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OF PAPUA NEW GUINEA

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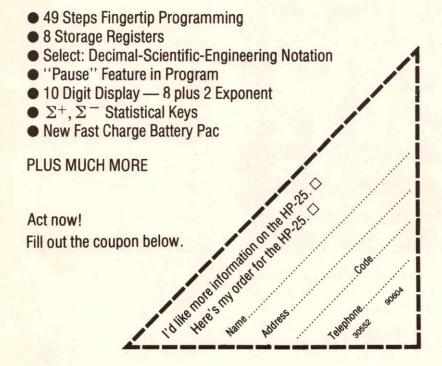


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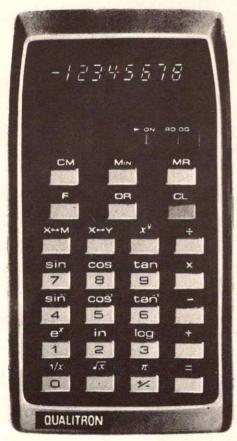
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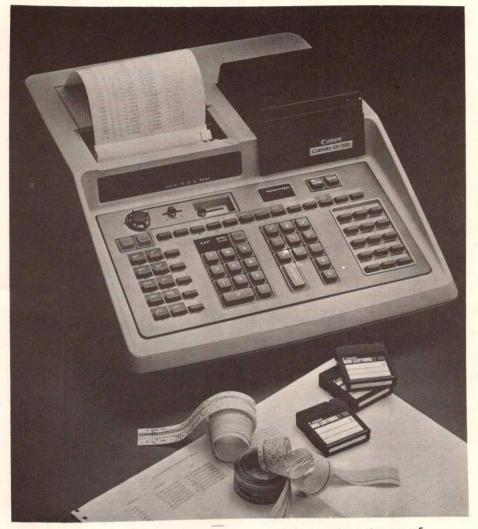
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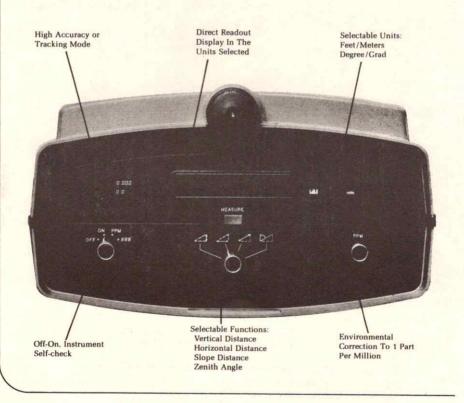
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Some Remarks on Orthogonal Transformation

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SOME REMARKS ON ORTHOGONAL TRANSFORMATION AND APPROXIMATE MATRICES OF TRANSFORMATION

By: H. L. OSWAL

ABSTRACT

Although orthogonal reference systems have been employed in surveying for a long time, the use of orthogonal transformation is relatively recent compared to the mathematical development of matrices for such transformation. Some interesting effects of this delay on the development of photogrammetric techniques are examined. Construction of some approximate orthogonal matrices is described with a veiw that they may be of interest in some photogrammetric applications. It is proposed to present the results of numerical investigations on the use of these approximate matrices at a later date.

Introduction: Concept of Orthogonality or Rectangularity.

The two basic concepts in surveying - distance and direction are capable of instinctive acquisition by man. With their help the early man was able to make small journeys from his abode and return to it after the purpose of his journey was fulfilled. It was not until language was evolved as an effective means of communication that he developed the capability of charting his journey by spoken words, and not until a few thousand years ago by graphics. Such journeys essentially consisted of irregular traverses of short straights and curves depending upon topography and vegetation.

The next development in the concept of direction was the instinctive appreciation of the right angle. The earliest expression of this may have been a rectangular hut put up as an abode or, to some less-defined extent, the design of man's early implements. The natural appreciation of the right angle is probably at the base of the division of the circle into four quadrants. Further, it is instinctive to realise that two efforts are mutually ineffective when exerted in perpendicular directions.

When man began to organise his skills of winning food from soil we encounter the evidence of subdivision of land into rectangular parcels. This system is the least wasteful, and is more amenable to accurate measurement. This essentially surveying exercise dates back to many thousands of years although claymodels depicting the method found in the remains of the Egypt's Nile Civilization date back to only about 3500 B.C. Another impressive example of rectangulation surveying is the Egyptian pyramids.

Orthogonal Reference Systems

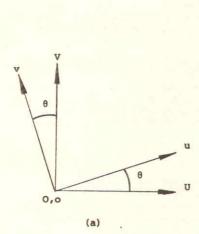
Although the examples mentioned and measurement of irregular land parcels by rectangular offsets found practical application early, it was not until the eighteenth century that the rectangular or orthogonal reference system

Professor H. L. Oswal, B. Sc. (Mining), M. Sc. (Engineering), Ph. D. (Photogrammetry) is Head of Department of Surveying at the Papua New Guinea University of Technology.

developed into a powerful mathematical tool in mensuration. This branch of mathematics is known as analytical geometry. Plane orthogonal analytical geometry is capable of dealing with points lying in a plane, and requires the definition of a system of two mutually perpendicular reference lines. Spatial orthogonal analytical geometry is based on the definition of a reference system consisting of three mutually orthogonal lines. We also have four and multi dimensional reference systems, but they are not of significant interest to surveyors.

Plane Orthogonal Reference and Transformation

A reference or standard is essentially necessary to intelligibly state a measurement. The choice of reference.is, however, a matter of mere convenience. Consider the essential surveying measurements of length and angle. For the former, a physical standard such as a meter bar is required. For the measurement of an angle between two planes, either plane may act as a reference plane, although it is infinitely more convenient to define a standard reference plane such as a magnetic meridian or a true meridian. The former can be more easily established; although the latter is to be preferred on account of its invariability. As a result both are in use, and since it is often necessary to use maps even several years after they are prepared a surveyor may be expected to express measurements from an old map to a new magnetic meridian or to the true meridian. Carried out on points expressed in terms of rectangular coordinates such as northing and easting, this is an exercise in plane orthogonal transformation. On most occasions however, the problem is solved graphically, and as such many practical surveyors are likely to find the preceding definition of the problem as somewhat strange.



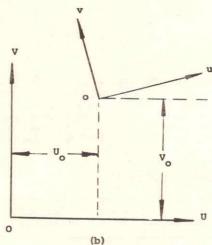


Fig. 1

In Figure 1(a), the origins of the two plane orthogonal systems UV and uv are coincident, and the angle between them in θ . The transformation of point coordinates from the (uv) to the (UV) system is given by

$$U = u \cos \theta + v \sin \theta$$

$$V = -u \sin \theta + v \cos \theta$$
(1)

In matrix form (1) is written as

$$\begin{pmatrix} U \\ V \end{pmatrix} = \begin{pmatrix} \cos \phi & \sin \theta \\ -\sin \phi & \cos \theta \end{pmatrix} \begin{pmatrix} u \\ v \end{pmatrix}$$
 (la)

In these equation, the premultiplying matrix is known as the 2x2 orthogonal transformation matrix. If the elements are designated

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$$

in the usual manner, the following three conditions must exist between the elements

$$a_{11}^{2} + a_{12}^{2} = 1$$
 $a_{11} = a_{22}$ (2)
 $a_{11}^{a_{12}} + a_{21}^{a_{22}} = 0$

These are apparent by considering the matrix in l(a). Thus, there is only one independent element in the A matrix, a function of θ , the rotation between the two systems.

If the origins of the two systems are not coincident as in Figure 1(b), the transformation equations shall be

$$\begin{pmatrix} U \\ V \end{pmatrix} = \begin{pmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} u \\ v \end{pmatrix} + \begin{pmatrix} U_o \\ V_o \end{pmatrix} (3)$$

where U V are the coordinates of the origin of the (uv) system referred to the system (UV).

Three-Dimensional Orthogonal Coordinate Transformation

Problems in ground surveying do not offer much opportunity for the application of three dimensional orthogonal transformation, since the heights are always measured along the vertical. In photogrammetry, however, the ground is expressed in several different entities and there occur numerous problems requiring transformation of rectangular coordinates from one entity to another.

Some examples are

- Given the photogrammetric model measurements (xyz), to obtain terrain measurement (XYZ).
- 2. Strip coordinates from model coordinates.
- 3. Block coordinates from strip or model coordinates.
- Coordinates of an absolute oriented model from the coordinates of a relative oriented model.
- 5. Terrain coordinates from photocoordinates of an overlapping photopair.
- 6. Converse problems of above.

