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of the

**Association of Surveyors
of Papua and New Guinea**



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OF PAPUA AND NEW GUINEA

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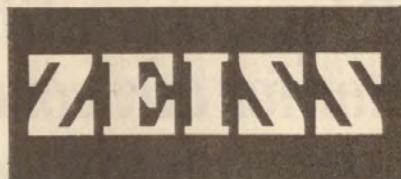
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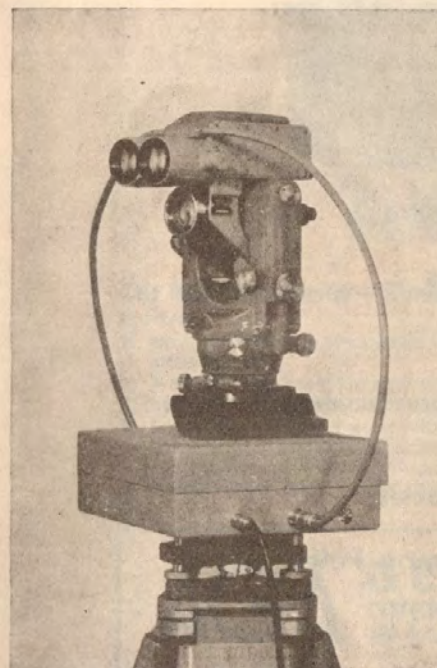


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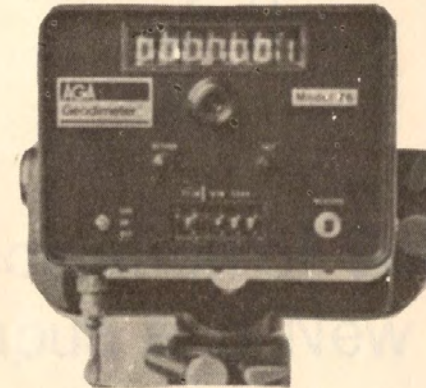
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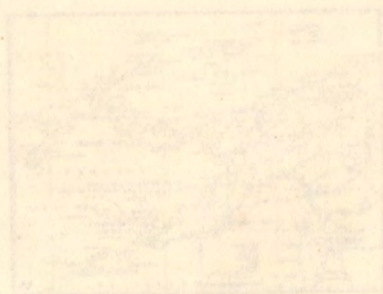


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FIFTEEN YEARS OF PAPUA NEW GUINEA

LAND MANAGEMENT IN RETROSPECT

by O.G.G. Dent

I have selected statements made by three very different people which boldly point to matters under review; they serve as my text and deserve to be committed and recalled to mind when discussing or evaluating any aspect of Land Management in this country.

Firstly (1)

"A scientific technology must be introduced to a developing country with minimum cultural disruption.

Frequently the meaning given to and the techniques of a technical process acquire cultural overtones. Many basic concepts and practices in Australian cadastral operations have evolved within the framework of Australian culture. The method of theodolite-band (chain), the system of isolated surveys, the accuracy of surveys and the professionalism of cadastral surveyors have roots in the attitudes toward and nature of Australian land settlement.

Such "cultural accretions" will tend to be unsuited to the conditions and needs of a developing country. They will tend to maximise cultural disruption. Although the denudation of "cultural baggage" is a painful process, the futility of anything less is obvious."

1. G.S. Toft - "Australian Cadastral Concepts etc."
Published in the "Australian Surveyor" -
June 1967

Secondly (1)

"A cadastral map", strictly speaking, is a map made to illustrate a "cadastre" which is a French work meaning "A public register of units of land with details of area, ownership and value compiled for the purpose of assessing and collecting land tax." A "cadastre" is merely an inventory of landed property made for fiscal purposes and it is not necessarily supported by any maps at all. The term "cadastral survey" however, has now come to be widely used with reference to registration of title, and a cadastral map in this connection has not necessarily anything to do with taxation. It is simply a map which shows how a locality is divided into units of ownership, the particulars of which are recorded in a register. It should be specially noted that physical features will not necessarily be shown on this sort of map unless they happen to be boundaries of a holding and, of course, the boundary shown on the map will not necessarily be indicated by any physical feature on the ground. It is a map which a layman may find very difficult to use and as a rule only a trained surveyor equipped with the necessary instruments will be able to translate the map to the ground and vice versa. I venture to suggest that a licensed surveyor has a strong vested interest in such maps. They are as much a part of his stock-in-trade as are title deeds that of the lawyer - even though we are unlikely to describe them as "difficult to read, impossible to understand, disgusting to touch".@

1. S.R. Simpson - "The role of maps and boundaries in land registration" - read at the Commonwealth Survey Officers Conference in Cambridge - 1967.

@ Remark by Lord Westbury quoted in "Land Registration" by Dowson and Sheppard (HMSO 1955)

Thirdly (1)

"In our unflagging belief that New Guinea would eventually conform to Australian preconceptions, and in our frequently mindless self-congratulation that what we have transplanted to New Guinea by way of Australian Institutions and practices was invariably suited to its people we have done them and ourselves a disservice."

Looking back over the past 15 years, the changes in the Administration and in the Public Service, the changes in emphasis, re-organizations, crash education, crash housing, political education, economic development et al. It is most interesting to see how the Surveying Profession has adapted to change.

From potentially bright beginnings with a Staff Surveyor in each District responsible for all the surveys necessary for the registration of leasehold titles in the Torrens System, the laying out of new towns, and the orderly planning and development of existing population centres - the professional could look forward to a satisfying role in colonial development with the emphasis on service to the country and its people.

Niggling at this job satisfaction was the commercial and financial pressure by expatriate business to "Restore Titles" to alienated properties, a process which depended on a "re-establishment" of boundaries by Licensed Surveyors, because all pre-war title documentation had been lost by war.

"Restoration of Title" became a fetish and by far the largest percentage of survey staff became occupied in the Gazelle Peninsula endeavouring to re-trace pre-war boundaries mainly for expatriate business interests.

1. Peter Hastings - "The Australian" 19th. January, 1970.

Without documentary evidence, all the practical experience, common sense and technical competence of the Licensed Surveyor was put to the test. Results were not produced quickly and decisions on boundary definition were often challenged and rejected, necessitating re-surveys. With normal expansion, subdivisional development, soldier settlement etc. the back-log of surveys mounted. The old catch cry of the pre-war Administration was repeated, there appeared no answer to the shortage of Surveyors.

It was in this period of the early '60's that the Surveyors formed their own Association to protect the rights and promote the interests of Licensed Surveyors in the Australian mould, and in an effort to catch up on the back-log of surveys, the Association sponsored a Scale of Fees for Private Practitioners. The survey fees accepted by the Administration were intended to be sufficient to encourage Surveyors to come from Australia and New Zealand on a permanent basis; there was no private work (in the generally accepted sense) only Government "Contracts" for authorised surveys. The practitioners thus relied on adequate funds being appropriated each year and the largesse of the Surveyor-General who administered these funds, in order to obtain reasonable remuneration for their professional services in accordance with the Scale. The Surveyor-General for his part had to ensure that the work was carried out to true professional standard to satisfy the expenditures, and a new set of survey rules and directions, ordinances and regulations, circulars and instructions were drawn up and adopted covering the whole gamut of authorised surveys by Licensed Surveyors, based mainly on the Queensland practice of isolated surveys in the Australian tradition. It is estimated that an amount of \$10 million has been expended by the Department of Lands, on surveys in this category in the period 1961-72.

