

THE JOURNAL

of the

Association of Surveyors of Papua New Guinea



VOLUME 6

No. 2

JUNE 1976

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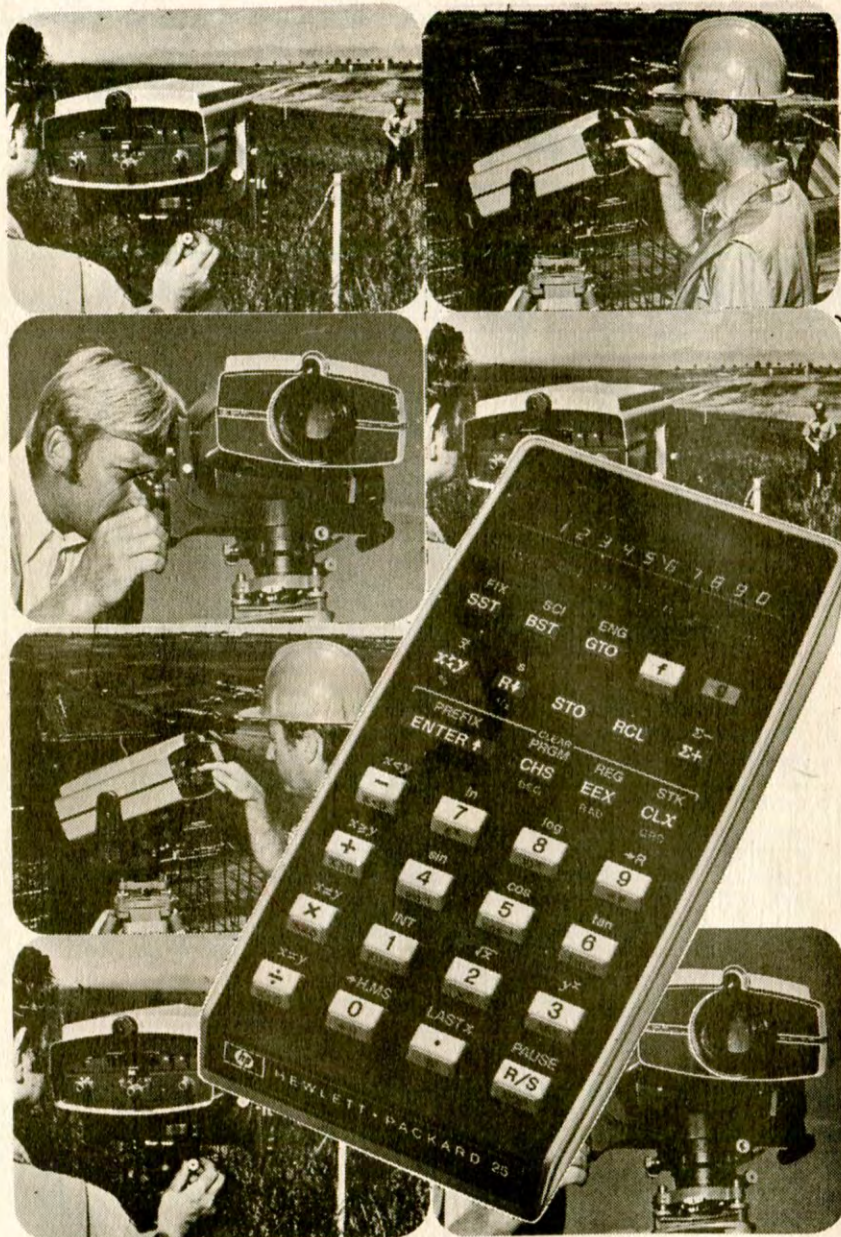
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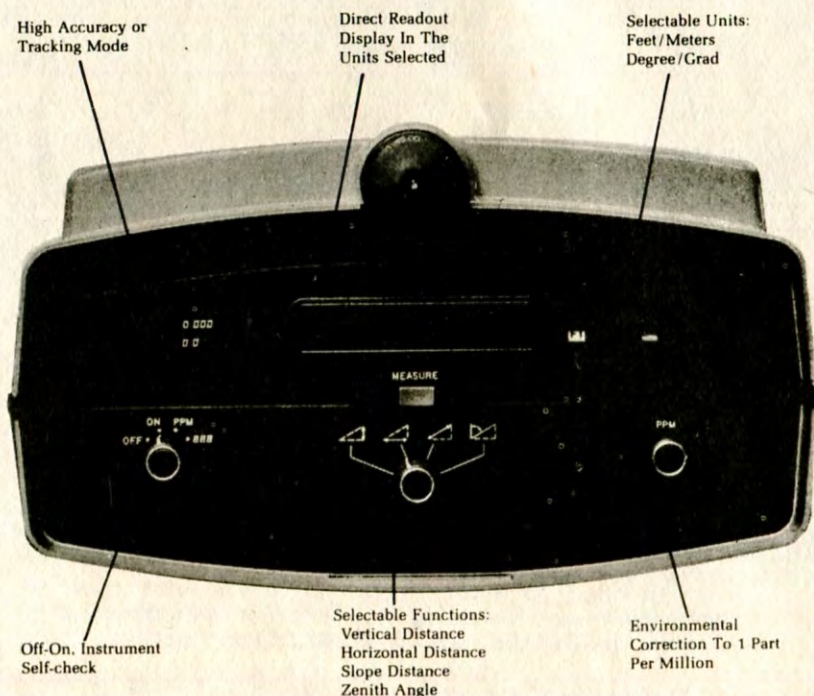


