

Newsletter

May 1969

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News of developments in the world of surveying and mapping

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The Revolution in Distance Measurement

In Newsletter No. 1 we featured a small item entitled 'Air or Ground' and promised to continue to discuss it in more depth. We now have pleasure in presenting a specially written article by Mr. A. L. Allan, M.A., A.R.I.C.S., Principal Lecturer in Land Surveying, Waltham Forest Technical College, in which he summarises ground survey developments both in equipment and technique.

It has often been asserted, with little fear of contradiction, that "Surveying is a constant struggle between man's inventiveness and the necessity for traverse." That this is no longer true is due to the ease with which distances can now be measured indirectly by a varied spectrum of instrumentation. In this article we shall give a brief resumé of the state of the art of distance measurement as it affects the engineer and the surveyor engaged in routine work involving short distances.

One is apt to forget the astonishing transformation which has taken place in survey practice over the past few decades, as a result of the development of tacheometers and distance measuring devices. Until recently, all tacheometers obtained their quick measurement of distance by an optical analogue solution of a triangle, one side of which was read on a staff held either horizontally or vertically, and in which various reduction devices were incorporated to give horizontal distances directly. Recently, instruments have been developed in which distance measurement by modulated light has been grafted on to a theodolite. The optical tacheometers are capable of accuracies of 2 cm over distances of about 100 metres, whilst the corresponding figures for the "electronic tacheometers" are 2 cm over two kilometres.

In conjunction with this instrumental progress, more efficient field procedures have been evolved; whilst the rapid acceleration of output has necessitated corresponding improvements in processing and drafting methods. Instrumentation already exists which fully automates the life of an observation from its birth in the field to its final destiny as a plotted position. Located between the old manual systems on the one hand, and the fully automated on the other, there lies a vista of great variety, from which the surveyor may select a modern efficient system, which not only suits his requirements, but is also in sympathy with his purse.

Optical Tacheometers

Although some decades have elapsed since the introduction of optical self-reducing tacheometers, too many surveyors and engineers in the United Kingdom have been slow to appreciate their several advantages: even the vertical staff tacheometers whose special diagram circles eliminate tedious tabular reductions, are surprisingly little known. National survey departments, survey companies and "free lance" surveyors are alike in seeing the economical justification for purchasing a horizontal bar tacheometer at £900. These latter systems are eminently suitable for traversing and detail fixation in congested urban or obstructed rural sites. In close

association with tacheometry, some surveyors have developed "booking" systems using tape recorders, which bring very substantial savings at the plotting stage. All the above mentioned systems are available from the two Zeiss firms, and their Swiss counterparts Wild and Kern.

For routine detailing, and even traverse work, the Zeiss Jena BRT 006 Telemeter can soon repay its initial cost of £500. This rangefinder device has a range of 61 metres, an average accuracy of 3 cm, and gives either the horizontal or slope distance as required. It has many "off beat" uses, such as the three dimensional survey of an interior, and may also be fitted with a small plotting table on which



A Mk. 6 geodimeter being used on the ground survey for the Tees Side Parkway urban motorway project.

the radial direction is automatically obtained.

Another favourite for detailed work, is the Kern RK plane table equipment. Let it be assured, however, that apart from basics this equipment in no way resembles the traditional British concept of plane tabling. The price of £500 alone should indicate its sophisticated and imaginative design, which incorporates a telescopic alidade with parallel guidance mechanism for various plotting scales, a self reducing tacheometer to be used with a vertical staff, and surprisingly it has a slow motion device which enables the drawing edge to be brought to a plotted point with consummate ease. Remembering that plastic materials are little affected by weather, and that survey umbrellas have their uses outside the tropics, this system has few equals for quick versatile mapping at scales of 1:1000 or smaller.

Electro-optical distance measurement and tacheometers

The impetus for the development of distance measuring devices using the radio or optical spectra has been supplied by topographical and geodetic surveyors, and whilst the early Geodimeters and Tellurometers may have their applications in routine survey work and setting out, neither civil engineers nor metrologists were sufficiently convinced of their particular suitability to take more than a passing interest in them. The recent arrival on the scene of the Geodimeter 6A, and of the various infra-red systems, all within the £2500 to £3000 price bracket, is causing them to consider these systems seriously.