It is this expenditure for surveys on the isolated system using the theodolite and chain technique which is now questioned as being far too expensive and inappropriate for the special needs of this country.

The isolated survey system as developed in Australia (1880-1900) required a high level of personal responsibility, and accuracy of measurements was as high as technology would permit.

We lose sight of the fact that Australia was vast and "unoccupied" when settlement took place and occupation was formalised by the survey of parcels of vacant land; whereas P.N.G. is and has been settled prior to cadastration, and the requirement is for the delimitation of parcels rather than the definition of boundaries. This can best take the form of large scale mapping of the occupance and use pattern. (1)

The technical advances made during the war in the fields of optics, radio, photography and electronics has led to the commercial production of vastly improved theodolites, measuring equipment, photogrammetric plotters and computers. Reasonably priced one second optical scale precision theodolites and electronic distance measurers have made the vernier theodolite and five chain band as out of date as the Model T. Ford.

The United States, Canada and South Africa are vast countries with many similar survey problems as Australia and in the 1950's they capitalised on the new development by devising the techniques to revolutionise survey practice. What has eventuated is generally known now as the "Integrated Survey System."

1. G.S. Toft Op. Cit.

In the 1960's Australia on a national plane "got on the band-waggon" and the Geodetic Survey of Australia was fully developed by the Division of National Mapping. However, in the topographical, cartographic and cadastral fields where States have control the revolution has had to contend with a conservatism of quite significant proportions.

P.N.G. land Administration and survey practice, being originally an off-shoot of Queensland, has tended to copy the conservatism of that State and preserve the old systems which apply to-day, albeit somewhat modernised by amendments intended to up date the old techniques. Obsession with these techniques has prevented most from recognising the facts of technical obsolescence.

Walter G. Robillard and others in the U.S. have written on "Technical Obsolescence - a Surveyor's Dilemma (1)". The dilemma is of course not only applicable to Surveyors but to all callings subject to research and technology for their improvement and progress. He says, "Technical obsolescence not only occurs in the physical aspects of an individual and the specific "tools of trade", but it all too often occurs in the mental attitudes of the individual towards the accomplishment of his job.

"Obsolescence literally means getting old or out of date - outmoded - a kind of style no longer current. This is exhibited at each birthday as one more candle is added to the cake, one more inch to the waistline, or one less hair to the head. Personally we can do nothing about the candle, we can jog to take care of the waist and can use a washcloth to comb the hair, while we wonder what happened to the old stick (gear) shift or the narrow necktie.

1. Quarterly Journal of the American Congress of Surveying and Mapping - September 1972.

Webster defines technical as "having special use, practical knowledge of a mechanical or a scientific subject, marked by or characteristic of specialization." This is certainly characteristic of any organization or profession, such as surveying.

Using the combination of the two words, technical obsolescence can be envisioned as transcending both the individual surveyor and his equipment; or, if viewed from a different perspective, it can be technical obsolescence of the mind and of matter. The one - matter - can be solved easily by money; the other - the mind - is a more difficult area for solution.

As the individual is analysed today, we find the surveying profession manned or staffed by two diametrically opposite types: the college-trained surveyor-engineer (the other professions, i.e., forestry, geographics, etc., are not excluded) and the registered, practical surveyor of limited education and abundant experience. Both of these types are equally affected, for technical obsolescence is a result of attitude of the individual as it is shaped by his background, education, and experience."

Robillard concludes "each individual has the responsibility of determining his own placement within the profession and whether he is exhibiting the symptoms that could foretell professional disaster."

Even by 1960 it was found that expatriate Chainmen in a survey party were not only unnecessary and expensive but unsuited to local conditions. As the type of survey work was practically exclusively theodolite and chain traversing in close country, it was found that the technical capability required of chainmen was minimal but the physical and mental stresses associated with labouring

work in the tropics caused inefficiency, absenteeism and reduced output.

Using the standard Army training method of set procedures and repetition, one could train an indigenous chainman within twelve months to a high degree of efficiency in the above type of work, even though he may not have had any formal education.

Gradually, the local survey technician emerged; by the Lands Department running a 12 month Technician's (Chainman's) School and individual Surveyors encouraging and training junior staff for appointment to the Public Service.

The next step was the mastery of the theodolite and chain measuring technique which is the preserve of the Licensed Surveyor, and enshrined in a mystique of field notes, calculations and plans developed over a hundred years in the vast reaches of Australia where the degree of reliability of measurement formed the backbone of the isolated survey system.

The education of local surveyors was taken a step further in 1968 when a three year Diploma course commenced at the Institute of Technology in Lae. In its hurry to get surveyors, the profession opted for a sub-academic course of Diplomat rating, in the belief that a further two years of field training with a Licensed Surveyor followed by a practical examination before a "Board of Surveyors" would ensure a suitable standard of competency.

The Diploma course is oriented to cadastral surveying in the conservative tradition and the practical training is wholly in the theodolite and chain techniques required by the Board of Surveyors.

The end product at best is a competent Survey Technician, and it is a great pity that local surveyors cannot specialise in the modern technology through graduate courses in a Faculty of Surveying as it has now been proved that professional specialization is essential to progressive Land Management.

In 1968 one could say as I did in my paper on an "Integrated Survey System for P.N.G." (1)

"It is apparent that the Administration, on the advice of the Surveyors Association and surveyors in particular, has unwittingly accepted the Australian chain and theodolite technique with its restrictive regulations, methods and controls. Surveyors have developed a professional mumbo-jumbo of field notes and plans in a chain to pseudo-status which is far too expensive and inappropriate for the special needs of this country. In fact indigenous Survey Technicians with limited secondary can be trained in 2-3 years to carry out effectively normal survey functions under the chain and theodolite technology for which a Licensed Surveyor claims professional fees."

The role of Survey Technician elsewhere is being questioned on the above lines. In a report (2) on the Commonwealth Survey Officers Conference (3) I quote.

"In the remaining papers, Mr. D.E. Warren (4) broached the subject of "professional or technician" for cadastral Surveys, suggesting

1. Published in the Journal of Association of Surveyors of Papua New Guinea October 1971.
2. "Survey Review" Vol.XXI No.163, January 1972.
3. Cambridge, England, August 1971.
4. Director of Overseas Survey.

that the existing system of licensed surveyors carrying out all the survey work themselves was perhaps no longer appropriate, especially in the developing countries where technicians could be used for this, leaving the few professionally qualified men free to concentrate on the legal and planning aspects, and to become consultants rather than instrument men."

Again, it is interesting to ponder on the reasons why the Administration though the Lands Department (the Surveyor General advised by the Association of Surveyors) accepted the "Contract system based on the theodolite and chain technique, which was to cost in the vicinity of \$1 million per year, as the solution to the land survey problems of Papua New Guinea in the 1960's.