The coordinates systems used in the above situations are three-dimensional. In general, any two reference systems (UVW) and (uvw) will have noncoincident origins. In Figure 2, U V W are the coordinates of the origin of the (uvw) system in the (UVW)'system. The orientation of axes in the two systems is different and one of the systems, say (uvw) can be considered as having undergone rotations the components of which are

The total resultant effect in a right handed reference system will be given by the 3×3 product matrix R

$$R = \begin{pmatrix} \cos \gamma \sin \gamma & 0 \\ -\sin \gamma \cos \gamma & 0 \\ 0 & \gamma & 0 & \gamma & 1 \end{pmatrix} \begin{pmatrix} \cos \beta & 0 - \sin \beta \\ 0 & 1 & 0 \\ \sin \beta & 0 & \cos \beta \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \alpha \sin \alpha \\ 0 - \sin \alpha \cos \alpha \end{pmatrix}$$
(4)

Multiplication gives

$$r_{11} = \cos^{\beta} \cos \gamma$$

$$r_{12} = \cos \alpha \sin \gamma + \sin \alpha \sin \beta \cos \gamma$$

$$r_{13} = \sin \alpha \sin \gamma - \cos \alpha \sin \beta \cos \gamma$$

$$r_{21} = -\cos \beta \sin \gamma$$

$$r_{22} = \cos^{\alpha} \cos \gamma - \sin^{\alpha} \sin \beta \sin \gamma$$

$$r_{23} = \sin^{\alpha} \cos \gamma + \cos^{\alpha} \sin \beta \sin \gamma$$

$$r_{31} = \sin^{\beta}$$

$$r_{32} = -\sin^{\alpha} \cos^{\beta}$$

$$r_{33} = \cos^{\alpha} \cos^{\beta}$$

$$(5)$$

Complete transformation is expressed by

4.

$$\begin{pmatrix} \mathbf{U} \\ \mathbf{V} \\ \mathbf{W} \end{pmatrix} = \begin{pmatrix} \mathbf{r}_{11} & \mathbf{r}_{12} & \mathbf{r}_{13} \\ \mathbf{r}_{21} & \mathbf{r}_{22} & \mathbf{r}_{23} \\ \mathbf{r}_{31} & \mathbf{r}_{32} & \mathbf{r}_{33} \end{pmatrix} \begin{pmatrix} \mathbf{u} \\ \mathbf{v} \\ \mathbf{w} \end{pmatrix} + \begin{pmatrix} \mathbf{U}_{0} \\ \mathbf{V}_{0} \\ \mathbf{W}_{0} \end{pmatrix}$$
(6)

and therefore, only 3 of the r's are independent.

It is instructive to notice that transformation, such as expressed in (6) are, by definition, linear. Hence, if the problem is that of determination of the orientation between two orthogonal systems, or in other words, if the problem is one of determination of R, its elements could be solved by linear algebra if adequate number, 4, of points measured in both the reference systems were available. The distribution of the points must however, satisfy the requirement that the point are not coplanar. Many photogrammetrists have not favoured this approach because it fails to enforce (7) simultaneously. Their search for a linear solution for only three unknowns from which to construct a rigorously orthogonal matrix have been ultimately successful less than two decades ago, although some of the most elegant orthogonal matrices were constructed as early as the early 17th century. It was thus possible to convert an apparently intractable non linear problem into a simple linear problem, and this fact contributed considerably in economically programming analytical aerial triangulation.

Some Historical Misdirections

To appreciate the wastage of effort caused by the photogrammetrists' inadequacies in handling orthogonal transformation efficiently, two examples will be mentioned.

Between 1930 and 1957. Professor Earl Church was deeply involved in developing accurate analytical methods of determining the tilt of a photograph. In fact this problem meant the determination of orientation (rotations) of the photographic orthogonal reference system vis-a-vis the terrain reference system that is, the rotation components $\omega \varphi \kappa$ corresponding to $\alpha \beta \gamma$ of equation (4). However, Church defined the three angular components as

- t tilt, the angle between the plane of the photograph and horizontal plane,
- s swing, the angle between the principal line and a reference line defined by joining a set of fiducial marks, and
- ${\bf A}_{_{\rm Z}}$ the azimuth of the principal line referred to zero meridian in the ground reference system.

Although these definitions are sound, the approach prevented photogrammetrists including Church from tackling the total problem of exterior orientation in one single solution. They were obliged to first establish the exposure station coordinates, and then determine t, s and Az; or viceversa. The more serious disadvantages were that the problem remained non linear and it was impossible to obtain high precision in determination of the angular quantities. It can be easily seen that in modern aerial photography, tilt t is kept to within 10. As taken on nadir principal point and the principal line tends to become indeterminate. Thus swing s and azimuth Az both become incapable of precise determination.

Towards the end of his researches Professor Church became aware of the simplicity of the orthogonal transformation approach to the orientation problem, and attempted to use an orthogonal matrix. Unfortunately he still chose t, s and Az as the three independent quantities for its construction, and the basic shortcomings just seen continued to make precise determination impossible. With the choice of $\omega \varphi \kappa$ as the rotation components, the situation changed dramatically and H. Schmid was able to publish a most elegant general solution of the orientation problem in photogrammetry in 1953.

Another area in which photogrammetrists failed to use orthogonal transformation effectively was aerial triangulation. The main problem here is the connection of consecutive models through a thin superlap strip. Early photogrammetrists considered this to be a tedious non linear problem intractable on the desk calculator. This was understandably so as long as t, s, Az remained the angular orientation components in use. The failure to define the model connection problem as one of 3x3 orthogonal transformation of coordinates of points in one model to the system of the other model, and as such one capable of easily being tackled on a desk calculator (desk electronic computers were not yet available), forced the development of aerial triangulation instruments between 1915 and 1970. The manufacture of such instruments has now been abandoned by most manufacturers and most photogrammetric set-ups now carry out their aerial triangulation by the independent model method using orthogonal transformation matrices. Photogrammetric instruments of the future will thus be of considerably simpler design by excluding complicated aerial triangulation devices.

Rigorous Orthogonal Matrices

Equations (5) give the trigonometric form of the rigorous orthogonal matrix. As stated earlier, the rigorous form took many other experssions through the seventeenth century mathematicians particularly Füler. Another notable rigorous form was constructed by Rodrigues in the middle of the nineteenth century. Capable of construction from any three real numbers, this is a powerful form, and the most popular now with photogrammetrists, for it enables the orientation problem to be dealt with by linear algebra. It is not proposed to give any further space in this paper to rigorous orthogonal matrices where further research is not warranted.

Approximate Orthogonal Matrices

With satisfactory rigorous orthogonal matrices available, there exists some discouragement for the use of approximate matrices. But even so, approximate forms have their specific and important uses such as in iterative solutions which start with approximate values of the orientation elements $\omega\phi\kappa$. There may exist even other areas where approximate matrices may find even substantial application. For example, consider approximate procedures-designed for economy and used in jobs where lower precision in the photogrammetric end-product is acceptable. From this point of view an interest in approximate forms is justifiable. Some of the forms will be described in the following.

Any form of the matrix whose elements approximately satisfy the condition equations (7) is acceptable as an approximate orthogonal matrix. Strictly speaking, all approximate forms will give an affine transformation and this will approach orthogonal transformation depending on the errors inherent in approximations made.

Consider the transformation given by

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$
(8)

If the coordinates in (8) are measured in rectangular reference systems, as they normally would be in the surveying situations, the a's would be expected to satisfy conditions similar to those of equations (7). However, observational and measuring errors are unavoidably present, and therefore if the 9 a's of (8) were derived by linear solution of 9 simultaneous equations generated by three common points in the two systems, they would only approximately satisfy (7). The A matrix in (8), in such a circumstances should be regarded approximately orthogonal. It could be made rigorously orthogonal by using the least squares method of adjustment (Oswal and Subramaniam 1968). It may be shown that the rigorous matrix

$$v_{1} = v_{1}^{A}$$
where, $v_{1} = \begin{pmatrix} 1 + .5v_{1} & .5v_{4} & .5v_{6} \\ .5v_{4} & 1 + .5v_{2} & .5v_{5} \\ .5v_{6} & .5v_{5} & 1 + .5v_{3} \end{pmatrix}$ (9)

v's being the residuals with opposite sign obtained by applying the condition equations (7).

The most commonly used approximate form of the orthogonal matrix is obtainable if the magnitude of the rotations are small as is the case in near vertical photogrammetry. work are each small and in the range of 0 - 2 . Hence the following approximations are valid:

$$\sin \theta = \theta$$

 $\cos \theta = 1$

Substituted in (5), the approximate matrix takes the form

$$\begin{pmatrix} 1 & \kappa & -\phi \\ -\kappa & 1 & \omega \\ \phi & -\omega & 1 \end{pmatrix} = I + S \tag{10}$$

S being a skew symmetric matrix formed by ω , ϕ , κ . This form is commonly employed to start a solution in iterative procedures in various orientation problems. It has also been used to construct a rigorous orthogonal matrix (Oswal 1971) by the application of Newton's method of successive approximations with the following result

$$R = V_{n} \cdot V_{n-1} \cdot ... \cdot V_{2} \cdot V_{1} \quad (I + S)$$
 (11)

 V_1 is defined by (9) , and V_2 V_3 . . . etc. are similarly defined by (9) after each successive approximation. This form of R is not of much practical use. However, the first iteration from (11) gives an interesting form of the approximate matrix

$$\lambda (I + S) + \frac{1}{2} \begin{pmatrix} \omega \\ \phi \\ \kappa \end{pmatrix} (\omega \phi \kappa)$$
 (12)

which for most practical purposes is closely orthogonal provided the rotation components are within 2 in magnitude. λ = 1 - .5(ω^2 + ϕ + κ^2).