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The Journal

OF THE

ASSOCIATION OF SURVEYORS OF PAPUA NEW GUINEA

Vol. 6

June 1976

No. 2

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APPLICATION OF GEODETIC ENGINEERING

FOR SMALL SCALE SETTLEMENT STUDIES

By: Herbert W. Stoughton

1. Introduction

The San Francisco earthquake of 18 April 1906, resulted in lateral displacements of as much as six meters. The U.S. Coast & Geodetic Survey (now the National Geodetic Survey) believed that if displacements of this magnitude existed, the relative positions of all triangulation along the San Andreas Fault would be so poor as to render the net unsuitable for future surveys. At that time there were two schools of thought concerning the 1906 event. Some thought the permanent displacement was limited to a narrow strip of land adjacent to the fault. Others believed the displacement extended back from the fault several kilometers. If the first theory was true, only triangulation actually crossing the fault zone need be reobserved with occasional checks to other triangulation stations distant from the fault zone for orientation. Since reports indicated the second theory might be true, it was decided to re-observe the entire triangulation net.

The triangulation employed in the study was initiated in the San Francisco area in 1851, and extended in 1854, 1855, 1864, and 1866. From 1851 to 1899 primary, secondary, and tertiary work proceeded north and south along the coast. John F. Hayford and A.L. Baldwin studied all the early work and made comparisons with the reobserved data after the 1906 event. They stated in their report that there was measurable lateral movement not only after the 1906 earthquake, but also after the 1868 earthquake. They determined that the movement was not limited to the immediate fault zone. This was one of the earliest studies of the application of geodesy for seismology.

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Dr. A. L. Day of the Carnegie Institute recommended that the U.S. Coast & Geodetic Survey extend triangulation along the entire San Andreas Fault system. The net was to be reobserved at intervals of about five years. This objective was never obtained due to national priorities resulting from the Depression and World War II. However, the work which was done has enabled several geophysicists to develop programs to detect gradual displacement along the fault, even though there has been no significant earthquake. Charles A. Whitten's work of 1948 was the initial step in the development of fault monitoring systems, which are presently employed.

The early work was not limited to the study of lateral motion. Many believed that relative vertical motion was a simple quantity to determine. The question which arose from these observations was: Which bench mark did not move? As a matter of fact, even today, this particular issue will engender spirited debate.

Because precise values for small vertical displacements are relatively simple to determine, a great number of subsidence studies have been initiated to study ground depletion, oil pumping, crustal rebound. One of the earliest major applications of geodetic levelling for subsidence studies not related to seismic activity was the study of the crustal deformation due to the filling of Lake Mead. At about the same time programs were developed for studies in the San Joaquin Valley; Brea Canyon; Long Beach, California; and Houston, Texas.

The work prior to World War II illustrates experimentation in each program to devise a satisfactory observing program. Since the mid-fifties, the programs have been standardized. Today, there is a study to evaluate the use of water levels for the accurate determination of small amounts of crustal tilting.

2. Small Area Studies

Until recently these movement studies were designed to cover hundreds of square miles. Today, there is an increasing demand to conduct studies of areas of a few acres to a few square miles, which cannot be accomplished by classical mensuration techniques (i.e. arc triangulation).

Engineering considerations weigh heavily in the design of a geodetic network. First-Order, Second-Order, and Third-Order horizontal control definitions must be revised to accommodate small scale projects. The probable error of pointing a theodolite on a target at three hundred meters distance is about three seconds of arc, which will be four millimeters "off-line" (about one part in 75,000). Triangle closures may exceed five seconds in some instances. If all the lengths in the scheme are observed (with a probable error of about two centimeters) and not computed, the interrelationship of the stations is improved vastly. Personal experience indicates that the best scheme is a series of interlocking - over-lapping triangles. The scheme is "tied" to distant stations to detect rotation, and the net is adjusted without constraints on any station.

Figure I illustrates a horizontal control net established to monitor movement around a small reservoir. No line in the scheme was longer than 475 meters. After the adjustment of each series of observations the results were compared with previous observations. A comparison of summer (August) and winter (February) observations indicate an elongation of the summer values by about twelve millimeters for each line.

Once, when the reservoir was empty; a series of observations were made when the reservoir was empty, filled to one-half capacity, and filled to capacity. The lengths for the every line increased in length by about fifteen millimeters for the one-half full data when compared with the empty data. The trend reversed when the lengths for the full reservoir were compared with the one-half full lengths. This reservoir was shallow and the results were anticipated by civil engineers.

The values cited are not absolute, but are as good as the uncertainty of the observations (which the geodetic engineer must ascertain). The adjustment resolves the inconsistencies of the observations, and derives the most probable values, which are dependent upon the criterion of the adjustment.

The comparison of observations does not give absolute results. If the differences are less than the uncertainty of observations, nothing is resolved.