Guidelines for the adoption of the new techniques in angular and distance measurement within the framework of existing practices already were promulgated in Australia. Learned leaders in the profession had developed the detailed procedures which were already included in the curriculums of Degree Courses in several Australian Universities and the equipment although expensive compared to theodolites and chains was readily available.

The profession was aware that in order to develop and practise the new techniques specialization was essential. The integration concept required graduate surveyors versed in error theory and the calculus of observations to implement the procedures and fix the allowable tolerances necessary to make the system work.

On the other hand the isolated system in the Australian tradition required only as Robillard says "a Registered (Licensed) Surveyor of limited education and abundant practical experience." This then is the crux of the matter.

In this period (the mid 60's) the Association of Surveyors, after some prompting, sponsored the preparation of a Survey Co-Ordination Ordinance, but balked at introducing a plane co-ordinate system for general use.

As Toft (1) says, (Survey Co-Ordination) "Acts do not destroy the basic principle of an isolated system; that of working from part to whole. They do attempt to modify this principle by introducing a system of correlated surveys. That is, the parts of the whole may be connected to an unconformed whole. The acts do not facilitate the diversification of survey methods because a plane co-ordinate system for general use has not been introduced with them. The Acts do not perceive the various fields of survey operations (2) as comprising an integrated and systematised whole. Rather they maintain these fields as mutually exclusive and provide only for connection between them."

Without a basic co-ordinate grid the Co-ordination Ordinance achieves no advance other than increasing the work load in isolated surveys and providing some common sense in mutual co-operation.

However, if properly administered the Ordinance may help to save us from the predicament so succinctly quoted by Henry Werner (3) and paraphrased as - "A keen observer will notice in our cities that a variety of survey marks including hydrant boxes belonging to different survey authorities, can be found within 1 to 10 metres of each other at prominent places, mostly on footpaths or

1. G.S. Toft Op. Cit.
2. The cadastral, topographic, photogrammetric, engineering, hydrographic, mining, geodetic.
3. A.P.H. Werner - Senior Lecturer in Surveying at the University of N.S.W. "The Australian Surveyor" - March 1972.

roads near intersections. He reads the inscriptions on lids or brass plaques and proceeds to the nearest Lands Office in order to purchase a large scale map which will reveal further details of interest to him. But there is no map and the Surveyor who placed Permanent Mark No.273 in 1967 is either just out and has the fieldbook with him or died last year.

For 60 years now the Surveyor in P.N.G. has been the tool or the Government or the private Company in implementing a westernized land management system. Naturally he is viewed with some awe and suspicion by the primitive society. The views of the more sophisticated people run the gamut of feelings from downright hostility to subdued acceptance of the Surveyor as a land management consultant. It is increasingly common when people talk of their customary land to let emotions flow and reason and compromise fail to get through.

Land disputes and claims continue to occupy the urgent attention of Administration Officers all over the country.

How much these disputes and claims result from faults in our system, such as the lack of reliable mapping, or from inexperience and ignorance or from a determined rejection of our law, could well be studied as a matter of urgency.

Our westernised tenure system requires legal contracts, agreements, documentary titles, individual registered proprietors and lessees, valuations and re-appraisals etc. Native custom requires merely verbal communal agreement to any course of action. Over the past 15 years verbal agreement has become a practical impossibility in any native community, with the result that progress in land management is completely

stifled. The younger generation with progressive intentions is expressing its frustrations at our inability to bridge the two systems.

Public opinion through its elected representative appears to be on the verge of rejecting our westernised system, by instructing an independent Commission of Inquiry into Land Matters to evaluate alternative solutions.

The frightening fact is that there will be little chance of any greater use of our land resources unless an accepted cadastre and land management system is adopted and operating at the time of independence.

It is submitted that modern technology has already provided the means whereby a new system can be introduced with minimum cultural disruption(1), and it is to be hoped that the Commission now takes cognizance of the solutions which modern technology can offer.

1. G.S. Toft Op. Cit.

1. A right step in the direction of survey integration would be to do away with calculating meridian convergence between an observation point and the S.W. corner of the Fourmil and instead calculate the grid convergence for the particular U.T.M. mapping zone in which the survey is being carried out.

The Fourmil and Milinch may still be quoted on the survey plan as identifications of locality.

The grid convergence enables grid bearings based on the U.T.M. projection to be shown on survey plans and gives immediate integration with the existing series of Topographic mapping.

For third order surveys
Grid Convergence = Diff. in longitude
X Sine latitude of
the observing point.

central Meridians of the mapping zones in which Papua New Guinea lies are 141° , 147° and 154° East of Greenwich for zones, 54, 55 and 56 respectively.

Meridian convergence simply calculates the angular amount by which the observing meridian and the Fourmil meridian are not parallel on the surface of the earth. Alternatively it may be thought of as the amount by which the true bearing of the line changes between the observation point and the origin of the Fourmil.

2. Is there a need for the Surveyor's Board? Registration of surveyors initially was introduced as a measure of competency and an authorisation to make legal measurements of land boundaries. With the changing nature of the profession perhaps this responsibility may better be handled by the Association.

Anybody like to comment?

In Papua New Guinea

All our survey rules and regulations, and practices have been derived from Australian states. And although these differing rules and practices bear no major conflicting consequences as far as efficiency of Surveyors go; and also though there is no demaging effects to our profession as a whole I feel as Papua New Guinea moves towards self-government and independence it is becoming apparent each day that this country must look forward to adopting its own survey rules and regulations i.e. there is a need now to standardise our survey practices.

Lets have a look for example at our sun observations technique, Some surveyors use L, R, R, L etc. methods, others use L, L, L, L, etc.; and then for computing the true bearings we use two or three types of calculating forms. I personally think this is ridiculous. Rather than using many methods why not consider using one and get rid of others.

Then when the survey is submitted for examination our examiners as well as draftsmen will undoubtedly find it easier to check through the comps.

Apart from these different practices I feel there is also a need to examine our (Survey) rules and regulations because I think some of our present rules are not suitable to this country. For example we have a rule that says that all cement pegs on flat country or generally flat country, should be placed at no more 204 metres. You all must have heard that one of the reasons of Land disputes in the Highlands is that the native people are not happy to see many cement pegs separating their clan boundaries. They claimed they never had many troubles before this.

Now if such a system as we have brought in do not suit the situation here, isn't it therefore essential we re-examine our rules so that they be accepted by the people.

I am not advocating for one moment that we have to completely revise our rules and regulations. This is not up to my point. Being a Papua New Guinean and having been involved in the practice myself, I feel one or two rules require alterations or changes purely so that they suit this society.

As far as survey practices go, I firmly believe it is far better for us to use only one type of method rather than two or three. Because of an Independent Papua New Guinea, it must surely have one standard survey rule, and regulation and practice.