Some more approximate orthogonal matrices are obtainable by expansion of the trigonometric form by infinite series and retaining terms of upto first, second, third or fourth order. In that very order they improve in their orthogonality. By retaining terms of only the first degree we obtain the form expressed by (10). Retention of terms upto second, third and fourth degree give the following matrices respectively.

$$r_{11} = 1 - \kappa^{2}/2 - \phi^{2}/2 + \phi^{2}\kappa^{2}/4$$

$$r_{12} = \kappa + \omega\phi - \kappa^{3}/6 - \omega^{2}\kappa/2 - \omega^{3}\phi/6 - \omega\phi^{3}/6 - \omega\phi\kappa^{2}/2$$

$$r_{13} = -\phi + \omega\kappa + \omega^{2}\phi/2 + \phi^{3}/6 + \phi\kappa^{2}/2 - \omega^{3}\kappa/6 - \omega\kappa^{3}/6$$

$$r_{21} = -\kappa + \kappa^{3}/6 + \phi^{2}\kappa/2$$

$$r_{22} = 1 - \kappa^{2}/2 - \omega^{2}/2 - \omega\phi\kappa + \omega^{2}\kappa^{2}/4$$

$$r_{23} = \omega + \kappa\phi - \omega\kappa^{2}/2 - \omega^{3}/6 - \phi\kappa\omega^{2}/2 - \phi\kappa^{3}/6 - \kappa\phi^{3}/6$$

$$r_{31} = \phi - \frac{3}{\phi}/6$$

$$r_{32} = -\omega + \omega\phi^{2}/2 + \omega^{3}/6$$

$$r_{33} = 1 - \omega^{2}/2 - \phi^{2}/2 + \omega^{2}\phi^{2}/4$$
(b5)

(15) is sufficiently rigorously orthogonal even for relatively large rotations.

Further Investigations

Further investigations are in hand at the Papua New Guinea University of Technology to define the level of orthogonality achieved by each of the above approximate forms, particularly when the magnitude of rotations increases. The scope of the investigations will include an enquiry into resulting errors and their propagation if some of the closer approximate forms of the orthogonal matrix were used in such procedures as anylytical relative and absolute orientation and strip triangulation.

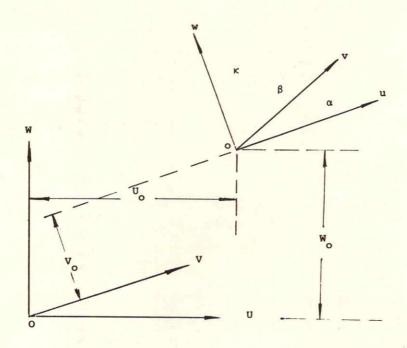


Fig. 2

REFERENCES

- OSWAL, H. L. and Balasubramanian, S. 1968. An Exact Solution of Absolute Orientation, Photogrammetric Engineering, XXXIV/10, pp 1079 - 1083.
- OSWAL, H. L., 1971. A New Method of Constructing an Orthogonal Matrix, Photogrammetric Record, VII/37, pp 70 - 72.

COUNCIL NEWS

The new Council has met every month since June this year. Two meetings were held in Port Moresby, one in Lae and one in Mt. Hagen. Business discussed included:

(1) MEMBERSHIP

The following Corporate Members were elected:-

Peter Alfred Bates-Brownsword Marcelino S. Tabin Bernard Moriarty

and the following Associate Members were elected:-

Kevin Joseph Murphy Dennis James Punniard Aipos Jeffrey Amevo Akiris Dion

There have been no applicants yet for the new grade of Technical Associate.

(2) SUB-COMMITTEES

The <u>education</u> sub-committee consisting of Messrs Page, Quick and Carson recently attended a meeting of the re-constituted Board of Studies held at the University of Technology under the chairmanship of Professor Oswal. Their first report has been submitted to Council for consideration.

The <u>Scale of Fees</u> committee recommended an increase in the base rate and their recommendation was accepted by Council. Members have been circularised.

Land Matter Sub-Committee. Mr. Larmer and Mr. Saliau have met with the Housing Commissioner to discuss ways of obtaining Title to urban allotments by more economical means than at present. It was suggested that Registered Surveyor carry out the control traverse whilst technician be allowed to work internal boundaries. Mr. Larmer is investigating the legal implications.

(3) OTHER MATTER OF INTEREST

CASLE Council is still awaiting notification from CASLE re dates for their 1977 regional seminar which is scheduled for Port Moresby. It seems that this will possibly be held in August and it is intended that our 1977 Congress should coincide with their meeting.

The Secretary has received a number of copies of the CASLE newspaper which gives news of activities of the surveying and allied profession in member countries. Members interested in receiving a copy should contact the Secretary.

Council News

Association Brochure. The association brochure has been printed and distribution is underway. Council has resolved that private consultants should be invoiced to cover the cost of production.

The next Council meeting is scheduled for Thursday, 22nd January 1976 in Port Moresby.

Any queries regarding the activities of Council may be directed to the Secretary.

> G. H. PHILLIPS Hon. Secretary

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THE SURVEYOR'S ROLE IN ENVIRONMENTAL PROTECTION

By: Claude Richard

The traditional role of the surveyor is to make his technical know-how and love of geometrical precision available to specialists who need them: town planners, architects, hydraulics engineers, public works engineers, etc. to mention only some of the main ones.

Most experts today are concerned with environmental problems. What are these exactly?

The protection of sites, the establishment of green spaces, refuse disposal, river, estuary and beach development, flood protection, the setting up of recreational facilities, dams, planning highways, installing works of art, sewage treatment plants, etc.

The surveyor is not a 'blind' agent. Of course, he follows guidelines and conforms to professional principles. But the knowledge expected of him goes far beyond strict mathematical principles. His training has been such as to enable him to work in close co-operation with the architect, the town planner, engineers and even those who are concerned with the law.

In any project whatsoever, there are always moments of indecision and irresolution during implementation. There are always the unforeseen effects of certain measures that are likely to affect the environment. Only the surveyor, if he is environment-minded, can sometimes foresee such effects. It is then his duty to either point them out if there is still time, or take steps to rectify them as soon as possible.

Let us consider some concrete examples: in certain countries, a policy aimed at consolidating rural land involves work associated with it such as the elimination of hedges, embankments, drains, etc. Work of this nature carried out indiscriminately has resulted in a speeding up of the erosion process. River development work in New Caledonia has resulted in establishing new banks that are not very stable as there is no vegetation on them, so that they are swept away when the river swells, this leading to bridges and roads being laid bare. In many Pacific islands, coastal roads - of unquestionable utility no doubt - have been constructed between lagoons and marshes without too much attention being given to the drainage of these marshes, so that mosquito breeding sites and the risk of epidemics are multiplied.

In other islands, filtration galleries have been constructed for the utilization of water resources, but no protective zone has been set up. In other places, sewage treatment plants have been set up without due consideration of discharge facilities or in the vicinity of residential areas which accordingly suffer from the attendant odours and flies.

Claude Richard is Public Health Engineer, seconded from the Ministries of Agriculture and Foreign Affairs to the South Pacific Commission, Noumea.

ADVERTISEMENT

CARE & CALIBRATION OF EDM EQUIPMENT (Submitted by Peter Philipp, Calculator/Distance Meter Staff Engineer, Hewlett-Packard Aust. Pty. Ltd.)

This article is the first of two articles dealing with the care and calibration of Electronic Distance Measuring (EDM) equipment. In this article, general information on the care of EDM equipment, and the auxiliary equipment associated with their use, will be discussed. Some of the items covered will be common knowledge to all surveyors and are included in these notes for completeness.

TRIPODS

One of the biggest problems with the majority of tripods is that as they age the wooden components shrink away from the metal components and the feet, head and joints become loose. Most manufacturers supply a wrench that should be used to tighten these parts so there is no movement between the metalic and wooden parts. Users must check periodically that the feet, head and joints are tight.

Another problem that develops with usage is that the top of the tripod distorts from the original plane surface such that the tribrach will not sit flat on the tripod head. If this happens, the top of the tripod should be filed or ground flat. The protective cover for the tripod top supplied with the tripod should be used at all times when the tripod is not being used to support field equipment. This is particularly necessary when the tripod is being transported.

TRIBRACHS

The tribrach is a most important piece of field equipment, as it is the mount for most field equipment used by an in association with the distance meter. When being attached to the tripod it should be screwed on firmly, but not too tight.

Users must regularly check and adjust the bulls-eye bubble if one is provided on the tribrach. This can be done as a separate adjustment or can be checked when the tribrach is

being used with a theodolite. If the tribrach is provided with an optical plummet, then this must be regularly checked and adjusted so when the bullseye bubble is centered, the optical plummet defines a vertical line. are many methods available to adjust the optical plummet and users should consult the manufacturer's literature for the adjustment procedure. The footscrews of the tribrach should be kept clean and free from dust and grit. It may be necessary from time to time to grease the threads. If this is necessary, then the lubricant recommended by the manufacturer should be used.