The most accurate commercially-available instrument is the Geodimeter 6A, which is capable of an accuracy in the region of 1 mm if various precautions are taken and special simple techniques are adopted for measurement.

And the next problem please

The aerial survey of the moon by Apollo 8 will produce some extremely accurate photogrammetric maps of this "romantic sphere." The sophisticated and highly expensive vehicle apart, this was routine air survey using familiar materials and data evaluation techniques. It does drive home what photogrammetrists have been saying for 50 years or more—that for measuring inaccessible or complex shapes and surfaces, photogrammetry cannot be beaten. Photogrammetry has proved to be the most practical method for measuring large engineering structures such as radio dish-aerials, difficult radio-active subjects, the height of waves produced by hovercraft and very recently facial morphology and the rate of change effected by orthodontic treatment.

The work has been pioneered at the famous Addenbrooke's Hospital, Cambridge, where, in conjunction with Fairey Surveys, an instrument suitable for use as a camera and a projection plotter has been developed. The

The MR4 Tellurometer embodies the additional advantages and disadvantages of a radio system, is accurate to $1 \text{ cm} \pm 5 \times 10^{-6}$ of the distance, and has been employed on urban traverse work; its weight, size and cost, however, render it less attractive to many surveyors.

Undoubtedly, the most exciting new instrument personally known to the author is the Wild DI 10, an infra-red system with an accuracy of 1 cm and a range exceeding 1 kilometre. It may be used only for distance measurement, or its optics may be mounted on a T2 theodolite producing a tacheometer with a superior performance. Two similar instruments exhibited at the recent London Congress of the International Federation of Surveyors (FIG), are the Askania Adisto 2000, and the Zeiss Oberkochen SM 11, for which ranges of two kilometres and a higher accuracy ($\frac{1}{2}$ cm) are claimed. News has also reached us of the Reg Elta 14, a completely automated version of the SM11, with visual or punch tape readout of angles and distances. No price nor availability are known, nor is there definite news of a commercial version of the NPL Mekometer, whose extremely high accuracy of 0.01 cm has been established by prototypes.

Field procedures

Reference was made earlier to the evolution of new field techniques designed to accord with this instrumentation. These include the wholesale application of radiation methods, the increasing use of entirely linear fixations, or trilateration, and a complete upgrading of traversing as a means of establishing control.

Survey networks have been given a new freedom, because lines of sight need not pass close to the ground, in fact much use is being made of elevated instruments and reflectors to clear urban congestion. Traverse accuracy has been enhanced,

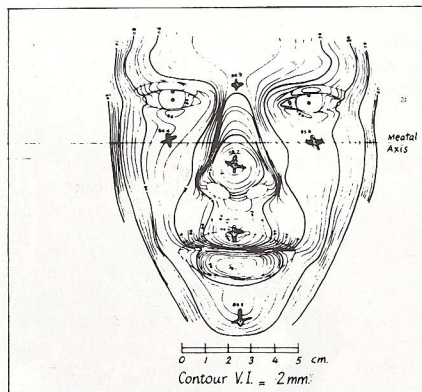
since longer legs are available, by the location of points on roof tops; while systems have been developed to transfer the high points down to the ground. The height from roof to ground can also be measured by the electro-optical instruments.

Some engineers have been quick to take advantage of these instruments in setting out works from an isolated instrument position, such as nearby buildings: such setting out requires the construction of a short rail mounted on a tripod, and is technically advantageous since each point located is virtually independent of all others.

Even the well established procedure of traversing has undergone modification, particularly in roof-top work: it is more efficient to measure an angle in two separate parts, connected by an intermediate reference object such as an "up station", or a collimator made from an old level telescope.

It is sometimes argued that these expensive tacheometers will lie idle much of their lives, since there are few occasions when they are really required. This view forgets that they can be used effectively as ordinary work-horses: a grid of levels for example can be surveyed by radiation methods with results only slightly inferior to ordinary levelling, but in a far shorter time. If the questioning finger of unreliability is pointed at these new instruments one can reply with conviction that errors from this source are negligible, and that checking procedures have been devised which prevent serious blunders: the wise surveyor does not accept blindly the output from the new "black boxes."