F. Posanau.

Personality Corner

Michael James Larmer

- 1957-60 Articles with Messrs. Little & Brosnan of Melbourne.
- 1961-62 Employed with J.M. Horne, Frankston, Victoria, Subdivisional Estates.
- 1963 Certificate of Competency & Licence, Victorian Surveyors Board. An Associate in firm G.F. Hamm & Associates. Carried out surveys in Snowy Mountains.
- 1964 Arrived Moresby with Graeme Arman. Carried out large scale Engineering Surveys at Taurama, Goldie River and various Army Camps. Cadastral surveys Morobe District.
- During this year Mick and Graeme Arman formed the partnership of Arman & Larmer, later forming Company of Arman & Larmer Pty. Ltd.
- 1965-73 Cadastral Surveys Central Gulf & Milne Bay Districts. Large scale Engineering & Cadastral Surveys in Port Moresby & environs. During frequent forays unto Gulf District, earned title of "Kikori Kid", a fearless traipsers of swamps, & loyal and undaunting loser of bets to the feared Harry Wilson of Kerema. More recently involved in consulting to Exploration Companies intending to operate within P.N.G.
- With Graeme Arman, has established a promising practice in Indonesia, and in process of opening offices in Australia.
- Energetic supporter and worker for Association of Surveyors of PNG, having served as a Councillor for many years, Chairman of Survey Co-ordination Committee, Chairman of Scale of Fees Committee, Business Manager for the Associations Journal, & finally and fittingly, President of the Association.
- Enjoys an occasional ale and losing most of his bets. Active follower of sport, particularly Australian Rules, and is known to be an unbiassed supporter of Essendon (ask Harry Wilson).

Michael will be settling into Brisbane late in 1973 with wife Diane and their five children.



Michael Larmer in typical pose.

The Lae Group

Fay and John Hastings shortly leave for an around the world tour in 40 days - a little research in Copenhagen.

Jan and Bruce Forster are getting ready to go for a years study leave in England. Best wishes to Jan and Bruce.

Rumour has it that Ivon Brynning has emigrated to West New Britain.

Congratulations to baby producers Marianne Skehan, Pam McCarthy and Beryl Day. A considerable amount of coin crossed the towelling bench.

Bob George was all smiles as he set off for three months survey work in Wau - best climate in Papua New Guinea.

Roy Lea, king of the dartboard, claims to have mown up the last oyster shell from the congress - 4 months worth.

The Hagen Axe

Ed Palaitis, the Lituanian refugee, was snared by somewhat unsportsman like tactics and was married in an eventful ceremony at the Hotel Mendi "Haus Wind" on 10th March. The reception lasted three weeks and Mal Gray has stated he does not intend to invite honeymooners to stay for a night again.

Clive Carson, after an extended field trip was ordered to the Hagen Country Club so that the children would not be "disturbed" and could be fed and bedded. After two lightening Carlton Draughts, Clive in his anxiety to ascertain the condition of his progeny collected a beautiful beaten metal finish to the roof of his V.W. Hope you did better the next evening Clive.

Not to be outdone our fearless Dave Forster took to the same road, but a section with a steeper bank, and made a few alterations to the sides and roof of his V.W. Dave, an adovate of "don't wash ya windows Mate" carefully removed most of his in the process.

Mr. Neat Graham Bateman, has been looking somewhat tired and listless as he arrives at work at 7.44am (obviously spied by the nightwatchman). But rumour has it that Margaret is now in the "Bundles in the Tummy" club. Congratulations Graham, now please get some sleep.

Not to be outdone (no not D.C.F.) Ed. P. has proudly announced his beloved is expected to foal about February. Long hair and beard guaranteed.

John Wood has been noted spending long periods in isolation. Meditation was the general consensus of opinion but our roving spy has reported that he is actually reading the "Epicurean" and other gourmet publications. Maybe there was some truth in the story that his mother wouldn't recognise her big boy if he weighed less than 57 kilograms.

Back to Mr. Carson, Mt. Hagen. He is presently spending all his hard earned in a pleasant trip during which he hopes to visit Scotland. When asked why Scotland he replied, not too enthusiastically, about seeing his wifes relatives and then mumbled something about an old trusty friend of his, John Walker.

Big Noel Sharp left his mark in Hagen one Friday night. The mark took the form of a green and yellow lumpy line extending from the Country Club to his flat some 200 metres away. They must have used some rotten potatoes in the making of the chips.

The Bougainvilleans

Mrs Bryan McLennan (Stephanie) has gone South to Brisbane to bring forth her third in late September.

Bryan will head to her side to assist with the birth.

Norm Leet will soon be transferred to Madang.

Alan Cullum picked up a few hints from Tony Skehan and is giving swimming instructions.

Colin Hard is busy working out what to do at the Congress (Forthcoming) in conjunction with B. McL. Has been doing the rounds of all the pubs, clubs and watering houses to find which will suit everybody best.

Don Smith has not been seen since the Congress. It is believed he is deeply engrossed in work to pay for the last one and the big Barbeque to wind up the next one.

NINTH SURVEY CONGRESS

BOUGAINVILLE: 15TH - 19TH JULY, 1974

P.O. Box 430,
ARAWA P.N.G.
1st Dec., 1973.

Dear Member,

The theme of the next survey congress is "Surveying: future trends and techniques".

We chose this theme as we feel that the surveying profession is now in a critical period of transition. To retain or increase our professional system, we have to accept, as any profession must, that there are certain problems which must be recognized and resolved. We must make every effort not to be left behind due to our lack of efficiency, resistance to change and insufficient interest in modern trends and techniques.

Naturally it will be desirable that the majority of papers come from our own members. Many of you must have strong feelings on various aspects of surveying. If you feel that jobs you have done, pet theories you may subscribe to, or sophisticated equipment you are familiar with, has any relevance to the work that will be carried out by the professional surveyor of the future, then give serious consideration to presenting a paper at the Ninth Congress.

If you are thinking of presenting a paper, please complete the form below and mail it to me before the 14th of January, 1974.

Yours faithfully,

Bryan McLennan
CONGRESS MANAGER

REPORT

The eighth survey congress
and fourteenth annual general meeting.

Lae , July, 1973.

List of Registrants

Overseas delegates

Mr. Hampton Mar,
Assistant Director (Survey),
Department of Lands & Mineral
Resources,
Suva, Fiji.

Dr. & Mrs. P.V. Angus Leppan,
Professor and Head of School of
Surveying,
University of N.S.W.

Mr. I.K. Cameron,
Manager Wild (Aust.) Surveying
Instruments Division,
N.S.W.

Mr. C.G. Van Senden,
Assistant Surveyor General
(Interstate Operations),
Dept. of Services & Property,
Canberra, A.C.T.

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D.R. Johnston & Co. P/L,
Melbourne, Victoria.

Mr. E. Jensen,
Sydney, N.S.W.

Mr. G. Fuller & Son,
Sydney, N.S.W.

Mr. J.P. O'Keefe,
Sydney, N.S.W.

Mr. E. Gardiner,
Deputy Surveyor General,
Brisbane, Queensland.

Papua New Guinea delegates

Mr. A. Bale,
P.O. Box 1299,
Boroko,.

Mr. Paula Moala,
Ministry of Lands and Surveys,
Nuku'alofa, Tonga.