The tribrach should always be transported so it will not be knocked or bumped. One of the best methods is to transport the tribrach with the instrument or attachments with which it is used. If this is not possible then it should be transported in a padded case.

PRISMS

For all electro-optical distance measurements, retro-reflective prisms are used at one end of the line. The prisms are a necessary part of the measuring equipment and must be treated as such, ie., with the same care as is given to the distance meter itself.

If, during field use, the prisms become wet or covered with dust, they should be wiped clean with a soft cloth and allowed to dry before storage. The glass surface should be cleaned, such that the surface of the glass is not scratched. If the glass surface becomes marked (say with greasy finger

prints), it should be cleaned with a soft cloth dampened with ether or alcohol. When the prisms are stored or transported they should be covered with the plastic cover and carried in a padded box.

The sighting pole or target attachments should be checked to see that they fit correctly and the mounting thread or studs should be carefully protected to insure they are not bumped or burred.

DISTANCE METER AND ACCESSORIES

The distance meter is an expensive piece of equipment and careless use and abuse can lead to expensive and time consuming failures. To avoid costly repairs and extended time delays without the equipment, care and attention is necessary when storing, transporting and using the equipment.

Carrying Case

This should be kept as clean as possible on the INSIDE. The case should be closed when in the field and should not be left open when the distance meter is being used.

Power Pack and Batteries

If a separate power pack control unit is used with the instrument, it should be kept clean as possible. All dust, rain, snow and salt spray should be wiped off the case and under no circumstances should it be stored for long periods of time in extreme temperature conditions. The cable connectors on the power pack should be kept clean and the dust covers replaced after use. The battery clips should be checked regularly and kept free from corrosion (any mild alkali such as baking soda solution can be used to clean the clips). The power cable plugs should be kept clean and free from dust and sand and the cable itself should not be bent at too sharp an angle when being used in the field or when being stored.

If nickel cadmium batteries are used as the power source, a record should be kept of the charging and use time in case the batteries develop "charging memory". Lead acid batteries should be stored in an upright position. Before charging, the water level should be checked and, if necessary, filled to the correct level so excessive heat will not build up during charging. (This precaution is not necessary in sealed lead acid batteries).

The power pack should be transported such that it will not be bumped or knocked and when used in the field it should be handled with care.

Distance Meter

The distance meter optics should be kept clean. Care should be exercised when cleaning the lenses. A special brush, special cleaning paper or cloth should be used. When not in use the optics should be protected by the lens cover(s) if supplied. After use in the field it should be wiped down and cleaned, especially when covered with salt water spray or mist. The instrument should never be stored when wet. It should be wiped down and left in an open case to dry. When distance measurement is completed at a station, the instrument should be placed in the carrying case. When transported it should be placed in the "best position" so bumps and shock are minimum and the instrument should not be stored in extreme temperature conditions. The tangent screws and clamps on the yoke should never be forced or clamped too tightly and the tribrach mounts should be protected from damage.

The second part of this article on the calibration of EDM equipment will be presented in the next issue.

The Surveyor's Role in Environmental Protection

These few examples show that the surveyor, far from being a blind and programmed operator, should show responsibility in what he does, not only insofar as precision in making readings in concerned, but also as regards the purpose of his work.

I have personally seen architects studying sewage systems which could not be operated because these architects were not as knowledgeable in hydraulics as one could have desired. While many surveyors are trained in hydraulics.

In Europe, agricultural irrigation projects are entrusted to surveyors. The same applies to many projects relating to agricultural hydraulics, water supply, sewage systems, forestry, rural roadways and waterway hydraulics.

Without claiming that he is a hydraulics engineer, a forestry expert or a roads engineer, it may be recognised that the surveyor generally knows the ABC of these specialities and their relationship with the environment in which the projects are to be implemented. In this respect, he not only works in collaboration with these engineers but, in the case of multidisciplinary projects, he has a co-ordinative role to play.

His activity consists to begin with in modifying the environment to some extent. In doing so, he should be in a position to consider all aspects of the same in a concrete manner, as he goes round in the field. He sees details that might have escaped the notice of other technicians.

In short, environment is the order of the day. It concerns all users. The surveyor is also one of these users. But he is also the one who is in a position to read a map as effectively as possible, to interpret aerial photographs, profiles and cross-sections. His rapid calculation methods make it possible for him not only to appreciate angles and distances or differences in level, but also slopes, watershed areas, plateaus, valleys, etc. This knowledge of the morphology of lands enables him to describe the environment better than anybody else.

He is no stranger to human ecology. He can recognise at a glance the type of settlement that lies before him and he can accordingly plan the future developement required.

The surveyor is not a blind machine, being much more than the land-surveyor he used to be. He may be the brains behind elegant solutions, or at any rate solutions that are satisfactory from the environmental development viewpoint. Moving constantly within and without the ecosystem, he has a knowledge of the environment that has to be far superior to that of the man in the street. Without being a specialist in ecology or the environment, he must be capable of thinking up solutions where they do not exist. This calls, of course, not only for the theoretical knowledge acquired in school but - and this is the main thing - some experience acquired in the field.

The Surveyor's Role in Environmental Protection

One of my masters would often repeat that it took ten years in the field to make an experienced surveyor. At least as much is required to make a good environmentalist. But one does not stand in the way of the other. The two activities involved can supplement each other most effectively.

Consequently, the surveyor is capable of initiating projects that are more or less important for improving the environment. His knowledge both of the field conditions and of ecology will enable him to make practical suggestions that are effective and do not cost much, e.g. the construction of a waste water treatment lagoon should the site be favourable for the same, instead of a small dam of compacted earth at the bottom of a deserted valley so as the recreate natural living conditions. He can even suggest hydraulic devices that do not consume too much power, hydraulic rams, windmills, etc.

Yes, the surveyor today has indeed a considerable part to play in the protection and improvement of the environment. Nowadays, it is no longer a matter of determining the shortest road from point A to point B, without worrying about the intervening areas. Above all, he has to be human. The surveyor is working for other human beings, and the road plan he lays out will be one that will be adopted not only in consideration of the sacrosanct imperatives of technique and economics but, above all, those that insist on respect for man and his environment.

H. D. EVE, SURVEYOR

By: G.P. Keleny

(Reproduced from the "Australian External Territories Journal" of May 1969, with the permission of the Department of Foreign Affairs, Canberra.)

Many visitors to Wewak, the administrative centre of the East Sepik District in New Guinea, have probably noted the small concrete cairn standing on the headland at Wewak Point overlooking the sea. It is 2 feet 6 inches square at the base, 3 feet 3 inches high and is surrounded by a concrete path approximately 3 feet wide. It has four sloping sides and there are three bronze plaques affixed to it. They tell us that it was erected:

IN MEMORY OF

HENRY DUNMAN EVE, L.S.

A NEW GUINEA PIONEER AND EXPLORER

WHO DIED AT WEWAK ON 13 OCTOBER 1938

AGED 38 YEARS

LATITUDE 3° 32' 52.2" S LONGITUDE 143° 37' 36.8" E

This cairn, which is still the original structure, survived with relatively little damage the wartime occupation and the heavy bombing of Wewak. There was some suggestion that the memorial was reconstructed after the war, but an Australian serviceman, who was at Wewak following the Japanese surrender, wrote to Eve's father of having seen the memorial amid the general desolation. At that time there was no sign of any houses or of any other habitation, and the hill was honeycombed with caves used by the Japanese. There were some large bomb craters in the vicinity and there was some damage to the cairn itself. The monument was later repaired under the direction of Mr. H.L.R. Niall, the first postwar District Officer at Wewak.

Who was Eve, what were his achievements, and what were the circumstances that led to the erection of the memorial cairn at Wewak?

Henry Dunman Eve was born in Sydney on 23 September 1900, the day Mafeking was relieved, hence his early nickname was 'Maf', but this was later superseded by 'Dinkum', his favourite expression. He went to Fort Street High School, served his articles as a surveyor in Sydney and was admitted as a licensed surveyor in 1928. From 1926 to 1930 he was with the Federal Capital Commission at Canberra as staff surveyor. In 1930 he joined the staff of Oil Search Limited and was engaged in surveys in New Guinea until his death in 1938.

A concise summary of Eve's work and achievements was given by the late ${\tt G.A.V.}$ Stanley:

Henry Dunman Eve was a close friend of mine from 1930 until his death at the end of 1938. He was a surveyor whom I selected for employment by Oil Search Limited to work with me in the Sepik District. We worked hand-in-hand for years. He was a natural born explorer and in the last three or four years he entered more new and hitherto unknown areas than anybody else I know.

His death was a great blow to us all. He is buried at Wewak. The monument was suggested by me to G. W. L. Townsend, the District Officer, and its exact position was astronomically fixed by Arthur Miller, the District Surveyor. The cairn was erected by the Administration and the plaques were sent by the Institute of Surveyors.

Eve died at Wewak of bush typhus. He was taken ill while mapping from Oil Search Limited's Green River Camp to the Yagroner Hills. I went from Maimai by a small Fox Moth plane to a small grassland near Yagroner and picked him up. The runway was too short to do more than put Eve into the plane leaving me behind. He landed briefly at Maimai and then flew on to Wewak. After lingering in hospital there, he died.

