly useful for roads and railways, five guineas.