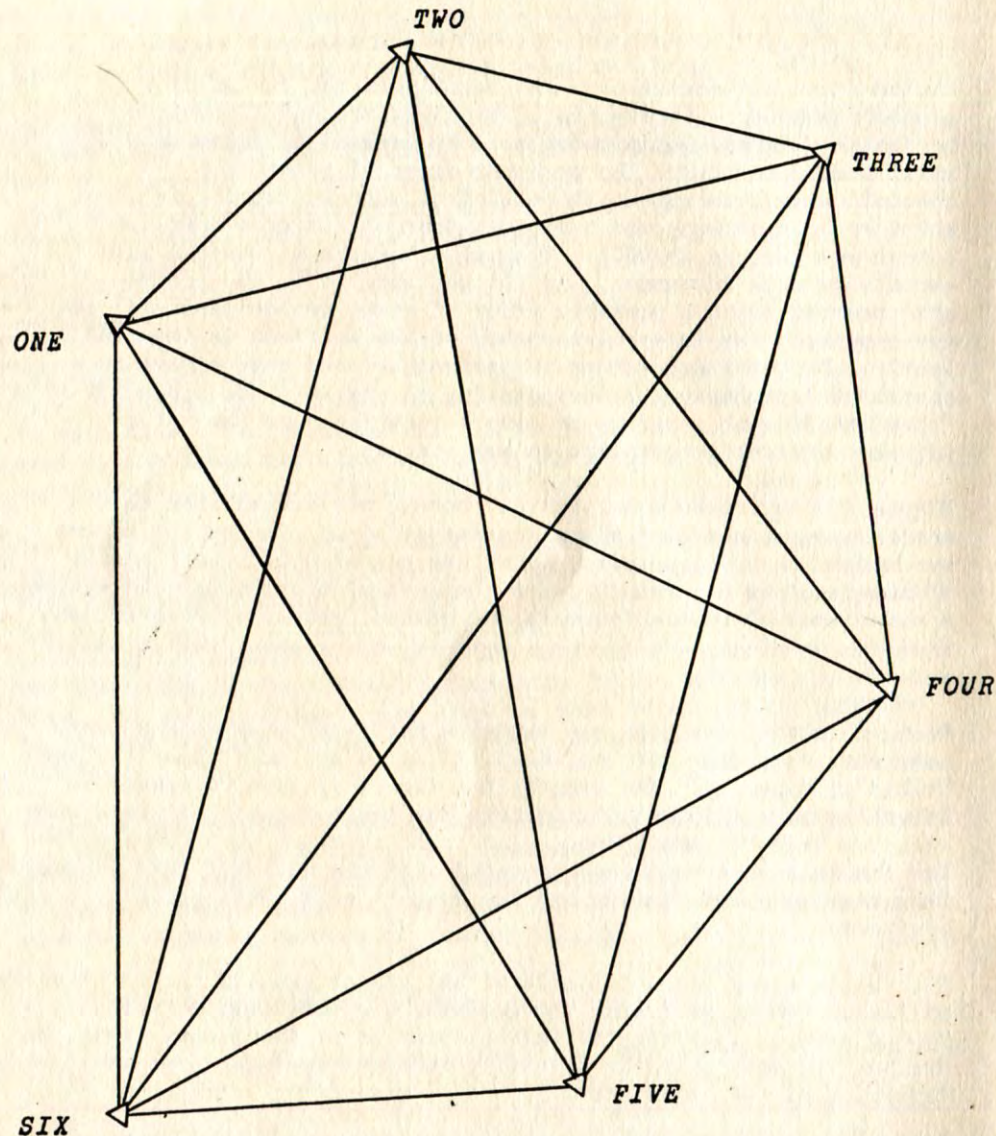


FIGURE I

However, over a period of time if the differences have the same algebraic sign, a trend becomes apparent, which will indicate either movement, or a systematic error in the observations.

For example: A study of the positions (derived from computations of the observations) of sixteen stations on the face of a concrete dam indicated movement between any two successive observations. But, when an over-all comparison was made, it appeared that the stations moved in "circular" paths. After obtaining the volumes in the reservoir and the seasonal temperature of the dammed water at the time of the observations from the civil engineers, it was concluded that movement was due to temperature effects and loading due to the volume of the impounded water.

Traverses are unsatisfactory for these types of studies. There are few - if any - redundancies to eliminate "warping" during computation. Durgin and Sutcliffe wrote in the *Manual of First Order Traverse*:

It must be remembered that in a traverse, unlike triangulation, there is no mathematical relation between the measured lengths of the sections and the angles between them. The angles and lengths are entirely independent quantities, and there is no way of telling how much of the discrepancy in the closing position is caused by errors in the angles and how much by errors in the measured lengths.

The criterion for observations of vertical displacements must be altered. The present specifications allow a discrepancy (partial) for the difference in elevation of double run sections of one-half the allowable discrepancy for a one kilometer section for all sections less than 0.25 kilometers long. It is not uncommon for bench marks at every rod set-up, which means the aforementioned criteria is employed. New specifications should be written for this type of levelling. However, if the plane parallel plate micrometer with the appropriately graduated level rods is employed with a suitable observing program, much smaller allowances on the discrepancies can be established.

3. Conclusions

There has been little literature published on small scale settlement studies. Many programs have been initiated, but more time is required to evaluate their effectiveness. Designing a good program involves several factors. They are:

1. Type of system required.
2. Type of equipment and personnel available.
3. Accuracy required.
4. Significance of the results.
5. Cost of the program.

For the optimum results for horizontal movement a combination trilateration - triangulation system should be observed. The horizontal and vertical control nets should have many checks and redundancies built into the system. Because these systems must be complicated, a computer is a requisite to reduce and adjust the observations. Also, the computer allows the geodetic engineer to design various analysis techniques, and display the results either digitally or pictorially.

By: N. T. VERGARA

SUMMARY

Papua New Guinea is very rich in natural resources. These natural wealth, coupled with the investment incentives set by government, are attracting foreign investors with their much-needed investment capital. However, land-ownership conflicts appear to discourage land-oriented investments, such as Forestry. A nation-wide land-survey program to fix boundaries and issue ownership titles seems necessary to minimize this investment problem.