Some details of the erection of the memorial cairn were described in a letter dated 4 August 1939, to Mrs. Eve from Mr. E.F. Griffin, of Oil Search Limited:

I think you would like to know that approval has been granted by the District Officer, Newak, Nr. Townsend, for the erection of a permanent memorial to your late husband. This will take the form of a concrete pillar set under a trigonometrical mark which will be placed in a permanent position visible from the sea. The pillar will bear a suitable inscription and the cost will be borne by the Company and the Institute of Surveyors.

During the years 1930 - 1938 Eve carried out many surveys in the Sepik District. His two most important expeditions were the Oakley-Eve Patrol of 1932 and the Eve-Townsend Patrol of 1934. The former had as its objective the opening up of a route from Aitape to the Sepik River. After walking 130 miles south, and at one stage being only two miles from the river, vast swamps were encountered. The party was forced to turn back and walk through 80 miles of newly explored country in addition to the 50 miles of partly controlled areas. Hunger, impenetrable swamps, and the hostility of the inhabitants made this a difficult task.

The latter major expedition in 1934 was successful in surveying a route from Mewak to the Sepik River and in returning thence in a north-westerly direction to Aitape. The geological explorations of Oil Search Limited in the Sepik District in the search for structures that might be suitable for drilling for oil had reached such a stage at that time that the company considered it advisable to undertake exploratory or feasibility surveys to ascertain the best means of access between the Sepik River and the area which runs parallel to the north coast of New Guinea and is very rugged. It reaches a height of nearly 5,000 feet and presents a formidable barrier. The company was faced with the problem that if oil were found, whether to carry the oil to Aitape on the coast or have a gravity pipeline to the Sepik River, for example, to Pagwi, and then take the oil downstream by barge. The Eve-Townsend expedition set out from

Wewak in a south-westerly direction towards Ambunti, a distance of 75 miles in a direct line. Uncontrolled territory was entered 18 miles from Wewak at the village of Minji-haranji. The area as far as the Sepik was found to be gently undulating to plain country, covered by kunai grass (Imperata sp.) five to six feet high. There were also occasional swamps covered with sago palm sac-sac, which had to be carefully avoided. Crocodiles were abundant in the swamps. A plane-table survey was made of the whole route and they reached the Sepik at Marui. Mr. Townsend rode a white horse during this patrol, the first horse seen by natives of this uncontrolled area. They called it 'big pig' and once their initial fear of the horse was overcome, they vied with each other in feeding it. Thus the party was assured of a safe passage.

From the Marui the party went upstream to Ambunti, 250 miles from the mouth of the river, in the government pinnace Osprey. From there they went further upstream to Chenap, where a connection was made with a point reached in a previous survey, the Oakley-Eve Patrol of 1932. The object of this trip was to reconnoitre the area to find a route to Aitape by avoiding the tremendous swamps which were known to exist north of Ambunti.

On returning to Marui a short trip was made due north to the village of Bainyik, which was located by Mr. Stanley in 1931 (today the site of a District Agricultural Station and a Farmer Training Centre). This route was over extensive grasslands. The natives were remarkable for their-short stature as compared with the coastal inhabitants.

This side trip accomplished, the party travelled towards Ambunti, as far as the mouth of the Screw River. Then mapping commenced on the trek to Aitape. The route to Aitape fringed the swamps extending northwards from Ambunti and the country traversed was mainly partly timbered. Eventually junction was made at the southern foothills of the Torricelli Mountains with a previous survey by E e. The journey then continued to Aitape through a new pass in the mountains discovered not long previously by surveyors of the company. These traverses provided accurate information on the topography of the uncontrolled territory lying between the foothills of the Torricelli Mountains and the Sepik River.

The two major patrols apart, Eve carried out many surveys, based principally on Aitape, in order to open up that part of the Sepik District. He was of a quiet disposition, but completely fearless in danger and in establishing contact with primitive people in uncontrolled areas. He developed successful techniques for approaching the villagers for the first time. He was constantly breaking new ground, was strictly fair in all his dealings, and left friendship and pacification wherever he passed. He was particularly friendly with the Arasili people, who lived in the mountains behind Aitape. They provided his overseers amd guides and became his faithful retainers.

Messrs Stanley and Eve formed for many years a team that did much of the pioneering exploration work in the area. Although they formed one team, Eve generally followed the tracks along the ridges and did the countour mapping, while Stanley went along the rivers and other watercourses in order to see the

rock outcrops and geological formations. They would keep contact with each other by messengers (runners), but would meet only about every six weeks. They generally lived on the land and obtained their food locally by barter. By this means surveyors and geologists were able to remain three to four months at a time away from the base camps. In those days, except near the end of the period, there were no aeroplanes and no radio contact. The explorers had to walk everywhere carrying their equipment and goods, and were only able to keep contact with the outside workd by sending messengers to Aitape or a similar centre.

The following notes extracted from reports of G.A.V. Stanley and kindly made available by Oil Search Limited, will indicate the range of work undertaken by H.D. Eve during the last few years of his life.

During January and February 1933 H.D. Eve made a topographic survey south of the Torricelli Mountains, between the areas of Wam and Palei. In September and October 1933 he completed the topographic mapping of the region lying to the south of the Torricelli Mountains by carrying his earlier work westward from the Palei area into the Wapi.

The Eve-Townsend patrol, already described, was undertaken during February-March 1934.

In January 1935 G.A.V. Stanley joined H.D. Eve at a base camp on the Nigia River about 15 miles from Aitape. Later in January, Eve left the Nigia Base Camp for Yupunda Village in Palei, where he established the Yupunda Base Camp and commenced the task of exploring the unknown region to the south and southwest, hilly country never previously penetrated by Europeans. In three comparatively short trips during February and March an area of about 300 square miles was explored by making a network of traverses, thus outlining the course of the drainage system and enabling friendly relations to be established with the natives, who were not then under Administration influence. Between December 1934 and June 1935, Messrs Stanley and Eve carried out geological and exploratory work in the Palei and East Wapi areas, which had to be interrupted because of the outbreak of dysentery in this region.

During April 1935 H.D. Eve continued his explorations in the uncontrolled area to the south. However, dysentery reached epidemic proportions in the surrounding area. In view of this it became necessary to abandon the work in the Palei. Eve left on 28 June 1935 to make a trip southward into uncontrolled territory, during which he was able definitely to locate the edge of the hill country, which was farther south than any point previously reached. He penetrated soutward to within about 15 miles of Ambunti on the Sepik Rover, thence travelling east and northwards, reached the coast at Matapau on 28 July. In September Messrs J.N. Montgomery and H.D. Eve made a brief geological reconnaissance survey through uncontrolled territories between the Amy and Palei areas, working far southward across the hill region and reaching the lowlands of the Sepik plain.

While on this survey, there occured on 20 September 1935 a major earthquake which caused widespread destruction in the Torricelli Mountains behind Aitape. This is the most energetic shock which has ever been recorded in New Guinea.

It registered 7.9 on the Richter scale, and is catalogued as one of the really great earthquakes on a world scale. It had a shallow focus and the epicentre was near the head of the Lipan River. This earth tremor was described in a series of articles by members of the geological survey staff of Oil Search Limited, namely G.A.V. Stanley, S.W. Carey, J.N. Montgomery, and H.D. Eve.

At the time of the first shock the survey party of Montgomery and Eve was between the villages of No'iu and Nabadua, some 14 miles from Kauinbei, on a forested plain on the Sepik River. The duration of the first shock was estimated to be about 3 minutes, with very little preliminary warning. Shocks of various intensity continued thereafter throughout October and faint tremors were still perceptible in Aitape on 4 November.

On the plain country little damage beyond fallen trees was noted and over the fringe of the hill country most of the villages and ridges appeared to have come through unscathed. North of this, however, towards the Torricelli Mountains, fallen houses, ruptured ridges, and landslides became increasingly frequent. The most southern rupturing of ridges was noted in the Maimai group of villages, some 28 miles north of the Sepik River. From the Makro-Namblo group of villages an extensive view was obtained over a 60-mile stretch of country immediately south of the Torricelli ranges.

Throughout this tract new landslide scars were visible as far east as Iwom in the vicinity of Mount Ushaka and the southern slopes of the main portion of the Torricelli mountains. Previously they had been densely forested, but now showed great stretches bared to bedrock and steep slopes replaced by cliffs. Eve found that the Lipan Pass over the dividing range from Yapunda to Aitape had been practically closed as a result of the landslides. The streams were blocked by extensive slips and timber jams formed lakes which made it necessary to make long detours round the precipitous sides and over the intervening spurs. On both the southern and northern flanks of the range there was abundant evidence of the severe shaking this area had undergone. Similar damage was noted at the other pass, where the No. 1 government track crossed the range at an altitude of 4600 feet. At the crest landslides removed most of the track and the northern slopes and spurs were found to present an aspect reminiscent of a glaciated region. Aitape itself appears to have suffered very little material damage.