Mr. R.J. Love,
Head of the Department of
Surveying,
Royal Melbourne Institute of
Technology.

Mr. & Mrs. E.B. Valentine,
Federal President Institution
of Surveyors (Aust.),
Hobart, Tasmania.

Mr. D.P. Cook,
Division of National Mapping,
P.O. Box 667,
Canberra City, A.C.T.

Mr. E.C. Cottrell,
Brisbane, Queensland.

Mr. K.J. Croghan,
Fremantle, W.A.

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Capricorn Aerial Mapping P/L.,
Brisbane, Queensland.

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Sydney, N.S.W.

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Mr. J. Saunders,
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Madang.

ADDRESS BY MR. ALBERT MAORI KIKI, MINISTER FOR
LANDS & ENVIRONMENT TO SURVEYORS' CONGRESS LAE - 16/7/73

One doesn't have to look far in Papua New Guinea to see the value of your profession to this country's development. Our towns, our important road links, are all, partly the result of your work.

You also have a role to play in the final solution of our land problems, and we hope, in their future prevention. Unfortunately, on the question of land division some Papua New Guineans would like to see your task as the division of our country, rather than the mere division of our tribal lands. Let us hope that day does not arise.

Papua New Guineans have long been used to waiting for directions from a European dominated Administration and as Father Momis said, this has created a dependence which has made us afraid to stand and make our own decisions. But those attitudes must and will change. The Government has outlined a new development plan and this plan will demand a large measure of self-help by non-government bodies. The need and the value of self-help, is well evidenced by the Surveyors' Association.

From your beginning in 1966, when you numbered only 13, your membership has grown to around 150. No doubt your ranks will be further swelled by the graduates who come from the University. But it is not just numbers that count (although the Chief Minister may not have agreed with that during the last House). Your efforts have promoted the needs and standards of surveying in the Pacific Region. But what is more important your efforts, and the University's in the development of certain courses, shows that you clearly see the needs of our country as well as the needs of your profession. I would like to develop this point a little further.

In previous years the task of surveying, for want of a better word, was left to the Patrol Officer - that unnecessarily maligned group of people who in earlier days had more roles to perform than even Miss Abijah (no offence to Patrol Officers there). To some degrees those days are gone. Papua New Guinea has its experts and it will need more. But - and I stress this point, Papua New Guinea needs TRADESMEN. It needs those people who will spend much of their time in the field. For it is in the field - in the rural areas, that we face our greatest task. On this point I would like to congratulate the Association and the University on the Development of the course for SURVEY TECHNICIANS.

The Lands Department in particular looks forward to seeing the first graduates from this course, but I would like to make one point about these technicians. Professional associations particularly those of developed countries, such as Australia, jealously guard their standards of entry to their associations. This may be well and good for Australia. But Papua New Guinea is not Australia. It has different problems and different needs. We would hope that these technicians these people that we need so badly would be given membership in some form to your Association.

The purpose of this Congress, as with others, is to allow the free exchange of ideas. The value of these exchanges goes without saying. The peaceful exchange of well researched ideas, aimed at the solution of problems is the sensible approach to any problem. It is an attitude that politicians might keep in mind at the moment.

And it is with that thought in mind that I wish to thank you for this opportunity and wish you well in the later sessions of the Congress. It is with pleasure that I declare this Congress open.

ADDRESS BY DR. J. SANDOVER - SURVEYORS' CONGRESS

INDEPENDENT SURVEYOR

Mr. President, Mr. Minister, Ladies and Gentlemen, welcome to the University of Technology, and to our newly completed "Haus Tamboran". It is a great pleasure for us at this University to act as hosts to the Eighth Congress of the Association of Surveyors of Papua New Guinea and to the Minister for Lands Mr. Maori Kiki. We hope that you will return here many times particularly as there is such a link between our training of embryo surveyors and your employment of them.

At this point it is also my very great pleasure and pride to welcome Kisokau Pochapon as the first Papua New Guinean Surveyor General and one of the first graduates of this University. This welcome also includes another graduate, Francis Posanau who is the next likely Deputy Surveyor General and the other graduates of the University who are with us this morning. It is a matter of great satisfaction to all your old tutors and friends that you are succeeding so well in your chosen profession.

Your profession - the profession of the Surveyor - the surveyor in an independent Papua New Guinea - can we call him an 'independent' surveyor? Ladies and Gentlemen if we don't have some independent minded surveyors in Papua New Guinea then we are going to be faced with chaos in a land where already land-tenure is almost a synonym for trouble. If I may ask your indulgence for a moment to make three quotations - two of them my own and gaining ground in this University and the third the surveyors 'by-word', I will show how these apply to the present situation in Papua New Guinea and why they underline the future of Surveying in an independent Papua New Guinea.

This first saying is short and to the point - 'there is no half-way house in Technology'.

The second is just as succinct and applicable - 'there is no excuse for failure'; and the third saying was always taught to me as the surveyor's credo - 'you always work from the whole to the part'.

If we take these three together then this to my mind implies that we must spend much more effort on mapping at different scales, we must ensure that there is a minimum of overlap of effort, we must use the most modern equipment and techniques and conversely we must not give the prominence to cadastral surveying that has been given in the past.

Taking these points in turn, it has been my experience in other developing countries that the major effort in surveying has been directed to a national or state programme of mapping at whatever scales are deemed expedient and economic. It seems to me essential that the major effort in PNG in the future should be concentrated on national mapping programmes - using the most up-to-date methods including any refinements in electronic and photogrammetric techniques that can be afforded.

At the same time and concurrent with this work there must be a concerted effort by all concerned to co-ordinate survey work, to centralise the data collection and the preparation of maps. I gather that the proposal for a Central Mapping Bureau is well advanced and this is a real matter for congratulation. If it is to function properly however it must have some powers of co-ordination, co-option and control otherwise the present conditions of apparent - 'do your own thing' will continue. On the other hand one has to be careful not to create a monolith that is merely a bureaucratic instrument of frustration. An effective C.M.B. must be adequately staffed and run by professionals but it must have a good advisory board with representation from all interested bodies to ensure that it actually functions. The old and tried method of checks and balances is essential but in the last resort,

the effectiveness of this instrument will depend on the calibre of the man or men at the top and their awareness of the problems which are particular to Papua New Guinea.

Margaret Mead spoke of one of these problems when she gave a lecture at this University in April. She quoted a Papua New Guinean who spoke of land boundaries being 'fluid'. This, she said, meant that the PNG concept of land boundaries was not the same as that of the European and there was not this exact concept of 'my land and thy land' in a strictly physically delineated manner. Land can be loaned and used by another, feuds altered boundaries temporarily and land did not necessarily belong to individuals. Evidently Papua New Guineans, are, in some areas, rapidly accepting the European aspect of ownership as witness the Butibum claims to land in Lae. In other areas these ideas are not formalised and I can well see that the Land Commission is going to have a remarkably difficult time in reaching acceptable decisions. Ultimately the government will have to grasp this nettle and make decisions on this question of land ownership - one could even consider it making a radical socialist assumption that all land belonged to all the people and should be administered and leased by government. I doubt that this will happen but it is worth considering because the whole philosophical question of land ownership is an interesting one. I cannot actually own a piece of land - the best I can do is to take temporary possession of it either by purchase, by lease or by force of arms. It is never strictly 'mine' however as I can only occupy it, use it and work it. Long after I and all my family have gone it will still remain with someone else saying, in turn, 'its mine'.