INTRODUCTION

As a newly-emerged nation and as the latest addition to the family of Nations of the World, the Independent State of Papua New Guinea has a lot to feel lucky about: it has a vast land area relative to the sparse population (population density: about 5 persons per square kilometer); it has rich mineral resources, if the few mineral deposits explored and analyzed so far are any indicators; it has a fine tropical climate that is suited to growing almost anything; it owns a vast reserve of forest resources (over 70% of total land area) which can be tapped to accelerate economic development, and many more. If judiciously utilized, these natural resources will propel Papua New Guinea to undreamed-of heights of progress and development.

A recent PNG trade mission to Europe headed by the Minister of Commerce and Industry aroused considerable interest among Western European investors. Subsequently, several heads of industrial concerns paid exploratory visits to PNG to assess, among others, the raw material resources of the country on which investment will be founded. It is very significant to note that most of the visiting representatives of foreign investors have come solely for the purpose of evaluating the prospects in the forest-based industries.

Apalling world shortages in wood-based products are predicted by the UN/FAO in the next two and a half decades. To meet such short-falls, industry is relying on two approaches: (a) establishment of fast-growing, intensively-managed forest plantations, and

Mr. N.T. Vergara, B.Sc. Forestry (U.P.) M.Sc. Forestry (N.Y.) is a Lecturer in the Department of Forestry at the Papua New Guinea University of Technology.

(b) development and utilization of hitherto untapped natural forests. Since PNG is one of the few areas in the World which contains vast unexploited natural forests, it is only logical that prospective foreign investors flock to this country.

In addition to its tremendous natural wealth which attract foreign investors, PNG has legislated certain business incentives to lure foreign capital into the country to accelerate industrialization. Tax holidays and repatriation of profits are examples. The next large problem of the PNG Government is how to translate the expressed interest of many foreign investors into real industrial investments.

SOME DISINCENTIVES TO FOREIGN INVESTORS

Conceivably, not all the prospective investors will eventually set up business firms in Papua New Guinea. There are a whole range of reasons for such a sad eventuality are: (a) infrastructure is relatively undeveloped and business firms might be forced to make huge outlays to overcome this deficiency; (b) labour productivity is comparatively low; (c) wage rates are relatively high; etc. In the forest industry in particular, the disincentives faced by investors, in addition to the above, are the following: (a) poor accessibility to a huge portion of the forest resource base, (b) unsettled land ownership of forest lands. The latter is a special problem found in this country and deserves a more than passing attention.

LAND TENURE PROBLEMS IN PNG

This country is unique in so far as forest land ownership is concerned: while other countries employ the Regalian Doctrine in respect of natural resources, i.e., resources such as waters, mineral deposits, forests, etc. belong to the state, PNG is directly the opposite. Almost 100 percent of the land including forest lands that normally are part of the public domain, belong to private persons or clans under the customary or traditional land ownership system. As a consequence surface resources (e.g. forests) and sub-surface resources (minerals) are likewise privately-owned.

Since clan ownership is nebulous at best, and land boundaries move back and forth with the tides of clan warfare, there has arisen a problem that seriously confronts investors: the problem of who to negotiate with and what land properties to negotiate for prior to investment.

A case in point is a large wood-based foreign-owned firm in Madang. It is operating four forest blocks with an aggregate area of 86,000 hectares. One of the blocks has an area of 63,600 hectares. To effect the Timber Rights Purchase (i.e., the purchase of the timber but not of the land), the Government had to "negotiate" (in behalf of the investor) with 250 distinct land-owning clans speaking eight different languages. Each clan averaged about 10 persons, and each clan landholding averaged 254 hectares, the boundaries of which would change in location, depending on which clan is being consulted. Needless to say, the timber project was almost dropped, and Madang almost lost a K9.8 million investment employing 550 PNG nationals.

LAND SURVEYS NEEDED TO FIRM UP OWNERSHIP

If the Government wants to establish possession of these clan lands, there are two possible approaches:

(a) land purchase and (b) legal means (such as passing a legislation that transfer ownership of natural resources to the State). The first approach is very expensive, and the Government cannot afford to spend that much money at this stage. The second approach will probably lead to socio-political upheavals that may destroy the country. This is especially so since the people view land as almost a sacred object the ownership of which shall be protected at all costs. It would seem, therefore, that a status quo in land ownership will prevail.

But while accepting that it is not feasible to alter the present system of land ownership, the Government should modify whenever possible certain aspects of such ownership such that the disadvantages may be minimized. One important innovation may be in boundary establishment and issuance of titles of ownership. Each land parcel must be surveyed, the corners must be monumented and a title of ownership must be issued to the clan-owner. In this manner, land-based investments will not encounter too much difficulties in negotiations for land usage.

To effect this, it will be necessary for the Government to launch a massive, nation-wide land survey program utilizing all available manpower and using latest techniques, including aerial photogrammetry in order to complete the task in the shortest possible time. This program, while initially designed to solve the problems hampering the in-flow of foreign investors into the country to establish land-oriented business firms, will have far-ranging socio-economic benefits. One of the more immediate and significant ones would be the reduction of clan wars arising from boundary conflicts.

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(Reproduced from "The Australian Surveyor" of June, 1937 with the permission of the Executive Officer. This is the second of two parts.)