We will continue this discussion in later issues and hope shortly to include the views of a consulting Engineer who has had wide experience of both ground and air methods. Contributions from our readers will also be welcomed.



research work is being undertaken by the Department of Orthodontics and involves studying the growth of children's faces in three dimensions. Co-operation between this department and the photogrammetric department of Fairey Surveys has led to the adoption of a routine photographic procedure which is quick, accurate and completely acceptable for the patient. This last point is vital where children are concerned.

A patient is posed under the stereometric instrument, lying face upwards and with the head located

precisely in relation to the instrument. Photographic plates are exposed simultaneously in the two photo-carriers and after processing are placed back in the photo-carriers for stereo-projection. The stereo model of the patient is true to scale 1:1 and suffers from no intervening distortions or non-linearities

A contour plot is subsequently produced photogrammetrically and volume calculations made from the contours. At present the contour plots are produced by Fairey Surveys as there is no trained photogrammetric operator on the hospital staff, but the instrument at Addenbrooke's has proved its capability as a plotting machine.

One of the long term advantages of this simple fixed-base orientation approach is that any member of the medical team with good stereoscopic vision will be able, eventually, to produce the contour plots.

More than 60 patients have been photographed to date and it seems likely that this simple, accurate and compact device will stimulate interest in photogrammetric techniques from other branches of Medicine.

+ NEWS IN BRIEF +

New Magnetometer

Latest addition to the Fairey Surveys Geophysical Division is the Barringer 101B proton magnetometer which provides 0.5 gamma readout against only half this sensitivity on earlier equipment. Also installed in the geophysics Dove aircraft is Marconi AD 560 Doppler navigation to ensure maximum accuracy of line positioning.

SOME CURRENT U. K. PROJECTS:

Edinburgh Castle Rock—

25 centimetre horizontal-interval contouring of north rock face, using terrestrial photogrammetric methods.

Henley Royal Regatta Course

A 1 : 500 scale survey for planning improvements to the course.

Portmadoc Tidal Survey

1 : 2500 mapping with close contouring from photography taken at low tide. The survey will be used to plan deep-channel improvement works.

Berkshire County Photography

Complete cover at 1 : 10,000 contact scale.

TRANSPORTATION SURVEYS:

Luton-Dunstable Urban Motorway

1 : 500 plans with 2 metre contour interval and digital ground model to be measured on a 10 metre square grid.

Manchester Rapid Transit

Photography and some mapping at 1 : 500 scale for north to south rail transit scheme.

Renfrew Motorway Scotland

Four miles of 1 : 500 survey through western districts of Glasgow. Contours at 0.5 metre vertical interval and spot heights along roads and railways.

Wendover, Bucks Bypass

Ordnance survey 1 : 2500 revision with 2 metre contouring added.

Newcastle-Kilkeel Co. Down Road Improvement

Eight miles of 1 : 500 survey with 0.5 metre contours.

OVERSEAS

India

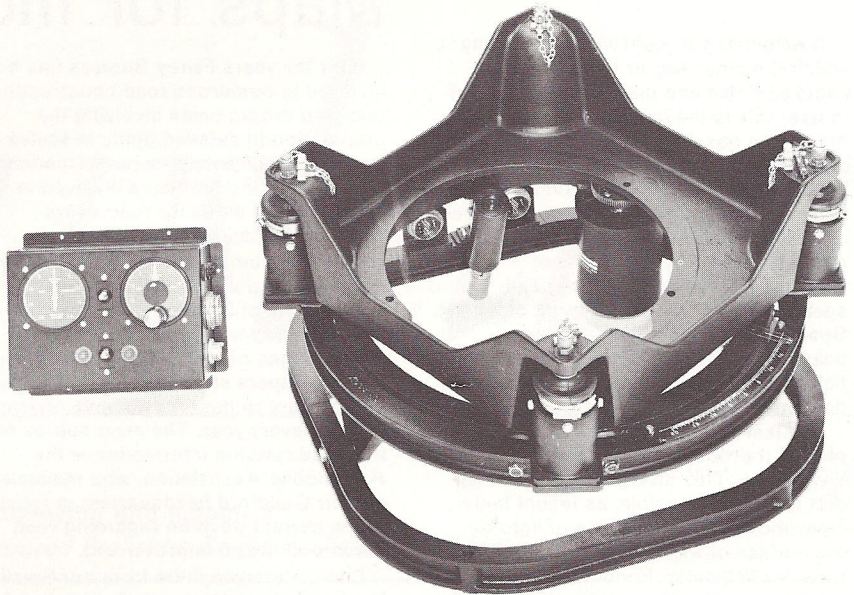
A Fairey Surveys DC-3 is scheduled to photograph pre-monsoon clouds as part of an investigation programme for Concorde route conditions.