On 25 June 1937, Messrs. STanley and Eve made a reconnaissance flight from Maimai westward as far as Yagroner. From the swampy nature of the flat country it was realised that it would be quite impracticable to establish and maintain a base camp near Yagroner, using carriers operating from the coast of Aitape. But large areas of grassland were seen to the southwest of Yagroner, which time did not permit to examine. Careful plans were made for transporting all stores along the Sepik River by schooner as far as the junction of the Hauser River, about 420 miles from the sea. On 18 July 1938, H.D. Eve and Patrol Officer Hodgkiss left Maimai overland for the mouth of the Yellow River, where they were to meet the schooner Winon. This contact was effected and the Winon proceeded to the mouth of the Hauser River. The stores were landed, tracks to the grasslands were located, and Eve selected a suitable site for a base camp and an air strip. A runway of 850 yards was completed on 19 August. On 22 August the first aircraft landed at the base - it was a DH Dragon piloted by K. Farer.

The passengers were J.N. Marshaw of Oil Search Limited and District Officer G.W.L. Townsend.

On 10 September Messrs Eve and Hodgkiss departed from the base camp to map a route to Yagroner. On the 23rd Eve was taken ill, at first he was thought to be suffering from dengue fever. Mr. G.M. Broadbent, who walked from Maimai in charge of labourers, made contact with Eve and Hodgkiss and located a small grass area between the Sukura and Babi Rivers. A small runway was prepared there on 28 September. The radio report of Eve's illness was received at Maimai on 4 October and Stanley flew to the new landing ground in a Moth aircraft. Mr. Eve was taken to Wewak hospital on the same day. He died there of bush typhus on 13 October 1938. He was buried in the cemetery along the seashore, below the cliff on which the memorial cairn now stands.

Eve died before the outbreak of the war and all the tributes were written shortly after his death. But it was after 1942, when New Guinea became a theatre of war, that the maps prepared by him and based on his surveys became of such vital importance in a wider context, in fighting the Japanese. Many a lond "independent" soldier working behind the Japanese lines in the Sepik District, among them Mr. Stanley, must owe their lives and success to the maps that were available as a result of Eve's pioneering survey work from 1930 to 1938. Had he lived, he would have no doubt rendered further outstanding and distinguished service in war, as he had done in peacetime, through his great knowledge and understanding of New Guinea and New Guineans.

Perhaps we could conclude by quoting a personal tribute written by J.N. Montgomery, at that time Chief Geologist of Oil Search Limited:

I had a deep regard for him, quite apart from our relations on the job. He had a wonderful likeable personality and was entirely devoid of failings in temperament . . His quiet unassuming manner was characteristic of the man himself. It did not imply any lack of determination or backbone; his performance in uncontrolled territories clearly demonstrated that. Rather it expressed a complete reliance in himself, without the aid of approbation or applause and a most remarkable self-control.

He gave unstintingly in his work and was ever ready to take the lead in the most dangerous and difficult tasks. Not only will all his colleagues mourn and miss him, but in many native communities there will be sorrow for the passing of one who understood them well.

The obituary notice in *The Australian Surveyor* 1 December 1938 summed up Eve's achievements in the following words:

In his passing Australia has lost one of her great explorers, as his expeditions in New Guinea are comparable with any explorations made in the world. The late Mr. Eve had many notable achievements to his credit, including two important expeditions, designated the Oakley-Eve Patrol of 1932 and the Eve-Townsend Patrol of 1934 . . . Though slight in build, Mr. Eve was endowed with an adventurous disposition and was by nature fearless - qualities which rendered him eminently fitted for leadership in the difficult undertakings on which he was engaged. He was also possessed with innate ability to handle natives tactfully and successfully and his reputation in this respect was probably unrivalled in New Guinea.

So this was the man in whose memory there stands a concrete cairn at Wewak Point overlooking the sea. It survived the wartime devastation of Wewak and let us hope will continue to stand there for many more years to come. It is a memorial and constant reminder not only of the life and achievements of Henry Dunman Eve, but of all the pioneers, explorers, surveyors, administrators, who undertook long, hazardous journeys, generally on foot and remaining for many months without contact with the outside world, into uncontrolled, unexplored areas, in order to open up and explore the country, bring peace to the people, and thus lay the foundations for the great developments that are taking place today throughout Papua and New Guinea.

Acknowledgements

The author gratefully acknowledges the assistance that was so generously extended to him by a number of persons, in particular: Mrs. Rosemary Morgan (Eve's daughter), Mrs. N.M. Briggs (formerly Eve), the late G.A.V. Stanley, Professor S.W. Carey, Mr. L.A. Morris and Oil Search Ltd, Mr. H.L.R. Niall, Mrs. M.L. Townsend and Mr. G.P. Sinclair.



"Do you thank that will be enough for the weekend, Mal?"

A BRIEF SUMMARY OF RECENT DEVELOPMENTS IN ELECTRONIC DISTANCE MEASURING EQUIPMENT

By: P.H. Mudge, B.Surv. (N.S.W.), M.I.S. Aust., M.A.S. PNG

PREAMBLE

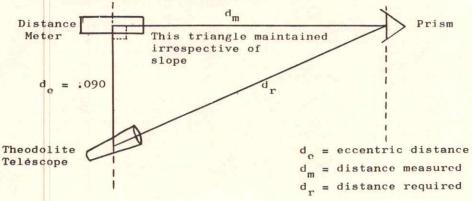
The last six months have seen a new type of distance meter introduced by several manufacturers and further time-saving and practical developments to current distance meters. These distance meters are far more portable than previous models and all are fitted to a theodolite by some form of adapter. The various alternative methods of mounting and measuring with these distance meters are discussed here. A brief comparison sheet is included at the end of these notes.

ALTERNATIVE ONE: Distance meter attaches to telescope of theodolite.

See Fig. 1

The AGA Geodimeter Model 12 is attached to the theodolite in this manner (also available under alternative 2). The advantages of having the distance meter attached to the theodolite in this manner are:

- Easier to point the instrument is aligned so that peak return signal
 is obtained once the theodolite crosshairs are on the target. Ease of
 pointing is particularly important when setting out.
- 2. No special target set required. Normal prisms can be used as the distance between the theodolite telescope and distance meter is sufficiently small to make eccentric corrections to distances unnecessary. Again, this is particularly important when setting out.



Suppose (taking an extreme case) d = 10.000 metres. By Pythagoras:

$$d_r^2 = d_e^2 + d_m^2$$
 $d_r = 100.0081$
= $(0.090)^2 + (10.000)^2$ = 10.0004 metres

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A Brief Summary of Recent Developments in Electronic Distance Measuring Equipment

By the Binomial Theorem the eccentric correction can be expressed as

$$= d_e^2/2d_m$$

and is negligible for theodolite telescope mounted E.D.M. as the "triangle of eccentricity" is constant regardless of slope.

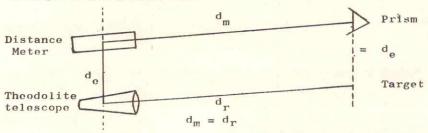
3. The AGA Model 12 incorporates both a visual gauge and audio signal. Once the prism is within the beam (1 metre wide at 400 metres) a buzzing audio signal changes in pitch depending on how close the prism is to line. On line the buzz is high pitched, and rather low-keyed at the edge of the beam. This becomes a very useful aid for setting out purposes. The operator and reflector man are both equipped with two-way radios. The operator holds his radio on so that the man with the reflector on the setting out rod can hear the buzzing signal through his two-way radio. From the pitch of the buzz he can tell if he is close to line or well off.

With the Model 12 the signal need only be peaked within two minutes of arc. There is no need to adjust signal or set attenuation. Signal level and attenuation are automatically completed by the instrument.

ALTERNATIVE TWO: Distance meter mounted over the theodolite, but not on the telescope. See Fig. 2

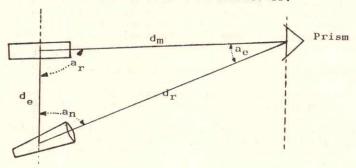
Relevant points concerning this adapter are:

- 1. Ability to plunge telescope to check for gross errors while setting out. This is of dubious advantage. With the instrument attached to the theodolite one would not attempt to read traverse angles where better than five second accuracy is required. It is considered to be a far better practice to remove the distance meter where precise angles are required. For setting out purposes, where an absolute accuracy of 10 mm per point is sufficient (10 mm being accumulation of angular and distance meter errors) setting out can be completed on one face, the distance meter removed and all radiations checked on the other face.
- A special target set is required where the distance meter is mounted in this manner. With this target set the distance between the prism and the target should equal the distance between the distance meter and theodolite telescope, to give parallel lines.



A Brief Summary of Recent Developments in Electronic Distance Measuring Equipment

If ordinary prisms are used the result is:



Using the Sine Rule and assuming the vertical angle is 3^{0} , the measured distance is 100 meters and the height of the distance meter above the theodolite telescope is 0.200 meters, the correction would be:

$$d_e/\sin a_e = d_r/\sin a_r = 100/\sin 87^\circ$$

Calculating a to obtain a r

$$\sin a_e = \sin 87^\circ \times d_e/100$$
 ... $d_r = \sin a_r \times 100/\sin 87^\circ$

$$= 0.00199725 = \sin 87^\circ 06'52"\times100/\sin 87^\circ$$

$$a_e = 0^\circ 06' 52"$$
... $a_r = 92^\circ 53' 08"$ $d_r = 100.010$

These corrections must be made for every distance measured or set out. The above calculation emphasizes the convenience of having a special target set when using an E.D.M. mounted off the telescope.