By: H. A. J. FRYER

One of the first duties of the surveyor is to examine and adjust the instruments of all parties and determine the zero errors: A base line is laid down with the tape and any corrections for k in the formula $d = ak \cos^2 A$ and $h = ak \sin A \cos A$ are computed. The correction for $(f+c)$ is ignored. The parallelism of the zeros on the compass and the line of sight is important where many parties are at work. Prismatic and oil compasses should be checked against the alidades; often errors of degrees occur. In the Sepik District the adopted value of the magnetic variation is $40^\circ 29'$ East, but observations tend to show it is slightly greater. Barometers are standardized on the coast and rechecked at the inland base, and in so doing diurnal variations are recorded and correction curves plotted. These are generally remarkably regular. The greatest correction is 110 feet at about 3 p.m., the correction being zero at 8 a.m. and 10 p.m. The Abney level is little used except on time traverses and in panoramic sketching. The author has found the Abney a handy and accurate instrument for the measurement of the amount of dip and direction of strike on contact surfaces. It is also useful for measuring distant slopes and physiographic dips, which are deduced from physiographic expression apart from rock exposure. In stadia traverses the prismatic is used only for panoramic sketches between stations, directions of intersecting paths, streams and spurs, bearings to adjoining native villages and the sound of native wood gongs or garamirts. These later bearings often permit the surveyor to determine the direction on which he will proceed the following day.

In detail work on the scale of 6 in.=1 mile, contours are shown at 25 or 50 feet intervals and drawn in the field from levels computed on the stadia slide rule. Readings and notes are recorded on a special form. In general work the length of "shots" averages about 300 to 400 feet, which means that "set-ups" are from 600 to 800 feet apart. To illustrate the nature of country crossed by long sights across valleys or kunai, time traverses are generally "run", the contours being fixed by interpolated aneroid readings. The adjoining country is sketched in from intersections and panoramas. In this class of survey geologists and surveyors work in collaboration, covering the area with stream and ridge traverses seldom more than half a mile apart.

In reconnaissance mapping on 3 in. to 1 mile, the surveyor usually covers the area to be mapped in wide circuits, giving the geologist some idea of the country which he proposes to investigate, and enabling him to organize in advance. Contours are drawn from aneroid readings only; no notes are kept except on the plane-table sheet. The heights of each camp site are fairly accurately determined by readings over twelve hours, and those during the day from the time correction curve. Panoramic sketches help to temporarily fill in blanks.

On long journeys where speed is required, time traverses can often be made with quite astonishing accuracy, even over the densest jungle paths. Traverses from near Boram to Angoram and back to Kazimin, and from Vanimo to the Rainbrum River disclosed an average error of about 1 in 70. The field book used for time traverses provides columns for time of departure, time of arrival, time occupied, speed, distance traversed in that interval (computed from tables), bearings recorded and heights, and miscellaneous remarks (includes names of places and streams, bearings to distant points and geological and topographical notes). In practice, a wristlet watch turned palmwards is employed with an oil compass held in the palm of the same hand. The surveyor sets out along the path and notes the variations of his compass bearings until he arrives at some point he wishes to fix, or at which he is delayed. Columns are filled in, the average bearing or a series of bearings for the time interval being recorded. The time of departure on the next leg is noted, and so on. Seldom does more than 20 minutes elapse between records. A complete map of the route of any normal day's walk can be made in this way, but for the surveyor working alone, encumbered by transport, the work requires rigorous concentration. In crossing streams it is most important to estimate from the volume the probable length. From this information quite creditable locations of position of watersheds have been made, and the correct streams can be joined up.

Panoramic sketches are self-explanatory. In India and some European countries an extremely simple instrument is utilized which provides permanently valuable sketches. A basic survey is a first essential. The instrument consists of a clinometer alidade pivoted at the centre of the plane-table. The sliding vein on the tangent

scale is collapsible on to the paper, and carries a pricking point. The table is oriented, an object is sighted, and a ray drawn. The vein is then pushed forward to the paper and the point permanently marked, the distance from the centre varying according to the height of the object. Utilizing a number of such points, a panoramic sketch is built up forming a complete circle, the level line being represented by a circle of radius equal to the distance from the central pivot of the collapsed needle at 0°. Bearings and elevations to any point can be obtained at any time by scale and protractor.

Before proceeding to a brief outline of the preparation of topographical and geological maps, the difficulties that often arise, and the work of the surveyor over one day in an uncontrolled area will be described.

On September 20th, 1935, when five of the staff were to the south of the Torricelli Mountains, the area behind Aitape was shattered by a major earthquake, the severity of which was so great that the seismographs in Sydney were put out of action. Shocks were continuous for months afterwards, and reoccurring up to the date of my departure. Fortunately all members of the expedition were in safe places, but it was many weeks before natives were able to pick their way over the Torricellis to allay the fears for the party's safety. The huge dams, landslides, collapses, crevices and fallen forests seen after the shock during the course of survey were not only awe-inspiring, but hindrances to progress. Ruined native villages were deserted, and with the disruption of their life the survey suffered severe setbacks. The geologists were even blamed as the cause of the shock, and many interesting and amusing situations developed. With the aid of the telescopic bubble the direction of propagation of gravitational waves following the main shock was observed by the author and bearings taken to the position of the preceding rumble. From later observations the approximate position of origin of the main earth waves has been fixed by intersections from south, west and east.

Crossing rivers is always a problem, whether by rafts, bridges, flying foxes or canoes. In unpopulated areas, in order to be able to provide food for the native line, it is often necessary when the rice supply is exhausted to cease work to cut sago palms.

Floods and bursting dams caused by the earthquake are normal hazards.