However philosophical arguments settle no land boundaries but I think my comments are sufficient to indicate that the primary job is to map the country as well as possible and then we can draw artificial lines of demarcation on it, related to the main survey grid, to our hearts content. How real and how permanent these marks are is really a matter for the lawyer, the politician and the valuer. Working from the whole to the part seems essential.

In the matter of modern methods and techniques, I gather there have been and are likely to be some reasonably hectic and heated discussions. That is all to the good as man, of a necessity in his fight for survival, has become a conservative animal. We must also of course have the innovators who occur in every generation and these two groups tend to act as counter balances producing an atmosphere which guardedly and reluctantly accepts change. With this in mind, in a country such as Papua New Guinea it seems to me to be essential that the correct line of attack should be for us to look elsewhere and see what methods and techniques are current in countries which have had similar development problems and which have proved successful.

At the same time it is essential that once a course is accepted then the most effective and up to-date methods of map making. There is no half-way in Technology.

At this University we are trying to ensure that we train our students to the limit of modern technology so that they will be of maximum use to the development of their country after graduations. However, it is essential for optimum use of these students that this point is realised in their graduate training. It will be disappointing and frustrating for employer and employee if the graduate is employed on types of survey which are regarded as essentially somewhat old-fashioned. This in turn leads to recriminations and the well known comment of 'give me a good certificate lad and I'll train him to do what I want him to do'. This is a perfectly reasonable and viable point of view and the required level of expertise will suit that kind of job. However it is a waste of everyone's time and money to put a graduate to do that work unless absolutely unavoidable. You don't use a race horse to pull a hay cart. We hope very much indeed that our graduates will be of great benefit to their country and their profession.

In this context it is well worth mentioning our intention to proceed with a school of 'Land Studies' where we hope to train graduates as we do at the moment but with some carrying on to an extra year's specialisation in special aspects of surveying such as photogrammetry and others in valuation proceeding to a fourth year B. Tech. giving them greater depth of specialist knowledge. We envisage a school with three departments - Surveying, Photogrammetry/Cartography and Land Economy each producing graduates at three levels, the Technician level, the limited supervisory of technical officer level and the fully supervisory and specialist operative level. No doubt the acting Head of the present Department would be more than willing to discuss this with Conference members who are interested in the educational future of surveyors in PNG.

Finally, I come to my other stricture - 'there is no excuse for failure'. Winston Churchill also noted 'your best is not good enough - do what is necessary'. With this in mind it is worth remembering that this Association has already contributed a great deal to the development of PNG but it is now moving into a transition era where its actions take on an even greater importance. Last Year you also allowed me the privilege of making the opening address at the 7th Congress and at the time I stressed localisation. May I stress it once again and ask you to think and act localisation in the Association and in the profession as so much depends upon this both in relation to men and to machines and techniques.

Gentlemen, Mr. Maori Kiki, there is no doubt that the future of surveying is in your hands in an independent Papua New Guinea. Your decisions and your actions will have the widest effect on your profession and on this country for many years to come and it is essential that your decisions be reached not in an atmosphere of emotion and self-interest but in one of calm and judicial reason. Please remember gentlemen that for the independent Papua New Guinea, no-one will excuse you for failure and you must do what is necessary for this country even if that is better than your best.

Mr. Chairman - Gentlemen please accept my gratitude for the honour you have shown me in asking me to make this opening address and we are also very proud that you should have made this University the venue for your Eighth Congress. I am sure that this will be a most successful meeting and I congratulate you on a most innovative Association which has contributed so much to the initial development of this country. Thank you.



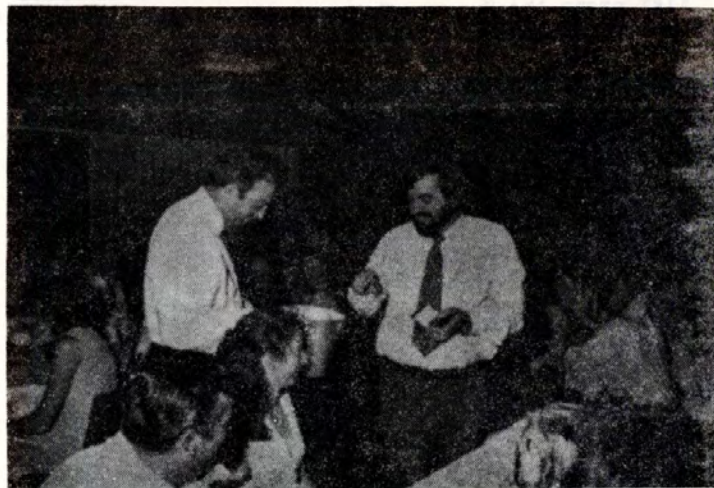
The then Minister of Lands, the Rt. Hon. Albert Mari Kiki opens the Surveys Congress at the open air "Haus" on the University of Technology campus.



The Annual Dinner gets under way.



Major and Mrs. A.W. Laing from Popondetta.



District Surveyor Malcolm Gray of Mt. Hagen pays a fine.



Mr. and Mrs. Ed Palaitis, Mt. Hagen.



Peter Angus Leppan, congenial Professor and Head of the School of Surveying from the University of N.S.W.



Stuart Scriven Downs the oysters.



Congratulations from the incoming president of the Association Jason Garrett.

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Turumu Street, Boroko.



Visitors to Papua New Guinea, Hampton Mar (above) from Fiji and Barrie Valentine from Tasmania. Barrie represented the Institution of Surveyors Australia and is Federal President.



University of Technology graduate Francis Posanau receives the stirrers paddle from previous holder and outgoing president of the Association Michael Larmer.



Another graduate, Edmond Van Hecke, pays a fine.



A new arrival Peter Fagan (above) and oldcomer Peter Jolly pay fines.

The handsome gentlemen holding the buckets are Ton Skehan and Karl Aschoff.



Jason Garrett hands out merit awards to Barrie Valentine (above) and Peter Jolly.



Guest speaker at the Congress Opening Ceremony
John Sandover, now Vice Chancellor at the University
of Technology, pays a fine.



Acting Head of the Surveying Department at the
University of Technology, Bruce Forster.



Incoming president Jason Garrett handing out merit
awards to Kisokau Pochopon and Gill Hole.



Left to right - Don Eagleson, Gill Hole and Barry Liston



Jan Forster pays a fine for some outspoken comments for Womens' Lib, while Alan Cullum looks on.

A COMPARISON OF ERRORS IN SUN OBSERVATIONS FOR VARIOUS LATITUDES

By A.J. McCarthy, B.Tech.(Surv.), M.I.S.
Aust., M.A.S.P.N.G., Lecturer in
Surveying at the Papua New Guinea
Institute of Technology.