Zambia

Latest contract covers 1 : 1000 survey of a copperbelt mining township. Photography was completed within 10 days of order, to beat rainy season. Over 300 map sheets involved.

Singapore

Contract recently signed to survey 225 square miles of Singapore and offshore islands. Fieldwork is already in progress for the 1 : 2500 scale photogrammetric mapping involving 412 map sheets. Mapping to be completed in 18 months.



For the best results use

One of the most significant factors in the success of an aerial mapping project is the quality of the photography. Brilliantly clear photography, accurately positioned to cover the area with the minimum number of exposures will go a long way towards guaranteeing that the subsequent mapping will be achieved with maximum efficiency.

Working towards this end, Fairey Surveys Research and Engineering Division has produced a series of highly successful camera mountings, designed for the Ministry of Technology and in use with the Royal Air Force. The latest, and the most sophisticated to date, is the Fairey Type 133 mounting. The mounting will carry the new Williamson F49 Mk 4 survey camera in Canberra PR9 aircraft, a camera which is the latest to be developed in the F49 series. It is fitted with the new 6 inch f/5.6 Wray survey lens which has high resolution characteristics with minimal distortion and greatly improved marginal illumination using all types of film and emulsions.

The Type 133 mounting supports the camera, attached to an adaptor, on four silicone-damped "Faireymount" vibration isolators. These isolators have been so designed that their natural frequency is unaffected by changes in load due to film transportation. Besides the very high degree of vibration isolation, the mounting also allows the camera to be remotely or automatically positioned so as to reduce the effects of aircraft pitch and drift.

A constant heading is achieved by attaching the isolators to an outer ring which can be rotated in azimuth, by means of a servo-motor, up to 20 degrees either side of the fore and aft datum. The outer ring is also supported in a gimbal which can be tilted up to

10 degrees in pitch by means of a linear actuator. A sensitive mercury switch attached to the camera adaptor, which energises the linear actuator through relays when the plane of the camera register glass departs from the horizontal, automatically compensates for major changes in the aircraft's attitude.

The remote control unit in the cockpit contains a demand-synchro (by which means the azimuth setting can be offset to compensate for aircraft drift), the pitch-motor control relays, and an indicator unit which tells the photographer that the mounting is correctly positioned before photography begins.

The mounting and the camera have undergone exhaustive environmental tests in the laboratory as well as flight trials overseas and they performed well throughout.

Research continues and meanwhile the Type 133 mounting may be regarded as a step towards the fully-stabilized platform with completely automatic operation. Photogrammetrists are well aware of the potential that this contains for the simplification of the stereo-plotting process.

If you require further information on items featured in Fairey Surveys Newsletter or would like to be added to the mailing list for future issues:

Please contact:
Mr. P. FORSEY
FAIREY SURVEYS LIMITED
REFORM ROAD, MAIDENHEAD,
BERKSHIRE, ENGLAND.
TELEPHONE MAIDENHEAD 21371
TELEX 22230

Lasers for all

A weightless straight edge, of any length, which does not sag or bend, can't be knocked down and disappears when not in use; this is the laser beam, which in nine years has progressed from a laboratory curiosity to a valuable tool for the civil engineer and surveyor. A fascinating talk on this subject was given at a Land Surveyors Meeting held recently at the Royal Institute of Chartered Surveyors, London. The speaker was Mr. D. L. Hardwick of Spectra Physics Limited, and laser beams were flashed around the lecture hall in the course of several interesting demonstrations.