Traverses through swamps and over floating grass plains always provide discomfort and thrills, particularly when the notorious Sepik mosquitoes are in their myriads, and of course, the uncivilized native, although generally friendly, is not to be trusted. One's own team of boys always requires attention, and in dispensing justice in the case of wrong-doing, the master must show the wisdom of Solomon. The organization of a native line and their training in survey work and personal service needs constant effort and patience. The danger to the morale of a man working alone is also a real one, and is combated by an enthusiastic interest in the work, reading and writing, collecting, studying native customs and language, and photography. To reach a doctor would usually take a fortnight, if the patient could walk. Outbreaks of dysentery in a native line has caused delays of months, and the sickness of one boy in uncontrolled areas might mean serious delays until he recovers. Working day after day in streams leads to a peculiarly painful rash on the feet. Skin diseases are common, also leprosy, on the coast. Tropical ulcers are easily contracted and difficult to heal, and malaria is always present in the system. Mail arrives every six weeks at Wewak, after which it has to find its way 100 miles up the coast to Aitape and inland five days before delivery. However real these difficulties are, it has been found that an officer can retain good health and spirits by living a clean, careful and regular life, arranging for himself a well-balanced diet, keeping always a complete medical and surgical equipment, first-class equipment, and heeding the best advice obtained from experienced men and scientific works.

In traversing, the surveyor camps at the end of each day's work - anything from two to twelve miles. The camp site might be on a ridge top beside a track some short distance from a native village. Villages are always located on the highest points of ridges, and ringed with coconut palms. The huts are thatched with sago palm leaves, and generally arranged in circular groups around summits or in long straggling lines along rides. On the friendliness of the inhabitants the surveyor depends for guidance, place names and the great essential - food for his native labourers. The camp

Topographical and Geological Surveying
in the Sepik District of New Guinea

consists of the surveyor's heavy quality tent fly, with a thatched cookhouse adjoining, the whole being surrounded by a rough latticed pit-pit fence to keep natives from crowding in and to permit of organized barter. The line boys build for themselves some half dozen little huts with pungal or sapling beds. According to the topography and the friendliness and numbers of kanakas, so the surveyor arranges his camp. At dawn, the three personal servants are up and about preparing early tea for the team, and a couple of "shoot" boys are busy cleaning the exterior of their muskets and providing a protection in case of an attack. The author sleeps with a Mauser automatic under the pillow, and a watch dog beneath the tube bed, not because it is necessary but as a convenient form of life assurance. At 6 a.m. the boss boy receives his final instructions for the day, and sees that the boys' cooks are busy preparing the morning meal for the lines. The "master's" breakfast is served at 6:30 a.m., on a portable table, and the personal staff busy themselves packing up. At 7 a.m. the boys fall in; twelve boys are selected for the day's survey. They pick up, when called, the plane-table and legs, alidade, survey umbrella, three stadia staves and a haversack of sundry instruments and gear. With two "shoot" boys carrying 12 gauge shot guns and six line cutters the party moves off. The remainder of the line packs up the camp under the watchful of the boss boy and three "shoot" boys. The survey party, accompanied by guides obtained the night before, continues on the traverse generally along a native track. The line cutters are accompanied by a "shoot" boy, and another follows the rear stadia rod boy. About 9 a.m. the carrying line appears, kept together by a "shoot" boy at head and rear, and the boss boy with musket in the centre. At about 10:30 a.m. the carriers are allowed to pass, and they move on to a resting spot a convenient distance ahead, where the personal servants lay the table and prepare a light lunch. When the surveyor arrives about 11 a.m., he can sit down, immediately refresh himself, consider his position, and be off by 12.

The survey party, holding fast to its guides, travels on along a track in the approximate direction of a native village determined the day before. It is most important to arrive that night in the vicinity of a village where friendly contact can be made and food obtained. The guide cannot, of course, speak "pidgin", and as the

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languages change so frequently, there is no interpreter available. The surveyor has perforce to use the universal sign language, by which, with much energy and conventional gesticulation, practically any idea can be conveyed and question asked. The guides are able to indicate bearings and distances, sizes of villages, temperament of inhabitants, nature of topography, and in general anything about which one has the patience to ask. One thing the guide never forgets - he always describes the perfections of his own people contrasted with the warlike tendencies of the next. When an idea of the ultimate location of the night's camp is obtained the carriers move past under the guidance of the boss boy and choose a camp site. In the case of new contacts or passing through villages the surveyor himself usually makes the first friendly advances to the natives, assuring them of peaceful intentions and requesting their co-operation in producing food and guides in exchange for trade goods. Sometimes it may be necessary to demonstrate the lethal quality of a shotgun before friendship can be assured.

By about 4 p.m. the survey party has arrived at the camp site, and quarters are already complete. Every boy has his set task - firewood, water, poles, sago palm leaves, tent erection, clearing, trenches, bed and cargo shelves, latrine, cookhouse, and so on. "Shoot" boys clean their muskets. Discipline must be rigid, yet benevolent and just. Any friction between native labourers and kanakas is avoided by previous instructions to boys, by watching details and understanding native custom. After dispatching a waiting cup of ovaltine, the next duty is to "buy" the food that the natives have brought. A plane blade, loin cloth and copra knife for a pig, razor blades for coconuts, rings for sago, beads for bananas, yams, taro and mami, and so on. Then the labour is lined and any ailment, sore or cut attended to. After the "shoot" boys and boss boy report, food is issued for night and morning - perhaps an issue of rice is required to supplement a meagre purchase. Then the day's traverse is inked in, one bath in the canvas tub, and dinner is served. Only by systematizing duties and by a patient understanding and care and the preservation of a friendly dignity can one expect efficient and willing service from the native, and without that no surveyor can proceed alone, month after month and year after year, in working efficiently in tropical climates with safety, good health and good spirits.