3. No wear on the trunnion axis of the theodolite. The AGA Geodimeter Model 12 weighs 2.7 Kg - about 20% lighter than other distance meters that have been mounted on the theodolite telescope. Some wear to the trunnion axis is likely to occur, however, one must weigh up against this the usefulness of having the distance meter on the telescope of the theodolite. Theodolites were once a fairly major capital outlay but now the purchase of a twenty second theodolite can represent only one-eighth of the cost of a set of E.D.M. equipment. The purchase of a one second theodolite represents only about one-third the cost of a set of E.D.M. equipment (depending, of course, on the make of the theodolite purchased).

A Brief Summary of Recent Developments in Electronic Distance Measuring Equipment

Once upon a time a theodolite was purchased almost to last a surveyor's working life, but now, with the likelihood of electronic and self-recording theodolites being available in the next five years, it is not practical to purchase equipment to last so long, and the equipment should probably be written off over a five year period, at the very most, over ten years.

ALTERNATIVE THREE: Distance meter mounted over theodolite. See Fig. 3

Here the AGA Geodimeter Model 76 is mounted on the left and right housings of an AGA-Franke theodolite (West German). Although E.D.M. like the Model 76 are not setting out instruments, an adapter of this type allows detail and other measurements to be picked up with the one pointing for each shot rather than reading angles and distances separately.

OTHER CONSIDERATIONS

- Portability has always been a major bugbear with E.D.M. equipment. Distance meters such as the AGA Model 12 overcome this problem. The Model 12 and its battery fit in pouches attached to the belt - see Fig. 4.
- The capability of a distance meter to measure to a moving target should not be underestimated. This speeds up the setting out process, without a trail and error, stop-start process.
- 3. The number of prisms required to obtain maximum range. The fewer prisms the less the initial expense and the more portable the unit as a whole.
- 4. The availability of adapters to suit any theodolite is an important consideration. Otherwise it is necessary E.D.M. fits and this makes the whole set of equipment rather expensive.

The adapter should preferably be one that can be left on the theodolite at all times and fits into the theodolite's transport case. If the adapter has to be attached each time the E.D.M. is used, then it must be aligned each time horizontally and/or vertically, depending on the type of adapter.

	1	The state of		O. TO GITTE	CETAS ELLE	TELL CD6
WEIGHT: AIMING HEAD, CONTROLS, DISPLAY	2.8Kg - 6.2Lb	1.6Kg - 3.5Lb	12.7Kg - 28Lb	21.8Kg - 48Lb	٥	3.7Kg - 8.1Lb
RANGE: TO 1 PRISM	1000 M	200 M	300 M	W 009	700 M S.L.* 1000 M T.L.*	800 M
RANGE: TO 3 PRISMS	2000 M	500 M	. 600 м	M 006	Not specified	1200 M
MAX. RANGE & PRISMS REQUIRED	2000M with 3	500M with 3	900M with 9	2000M with 9	3000 to 19 S.L. 5000 to 19 T.L.	2000M with 7
MEASURING TIME (NOT INCL. POINTING)	15 secs	15'secs	10 secs	15 secs	secs	- 1
ECCENTRICITY CORRECTIONS	Negligible	Negligible	Negligible	Negligible	Depends on prism	n Dep. on prism
ABILITY TO MEASURE TO MOVING TARGET FOR SETTING OUT	Yes-5M/sec	No	No	Yes	No	Yes
MEASUREMENTS PER BATTERY	300-400		500	200	500-1000	
POWER CONSUMPTION	17 watt	15 watt	14 watt	abt. 15 watt	4 watt	12 watt
ATMOSPHERIC CORRECTION	Automatic dial in before measurement	Calculate separately after measurement	Auto. dial in before measurement	Calculate separately after	Auto. dial in prior to measurement	Calculate sep after measurement
PLUNGE TELESCOPE	Yes & No	Yes	No	No	Yes	Yes
ATTACH TO ANY THEODOLITE	Yes	Only Kern	Only Wild	Only Wild	Zeiss avail. others later	Mounting to all theods.
ACCURACY AT SHORT RANGE	5 mm	5 mm	5-10 mm	10 mm	5 mm	5 mm
POSITION OF CONTROL UNIT & DISPLAY	Above telescope	e Around Telescope	Below * Theodolite	On the ground	Above Telescope	Above Telescope
DISPLAY: SIZE OF NUMBERS DISPLAYED	12 mm	4 mm	4 mm	5 mm	4 mm 4	10 mm
OTHER FEATURES	No ambiguity over 1000 M		Gives horizontal	1		



Fig. 1



Fig. 2



Fig. 3

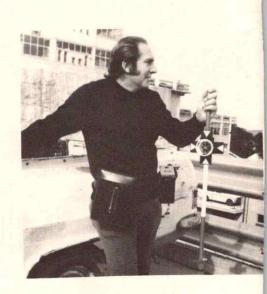
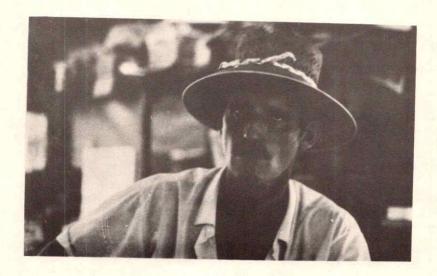


Fig. 4



Surveyor at work?



Bazza Mc Scriven? ? ?

Personal Notes

Mal Gray having "gone finish", thinks Australia is a great country so long as you don't live there.

Lou Rampant is looking forward to getting back to his labouring job in Cairns. He claims that a surveyor is only a labourer's apprentice anyway.

There is no truth in the rumour that Dave Rumble has retired. He is still working normally.

Bob George has been trying to convince suppliers that gin should be sold in unbreakable bottles. Perhaps he should try drinking it in a padded cell.

Tony Ferris can't decide whether to take up professional golf or cricket but he reckons either must be more profitable than surveying at the moment.

Wife Jennifer produced a 1975 Model (late series) Masta Mak in November. That gives Col and Jenny Hard a total of three sons and one daughter.

Bob and Gillian Prikulis are on leave in Australia.

Don and Jean Smith should be on leave in Australia, God and Air Niugini willing.

David Forster comes first of course, first in sport, first in dogs teeth, first in short socks (they are OUT now) first in at 7:30 a.m., first out at 4:06 p.m. First on your right on the second floor of Survey Section, first in the bar after squash Friday night. Must confess though convincingly wins in the situps division of our get fit (for drinking) campaign.

Gilbert Hole, therefore must be second, his effort in delaying his leave and then being told to take it just in time to make the first Test at Lords was magnificent. Truly a forward thinking fellow of great potential.

The Great Steaming Johnstone should not be third but how can he get any higher. He struggles with his press-ups every day, struggles through thirty tuck jumps forces himself into the sauna and struggles to stay awake the rest of the afternoon. But he is our only entrant in the Yule Island yacht race a great GREAT sailor.

John Crumpetbird, well it is not really spelt like that but one gets the impression that it should be. He has had the odd trip away tramping around East New Britain looking for roads (or orchids whichever comes first). The orchids are free of course, who needs Andree Millar.

To the third David, that is Thompson, lost 5 kg. in the last three weeks. Looks it too, bags under his eyes, shoulders stoop, cheeks drawn, clothes all hanging off. But insist he is fitter than in his wrestling and karate days some years (?) ago. In their new (?) house, working like a dog (burying the rubbish) making his little rest for what appears to be a long stay. Maybe he will come up with a couple of extra fledglings.

PERSONAL NOTES

John Hunter is off for a spot of leave until the middle of January. He and Jill have unloaded the children in Perth and are making for England and Scotland.

Aipos Amevo who has been working continuously on the Purari Mapping Scheme for the past 12 months is now back in Mt. Hagen prior to taking four or five weeks well earned holiday over in Lorengau.

Rumour has it that Noel Sharp may be seen around Hagen in the not too distant future. Sharpie was last sighted pointed in the direction of Wabo on May 26th this year and as he hasn't been sighted since, it's been assumed that he's been wandering the jungles from that time to this. However, an unconfirmed report from the Wau Golf Club has it that he's been seen there consuming the odd S.P., and that he's finally pining to get back to his regular stamping ground.

Rumour also has it that Mal Gray who left Hagen a trim (?) 14½ stone has relaxed the tummy muscles a bit and is now hovering around the 17 stone mark. Don't think they can recover that Golden Handshake, Mal, so there's probably no real need to drink it all in one foul sweep!

Dick Moody who's just had a few weeks back in Kiwi-Land, is back into harness again and celebrated his return by knocking up 108 n.o. in a recent match in Goroka.