The laser's key virtue is that the beam of light it produces has minimal divergence. This divergence is so small that it is quite possible, as recent tests have shown, to shine spots of light on the surface of the moon nearly a $\frac{1}{4}$ million miles away. Reduced to terrestrial proportions, a 2 inch diameter beam at 1,000 feet is a typical performance.

A civil engineering application where lasers are already at work is for alignment purposes. Once set up, either by theodolite or by aiming through a series of targets, the laser makes lining-up at any point along the beam, without assistance, a very simple matter. A second application is to use the laser as a measuring instrument, once again the narrow beam making high precision a probability. Trials with a prototype airborne laser altimeter have also yielded some exciting results.

As the growing usage suggests, the laser is shedding some of its former image as a potential death-ray and becoming an industrial tool requiring no extraordinary safety precautions.

Maps for motorists

Over the years Fairey Surveys has been involved in numerous road construction mapping programmes involving the preparation of detailed plans in scales as large as 1:500. Lately we have experienced at first hand the problems involved in the production of maps for road users rather than road builders.

This has come about because we have accepted responsibility for the cartography of a Road Atlas involving 126 pages of road maps, 90 town plans, and 16 pages of strip maps, in addition to the end-papers showing only motorways and primary routes. A complete revision is made every year. The main source of this road revision information is the Automobile Association, who maintain at their Guildford headquarters, a record of the current position regarding road construction and improvement.

Senior cartographers from our Small Scales Unit attach themselves to the AA Headquarters for a three week period each year, to compile all the additions and deletions. They then return to our offices in Maidenhead to supervise the drawing changes prior to the re-print each Spring. In addition to road changes, the town plans are checked over with the local authority concerned. This check includes all 15 categories of interest-features that appear on the map and the 25 different types of sporting centres shown. The real strength of this revision however, lies in the comprehensive AA field coverage. This enables us when in doubt to ask Guildford HQ to contact the relevant district office. These offices are in direct communication with their patrol men who will, if need be, go and have a look. This really is a compiler's dream come true.

The result of this closely integrated co-operation has been an undoubtedly successful publication. The Book of the Road is now in its 3rd Edition and has sold over 2,000,000 copies to date.



Winston Churchill Memorial Fellowship Award

All our readers may not be aware that a number of travelling fellowships were established as a memorial to Sir Winston Churchill. The object of these fellowships is to enable recipients by travel overseas, to broaden their knowledge on selected subjects. Candidates are required to disseminate this specialised experience on their return to U.K. thus spreading the benefit as widely as possible and keeping our knowledge up to date in all respects.

One of the 86 men and women awarded Churchill Fellowships this year is our Photographic Manager, Mr. L. W. Tarling. The fellowship will provide a two-month tour of the United States studying the latest developments in the use of colour and false colour emulsions in aerial survey photography.

Setting off in mid-April, his itinerary will include a course on the chemistry of colour at Eastman-Kodak, Rochester New York, visits to the U.S. Coast and Geodetic Survey Department, Department of the Interior and numerous commercial survey organisations. Mr. Tarling will also attend a seminar, 'New Horizons in Colour Aerial Photography' arranged as part of Photo-Expo 69 and taking place in New York City.

On his return in June plans will be made to visit Switzerland, Germany and Holland to see the results being obtained in these centres.

Len Tarling is a very experienced air photographer, having worked in 28 different countries. He was responsible for much of the colour survey of Malawi, one of the largest contracts of this type ever awarded to a private company. His wide-ranging practical knowledge will, as a result of this wonderful opportunity, be allied to a broad-based understanding of the academic aspects of colour-photography for aerial survey.

Lt. Col. D. L. Leach, F.R.I.C.S., M.S.I. (N.Z.) (left) discusses a map sheet from the recently completed Bahamas series with one of Fairey's Survey's senior cartographers.

The survey, which has just been completed, was a particularly interesting operation in many respects. The land surveyors travelled extensively by boat and considerable use was made of infra-red photography to determine water lines and to provide a horizontal datum for the contouring.

This photograph was taken at our Headquarters when Colonel Leach was visiting the U.K. from the Bahamas where he is The Supervisory Surveyor, Lands and Surveys Department.