Topographical and Geological Surveying
in the Sepik District of New Guinea

On the completion of any particular reconnaissance or piece of detailed work the parties engaged unite at a base camp for a conference and the preparation of a topographical and geological map. Large rolls of tracing paper are gridded on the required scale and "tie" points of traverses are traced to connect all sheets and determine misclosures in surround. The grid on the field sheets shows the amount of shrinkage, and although corrections for these minor misclosures and shrinkage could be made, in practice the misclosures are adjusted by slight swings, and the shrinkage by wrinkling the tracing paper over small sections required to be enlarged. When the topographical plot is complete, place names are added. These are recorded according to the R.G.S. System II, 1924, but the author, in order to be able to reproduce exact pronunciations, has enlarged the system to include modified vowels. On to the finished topographic compilation the geologist adds his traverses and dips. After a study of the dips, lithology and topography, lithological boundaries, anticlines, synclines, faults, lines of unconformity are shown. Any lack of concord in results deduced from available information is cause for further investigation. The final map is reduced by pantograph to 1 in. to 1 mile, and placed on the basic 1 in. sheets. Helio copies are made for reference.

The geologist in charge may decide that any particularly interesting structure by mapped in detail and further careful work on a larger scale will be made until that structure is proven or shown to be a non-commercial proposition.

Although many minor problems in relation to thrusts, overlaps, unconformities and faulting still remain to be solved, yet it is interesting to record that at the present stage a recommendation to drill has been made and preliminary work in regard to access and location is already being undertaken. If such work is successful in finding oil in commercial quantities, not only will it be a reward for the years of labour, enthusiasm and scientific research by an Australian company, but it will be a national asset the value of which cannot be over-estimated.

Brian Mennis joined the Brisbane firm of Clem Jones Pty. Ltd., and was articled to Ron Jones and John Pike. He obtained his licence in August 1956 and came to Papua New Guinea in June, 1959.

Brian has spent most of his time as surveyor in Rabaul and came to Madang as Regional Surveyor in 1971, a position which he still retains.

Brian was married in Canberra in January, 1964 and has a family of three boys and one girl.

'BJM' has always devoted time and enthusiasm to our Association and has been a hard working Committee man for several years. He was President 1974-75, and has shown a keen interest in helping the Papua New Guinea members of our Association.

Brian has two 'amateur' hobbies: in both of these he has attained professional standard, viz., photography and radio.

Brian and his family enjoy living in Papua New Guinea and hopefully his knowledge of the profession will be available to Papua New Guinea for several more years.



PERSONAL NOTES

Seen on a field trip in the Chimbu were Messrs Posanau, Hunt, George, English, Arman and Austin (What a team). Armed with blown up photographs and seeking to establish the ability of the Chimbu people to identify their land boundaries, the patrol set out, with drivers George and Arman following directions from Hunt, English, Posanau and Austin. The group arrived at a village and were quickly surrounded by budding land registrants. After much disagreement between the members of the patrol as to their whereabouts and apparently completely lost, one elderly gentleman stepped forward, examined the photographs and said "Mi savi, emi haus bilong mi, na gadin na banus na Kopi na diwai na altogeta samting bilong istap, mi lukim, na mi savi."

Some after thought on the pilot project - Bob George lost 5 kilos plus K20 having his car guarded - Francis Posanau bought shares in the Chimbu vegetable operation - James Hunt is learning Pidgin after 2 days of having no one to talk to - Peter English only drinks German wines and John Austin eats more than Francis Posanau (if possible).

Francis Posanau and Graham Matheson stopped off in Jakarta, Graham on the lookout for ADB projects and Francis having a look at the Indonesian Agrarian System.

Due to the extensive program organised by Host Arman, the pair of latent extroverts felt the need for personal attention to relieve their tired members of their aches and pains.

As a result Francis left Jakarta with a packet of Korean Ginseng tea bags and Graham is back in Jakarta so he must be getting somewhere.

Mick Larmer needed money to complete his new house on Tuaguba so he had to advertise in the Post Courier.

John Kronenburg has found he originated from a famous French beer family - visitors to his house should note his drinking vessel.

Bit of bad luck for John Kronenburg and his wife June when son Randell tripped and broke his hip while at school Brisbane. We all hope he is well and fit soon.

Personal Notes

David and Lauris Forster are attending the Congress in Madang partly for intellectual stimulation and partly sentiment as their first stay there was also the Madang Hotel 15 years ago.

Livingstone Tabua and Jerry Sipuman were last heard of on a recruiting campaign some months ago. Let's hope that one of them is at the Congress to keep us up to date on their activities.

David Thompson and family are moving to Madang at the end of June. He is to take up the Provincial Surveyor's position in the new 'establishment'. Squash players in Madang take note this fellow has tremendous potential, you ask him.

The trip to Lords for coaching last year for the great Gilbert Hole paid off recently in a grudge match with Roads & Bridges. After a beautiful back cut for two a leg glance a knee to point a hip to fine leg and a header to the boundary he retired out but unconquered and surprisingly unhurt.

David Johnstone was overpaid recently (isn't he all the time) and the P.S.C. after giving him a means test kindly allowed him to pay it off in two fortnightly installments of K500 each. So if you see him around with holes in his sails you now know why.

Noel Sharp and his lovely wife Somlak have stopped living out of a helicopter and have settled in Moresby. This seems to suit Sharpie as he is finding the power to drive his 9810 a little more reliable than at Menyamia.