Peter and Jan Jolley are off shortly to find out why Graeme Arman spends so much time in Indonesia. Jolley generously offered to cut costs and go on his own, but Jan insisted on going even if it was a case of "taking coals to Newcastle". After giving Arman the once over they plan to spend a week or two on Phuket Island off the coast of Thailand (For those members with either a flair for, or a failing in the English language, the above Island is pronounced "Puk-ett-" and not as it reads!)

The ninety second meeting of Council was held in Hagen in November with some notable visitors being in attendance. Kisokau and Francis Posanau left the meeting a little early with a distinct gleam in their eyes, while Mike Larmer with new moustache and looking a leaner version of Burt Reynolds, has offered to do the first "centre-fold" for the Journal.

Bob George is occasionally seen around Mt. Hagen in his role of Acting Regional Surveyor. Bob is currently commuting between Lae and Mt. Hagen, but is unlikely to move the family up until he returns from leave sometime in January.

Max Muller and family are at present holidaying in Queensland. Believe Max was put on a beer ration on the voyage down on the "Cathay" so that there would be enough drink for the other passengers.

Heard that Clive Bassett refused to visit his family so they have joined him in the bush.

Stuart Scriven is heading for Nauru for Christmas and New Year. It is understood he will be returning with several suitcases full of high grade phosphate.

Personal Notes

Marion Cichoki left Port Moresby recently for six weeks leave in New Caledonia. Marion apparently likes fireworks displays as he expects to get a birds eye view of the next series of French Nuclear tests in the area.

Tony Ferris was working in Moresby just before the Rabaul Cricket finals when he got an S.O.S. to get back there and spearhead his Clubs attack. Let's hope he gets some wickets as airfares Rabaul - Moresby - Rabaul are not cheap these days. The Club bought the ticket.

There is a little illegal betting going on at Lands H.Q. at Waigani. Mesdames Pochapon and Salaiau are both expecting picaninnys at any time. Kisokau is a shade of odds on to be a father first whilst Pomaleu is all the rage with the punters as far as the heaviest baby is concerned.

Francis Posanau has more serious things on his mind. As a member of the P.S.A. Executive he is concentrating almost exclusively on indexation.

Over at C.M.B. they are churning out work at a previously unheard of rate owing to a huge increase in staff. Apparently the holidaying Unitech students are responsible for this situation.

This increased activity during working hours is matched only by John Van As' increased social activity. It is the Christmas Cocktail party season in Port Moresby and John's after hours schedule would have Dean Martin in the horrors.

Janet Whish-Wilson went to Australia recently for a speech nite. Maurie, it is reliably reported, is on his third tin opener. The air traffic controllers are expected to resume work before Christmas so there is hope for roast turkey yet Maurie.

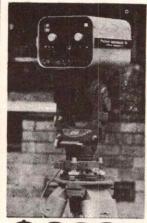
James Hunt has grown tired of the giant De Gaulle Class Citroen being the light of his life and has bought a 5 metre sloop called 'Nimbus'. It's enough to make the private surveyors sell their beaten up Land Cruisers and rubber dinglys and buy a ticket in the lottery.

Mirek Erben has just returned from the Star Mountains where he carried out extensive research into that great equalizer the penis gourd. Oh, by the way, whilst he was there he did a bit of control for Geological Mapping in the Nong River area.

Ian Sparks just left for the Fly River. In his eight months in P.N.G. he has worked almost entirely in the Gulf and Western Provinces. Mick Larmer was forced to give him an autographed copy of Mount Wilhelm the other day as Ian refused to believe there was a hill in the country which is very dangerous if you do a bit of flying.

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The BEETLE e.d.m. unit has been designed as an answer to today's inflated prices and labour costs. The BEETLE allows every Surveyor to use an e.d.m. unit without overcapitalising. The BEETLE allows Governmental bodies and Technical institutions to purchase e.d.m. units on reduced allocations. And despite the fact that the BEETLE is about half the cost of comparable models, it incorporates the very latest features and components not all of which are available in these more expensive units.

For example:-

- 1 the distance display is high contrast liquid crystal *.
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- 6 has an audio signal for ease of target acquisition.
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- 12 has an absolute accuracy of within 10mm. irrespective of distance.
- 13 absolutely portable available in belt pouch.
- 14 measuring time 7 seconds.

The BEETLE is manufactured by Precision International U.S.A. and over 800 units have been sold. The name BEETLE was selected as it has become synonymous with low cost and high quality. The BEETLE now makes it possible to equip every survey party with an e.d.m. unit without overcapitalising. Ring for further information or a demonstration to see for yourself. Finance can be arranged and you'll be happy with the delivery time!!





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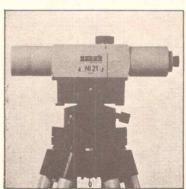
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The Journal of the A.S.P.N.G., December 1975, Vol. 5, No. 4.

The DH-1 has a computer built into the control unit. This makes it possible to set the vertical angle on the control unit and then display directly either slope distance, horizontal distance or difference in elevation. (option)

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SPECIFICATIONS SDM-3C

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Measuring range: up to 1,000m with 1 retroprism

in excess of 1,600m with 3

retroprisms

These ranges vary according to atmospheric

conditions.

Accuracy: $\pm (5 \text{mm} + 5 \times 10^{-6} \text{ D})$

Measuring time: 4 seconds

Read out: Digital 6 digits reading directly

up to 999.999m

Light source: Infrared Light Emitting Diode
Power supply: Ni-Cd rechargeable battery pack
This provides 3 hours continual

operation at 20°C (68°F), approximately 1,000 measurements.

Operating temperature range:

-10°C to 50°C (14°F to

122°F)

ANGLE MEASUREMENT

Objective aperture 35mm (90mm including transceiver)

Additional constant 0

Horizontal Circle:

Diameter 92mm
Graduation 20' (1g)
Micrometer reading 10" (50cc)
Estimation 1" (5cc)

Vertical Circle:

 Diameter
 90mm

 Graduation
 20' (1g)

 Micrometer reading
 10" (50cc)

 Estimation
 1" (5cc)

Level Vials:

Sensitivity of circular level . . 10'/2mm Sensitivity of plate level . . . 40''/2mm Sensitivity of telescope level . 30''/2mm

Optical plummet:

Magnification 2 X, Erect image

Weight of instrument: 9.1 kg

Control unit complete with battery: 8.0 kg

RETROPRISM

Type:

Precision ground corner cube retroprism

Aperture: 72mm clear

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Maximum divergence: ±2"



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© AGA GEODIMETER-MODEL 710

NEW FEATURES.

The MODEL 710 is a development of the MODEL 700. The new instrument gives a continuous indication of Height difference (2H) and of horizontal distance, stope distance, vertical angle, horizontal angle automatically in digital form up to 4.8 Km, to one second of arc and 5 mm accuracy. Under favourable conditions the MODEL 710 will measure up to 9 Km. The 710 has a lightweight fibreglass transport case and a continuous power supply.

APPLICATIONS.

Any survey, big or small, viz:- all setting out work, all traversing; construction work; urban and rural subdivisions; detail surveys; breaking down triangulation nets; supplementing cartographic work; trigonometric height measurments; underground measurements in mines and tunnels; photo control; Tacheometry, etc.

WITHOUT AUTOMATIC RECORDER.

The MODEL 710 is available with or without automatic recorder for collection of data or observations. The 710 can be used for all phases of subdivision work. Picking up detail and contouring for design purposes can be completed in ½th the time required by a conventional theodolite with attached distance meter. Similarly traversing is com-pleted in ½ the time and setting out in ¾rd of the time. From the control points, the surround boundaries can be redefined, detail and contouring completed, road centrelines and angle points in the subdivision can be pegged and levelled. 160 points can be set-out in one day. Once the subdivision and control is co-ordinated, the 710 can be set up anywhere on the subdivision and the unknown instrument station co-ordinated three dimensonally in three minutes by resection. This technique of "random set-up" can be used on many surveys. Three dimensional setting-out can be performed on construction sites. With the target height at the same height as the instrument the difference in level is immediately displayed

WITH AUTOMATIC RECORDER.

The GEODAT 700 punch tape is attached to the MODEL 710 and used to record and code all observations. With the GEODAT 700 punch tape comes the GEOCLEAN program which reduces, cross-checks and lists the punched information under station numbers in polar co-ordinate form. Some examples:-

- A punch tape containing 500 observations for contouring can be read and reduced ready for plotting in 3 minutes. A plot of the 500 observations can be automatically plotted in 30 minutes. This includes time required to specify points, e.g. type of tree and diameter. Contour intervals, not normally obtainable by photogrammetric methods are obtained, apart from being cheaper, more convenient and quicker. Over 600 observations can be recorded in a day.
- Cross sections can be punched, reduced and plotted, and earthworks quantities produced very quickly.
- Terrain models can be stored for future mass calculations and can be compiled quickly and inexpensively and updated at any time.
- 4. The horizontal distance and bearing displayed by the 710 can keep up with an object moving at 37 Km/hour (23 mph) so it is ideal for hydrographic work and saves time consuming intersections and plotting.

For demonstrations and further information on applications, please contact AGA or any of AGA's interstate agents.

The Model 700 geodimeter is still available at special prices.

THE MODEL 710 CHANGES WEEKS TO DAYS AND DAYS TO HOURS.



AGA2355