Abstract:

The accuracy of azimuth results by zenith distance measurement of the sun is generally considered to be of low standard. In Papua New Guinea, where control stations are found at less frequent intervals than in Australia and are frequently inaccessible to the cadastral surveyor, reliance for azimuth control must often be placed on paired morning and afternoon sun observations. An observing technique is chosen to minimise the effects of random and systematic errors in the data on the calculated azimuth. This paper analyses the sources of error and tabulates their effects for different times of the year and at different latitudes.

The observer in Papua New Guinea should produce more accurate results than his southern counterpart because of a greater overall minimisation of errors.

General:

The determination of the azimuth of a survey line is achieved by solution of the following equations, using these suggested techniques:

Azimuth of survey line = Azimuth of sun -
Direction of the sun with respect to the
survey line.

$$\text{i.e. R.O.} = \text{AZ} - \psi$$

The accuracy of the quantity ψ is affected by instrumental errors and random errors of pointing and reading the circles.

By observing the sun at an altitude as low as possible (but not lower than 15° because of variable refraction conditions), the error in observed direction, $I.Tan h$, caused by the main axis of rotation being not truly vertical, will be minimised and random pointing errors will be minimised because of the greater ease of pointing to the sun - especially in the tropics where the sun rises and falls more vertically. Secondly, it is suggested that a minimum of four double arcs be observed with a change in zero setting for each double arc, and that each double arc be separately reduced. Other instrumental errors will be cancelled out by the change of face and random pointing errors will be further minimised in the mean of the final result.

Usually the average cadastral surveyor will not be equipped with a solar prism attachment and will make eccentric tangential pointings on the sun with the aid of a dark glass.

The required pointing on the sun for one double arc are illustrated in Figure 1

Record for each pointing:	
	F.L. Horizontal Circle
	F.L. Vertical Circle
	F.R. Time (nearest minute)
	F.R. Average F.L. values
	Average F.R. values
	Calculate ψ ,
	mean vertical circle
	mean time

Figure 1

Azimuth of sun = $180 \pm$ azimuth angle

$$AZ = 180 \pm A \begin{pmatrix} + \text{p.m.} \\ - \text{a.m.} \end{pmatrix}$$

The azimuth angle is measured west or east from the south branch of the observer's meridian.

Determination of the azimuth angle involves the solution of the astronomical triangle whose three sides are known. See Figure 2.

The three sides are:

- i) the observed zenith distance, z , corrected for atmospheric refraction and the sun's parallax,
- ii) the co-latitude, c' , of the observer, equal to $90 + \phi$, where latitude ϕ is negative south,
- iii) the polar distance, p' , of the sun, equal to $90 + \delta$, where declination δ is negative south.

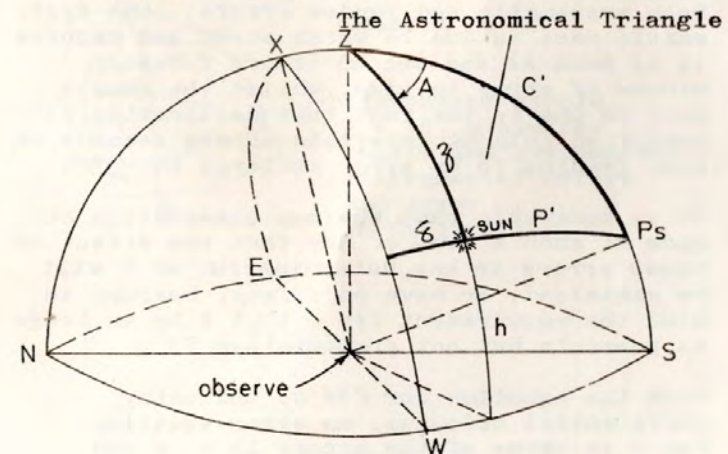


Figure 2.

From Cosine Rule,

$$\begin{aligned}\cos A &= \frac{\cos p' - \cos z \cdot \cos c'}{\sin z \cdot \sin c'} \\ &= \frac{\cos z \cdot \sin \phi - \sin \delta}{\sin z \cdot \cos \phi}\end{aligned}$$

Random and Systematic Errors:

Choice of the type of error in the data is based on one observation consisting of four double arcs.

An error in the latitude of the observer may arise because the latitude has been scaled from a map or has been predetermined. It is a systematic error.

An error in the observed zenith distance may be both systematic and random. The systematic part of the error arises from an error in the atmospheric refraction correction while errors in pointing and reading of the vertical circle are random.

The declination of the sun may also include both systematic and random errors; the systematic part is due to watch error and amounts to as much as one second of arc for each minute of error in time, whilst the random part is due to the fact that declination is tabulated only at intervals of six seconds of arc, leading to an error as large as $\pm 3''$.

It is desirable that the sun observation be made at such a time of day that the effect of these errors in the determination of A will be minimised, or have no effect, bearing in mind the requirement for ψ that z be as large as possible but not greater than 75° .

From the equation for $\cos A$, and using differential calculus, an error equation for A in terms of the errors in z, ϕ and δ may be derived.

$$\begin{aligned}dA &= -\operatorname{Cosec} A (\cot z + \cos A \cdot \tan \phi) d\phi \\ &\quad + \operatorname{Cosec} A (\tan \phi + \cos A \cdot \cot z) dz \\ &\quad + \operatorname{Cosec} A \cdot \cos \delta \cdot \sec \phi \cdot \operatorname{Cosec} z \cdot d\delta\end{aligned}$$

Analysis of this error equation while attempting to minimise the error co-efficients leads to the following conclusions.

$\operatorname{Cosec} A$ varies from 1 to ∞ . When $A = 1$, $A = 90^\circ$. Thus observations are best made on or near the prime vertical.

$\cot z + \cos A \cdot \tan \phi = 0$ when the hour angle is 90° .

$\tan \phi + \cos A \cdot \cot z = 0$ when the sun is at elongation.

The co-efficient of $d\delta$ depends mainly on the function $\operatorname{Cosec} A$ and, for a full range of declinations, is a minimum at low latitudes.

Figures 3, 4 and 5 illustrate the requirements necessary to minimise the effects of these random and systematic errors.

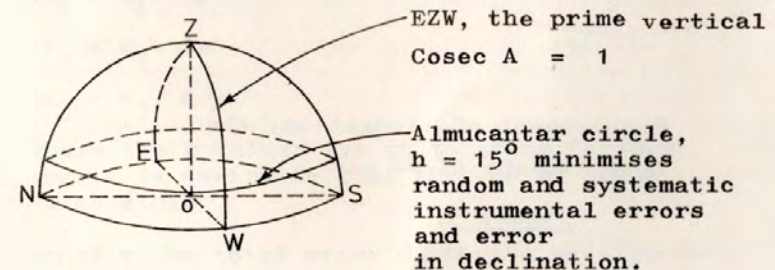
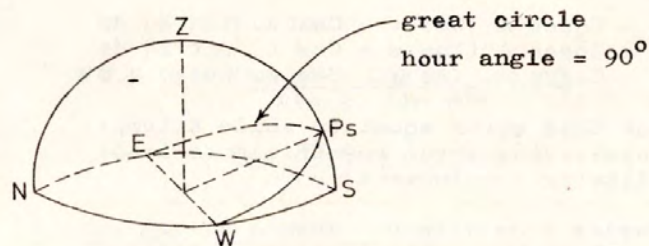


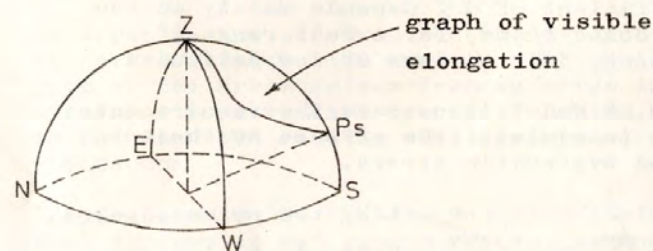
Figure 3.