Geoff Brown is seldom seen around Moresby these days and the Whiskey retailers at Popondetta are very grateful indeed. So is Brownie. He reckons Cigarettes and Whiskey are so cheap in the Northern Province that they must have forgotten to put the excise duty on these old staples. And about time too.

Ian Sparks recently emerged from the Gulf for the first time in months and shot down South for leave before Arman & Larmer had a chance to book him down to Ihu. He is reported to be having a shoulder high set of waders tailor made whilst in Sydney.

Graeme Arman joined Messrs Kronenberg and Pochapon to form a formidable PNG trio at the recent Australian Survey Congress on the Gold Coast. Between them they measured a significant amount of leisure and are now all back in PNG trying to sort out the misclose in their Bank accounts.

Dianne and Mick Larmer's new house should be ready by August. Larmer has been seen on the field a bit lately. Obviously trying to convince his Bank Manager that he is at least going to try to pay for it.

Gairo Wai, Selan Pambuai and Mela Popeu were recently admitted to the Association and like most first year members are to be seen out on the field daily. Their enthusiasm is beautiful to see and they of course must put in at least a couple of years in the sticks before they have earned a lifetime of office bliss like the rest of us.

Gairo Wai, Dick Moody and Tony Ferris are camped North of Kikori on intervisible hill tops. It's just as well they can talk to each other through those MRA 101s as there is no way known they are ever going to see each other in that part of the Gulf in June.

Jeff Tierney represented our Association at the recent World Habitat Conference in Toronto. This the Conference the Minister Yano Belo could not get a clearance from the Prime Minister to attend, proving of course that Presidents are more powerful than mere Ministers. There were about 11,000 delegates so presumably the President had someone to talk to.

Peter English continues to log up the air miles at a furious rate. He has recently returned from Melbourne where he represented Papua New Guinea at the National Mapping Councils Technical Sub-Committee Meeting.

The C.M.B. has changed its name to the National Mapping Bureau. If you wish to phone them you should read the local papers as they missed out on getting in the new telephone Directory and have consequently been advertising their numbers in the Post Courier.

Dave Rumble is back at work again after a trip to Australia following the serious illness of one of his children. We understand that all is well now.

By the way the Bureau have at last completed their big shift from Konedobu to their very chic new building at Waigani. Some of their Maps & P.S.M. sketches didn't quite make it as they, together with a drafting table fell off a truck going up Three Mile Hill. So remember what information they have not got at Waigani is almost certainly available at Rabiakini Squatter Settlement.

Was Mirek Erbens old 'hanwas' going so well that no one thought it necessary to present him with the traditional gold watch to mark his official retirement recently, or was it because he still turns up for work every day as usual? The old 'never say die' Mirek has reentered the National Mapping Bureau as a contract officer.

Colin Hard has been swotting up on his sewerage design following a brief of this nature. Quote of the month: "it's good to be back in the s--- again".

Don Smith is spending more time maintaining his boat. Quote: "Nothing else to do so we may as well go fishing."

Merlino Blanco passed the oral section of the Boards' Examinations recently, and is now a Registered Surveyor. He is presently on leave in the Philippines, and hopes to be back by the end of June, before the stork arrives in the first couple of weeks of July.

Grant Phillips was in high glee when Margaret's entry won the second prize in the YWCA Arts Competition held in Port Moresby recently.

The Lae Filipino Association made no mistake in commissioning Margaret Phillips to make a 2x3 feet copper beating of the famous Filipino "Bamboo Dance", which fetch over K200 when offered as a raffle prize.

Galy Taturan is not only proving himself a valuable member of the Surveying Degree staff but also as an accomplished folk dancer. He and his wife Isabel displayed their agility during the Fiesta Filipiniana held in Lae recently.

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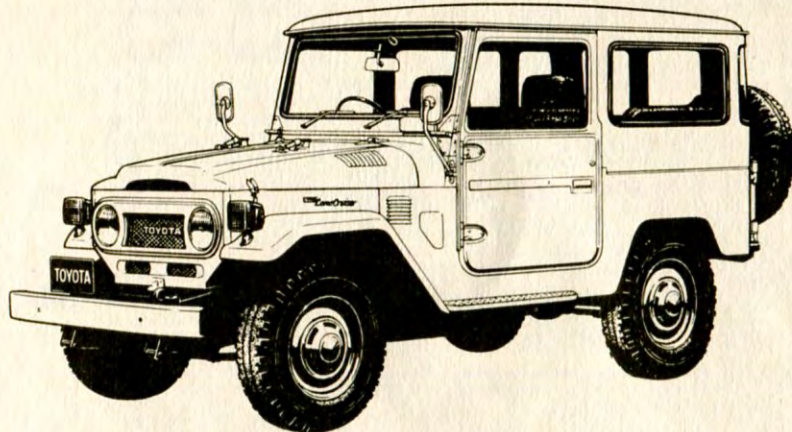
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Field of view $1^{\circ} 20'$
Minimum focus 8m
Stadia ratio 1 : 100
Additional constant 0

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)

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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 measurements; underground measurements in mines and tunnels; photo control; Tacheometry, etc.

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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 $\frac{1}{12}$ th the time required by a conventional theodolite with attached distance meter. Similarly traversing is completed in $\frac{1}{2}$ the time and setting out in $\frac{1}{3}$ rd of the time. From the control points, the surround boundaries can be redefined, detail and contouring completed, road centre-lines 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 dimensionally 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:-

1. 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.
2. **Cross sections** can be punched, reduced and plotted, and earthworks quantities produced very quickly.
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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.

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