Hour angle = 90°

The co-efficient of $d\phi = 0$

Figure 4.



Requirement of elongation, the
co-efficient of $dz = 0$

Figure 5.

Figures 4 and 5 indicate that the best observing time will be during the summer months when the sun is closest to the winter solstice.

In order to calculate the effect on the computed azimuth angle of the above errors, the following arbitrary values have been adopted.

Zenith distance	= 70°
Error in latitude $d\phi$	= $60''$
Error in zenith distance dz	= $10''$
Error in sun's declination d	= $5''$

Determination of the Error in Azimuth Angle:

To analyse individually the effects of the various errors on the calculated azimuth, the error equation given in the previous section may be subdivided into its component parts as follows:

$$dA_1 = -\operatorname{Cosec} A (\cot z + \cos A \cdot \tan \phi) d\phi$$

$$dA_2 = +\operatorname{Cosec} A (\tan \phi + \cos A \cdot \cot z) dz$$

$$dA_3 = +\operatorname{Cosec} A \cos \zeta \cdot \sec \phi \cdot \operatorname{Cosec} z \cdot d\zeta$$

The equations may also be written in the form:

$$dA_1 = k_1 \cdot d\phi$$

$$dA_2 = k_2 \cdot dz$$

$$dA_3 = k_3 \cdot d\zeta$$

where the k values are multiplying factors and it is desirable that they be as small as possible.

Finally the total error dA may be written down:

$$dA = dA_1 + dA_2 + dA_3$$

These equations have been solved for the prescribed values of $d\phi$, dz and $d\zeta$ at the first day of each month for latitudes from 0 degrees to 45 degrees south at intervals of 5° .

Tables 1 and 2 show results only of the extreme cases; there is uniform change in the variables between the two extreme cases.

For each latitude the first row gives the values of the azimuth angle, A , in degrees and decimals. These values are required in subsequent calculations, and are tabulated for the reader's information.

The second row, showing the hour angle, has been tabulated to give the observer an indication of the time in observation when $z = 70^\circ$. The approximate time of observation is midday + hour angle.

Row 3 shows the error in the calculated azimuth angle, dA_1 , caused by an error of $60''$ in the assumed latitude of the observer. In Papua New Guinea the effect of this error does not vary greatly from month to month and, as shown in row 4, the multiplying factor k_1 varies between 0.3 and 0.5. At higher latitudes the effect of the error is more variable and the multiplying factor may exceed unity during the winter months.

$$\text{For } \phi = 5^\circ \text{ South } 0.35 < k_1 < 0.46$$

$$\text{For } \phi = 35^\circ \text{ South } 0.19 < k_1 < 1.44$$

Row 5 shows dA_2 for an assumed error of $10''$ in the corrected zenith distance. The dz multiplying factor k_2 in row 6 clearly shows that the observer's calculated azimuth angle suffers far less from the effect of this error in P.N.G. than in higher latitudes.

$$\text{For } \phi = 5^\circ \text{ South } 0.1 < k_2 < 0.29$$

$$\text{For } \phi = 35^\circ \text{ South } 0.63 < k_2 < 1.55$$

Row 7 tabulates the error in the calculated azimuth angle caused by an error of $5''$ in the adopted declination of the sun. The effect of the error d is not lessened but is less noticeable in Papua New Guinea than at higher latitudes. Row 8 shows the range of k_3 values. The minimum values of k are less than lower latitudes.

$$\text{For } \phi = 5^\circ \text{ South } 1.06 < k_3 < 1.1$$

$$\text{For } \phi = 35^\circ \text{ South } 1.22 < k_3 < 1.85$$

In Row 8 the listed values for

$$|dA| = |dA_1| + |dA_2| + |dA_3|$$

are only representative but do show the possible maximum effect of the errors in data for various months of the year at various latitudes.

Graphical Tabulation of Results:

Figure 6 graphs the values of k_1 , k_2 and k_3 against months of the year for the equations $dA_1 = k_1 \cdot d\phi$, $dA_2 = k_2 \cdot dz$ and $dA_3 = k_3 \cdot d\delta$. Latitudes of 5 degrees and 45 degrees have been chosen to illustrate the extreme situations.

Figure 7 is a plot of k values against latitude when $\delta = +23^\circ 26' 16''$ for each of the three equations. This the worst time of the year for sun observations, and the effects of all errors on the calculated azimuth angle are magnified when further south than latitude 29° .

Elimination of Systematic Errors:

Having noted the extent to which the error in azimuth angle may be minimised for various latitudes and at various times of the year, it is possible now to write down the equation for an error in A arising solely from systematic errors.

$$\Delta A = k_1 (d\phi) + k_2 (dz_1) + k_3 (d\zeta_1)$$

where $d\phi$, dz_1 and $d\zeta_1$ are the systematic errors in ϕ , z and ζ .

Correct $A = \text{Calculated } A + \Delta A$

For paired morning/afternoon observations, using the subscripts 1 and 2,

$$R.O._1 = 180 - (A_1 + \Delta A_1) - \psi_1$$

$$R.O._2 = 180 + (A_2 + \Delta A_2) - \psi_2$$

Averaging the results,

$$\frac{R.O._1 + R.O._2}{2} = \frac{360}{2} + \frac{A_2 - A_1}{2} + \frac{\Delta A_2 - \Delta A_1}{2} - \frac{\psi_1 + \psi_2}{2}$$

For approximately equal zenith distances ($70^\circ < z < 75^\circ$), azimuth angles will be nearly equal and ΔA_1 should equal ΔA_2 . There is far more likelihood that $\Delta A_1 = \Delta A_2$ if the effects of the errors in ϕ , z and ζ have been lessened.

Conclusion:

The best results may be expected from sun observations if all possible precautions are taken to minimise the effects of error in the data. The main requirement towards achieving this situation is to observe the sun when $70^\circ < z < 75^\circ$.

For constant z and ϕ , minimum values of the error in azimuth angle, dA , vary throughout the year because of the change in declination of the sun, and the tables show that the best time of the year for sun observations is when the sun's declination is a minimum ($\zeta = -23\frac{1}{2}^\circ$), especially for observers in high southern latitudes.

Minimum dA values also change with change in ϕ . In the cases of dA_2 and dA_3 there is increase in their values with increase in

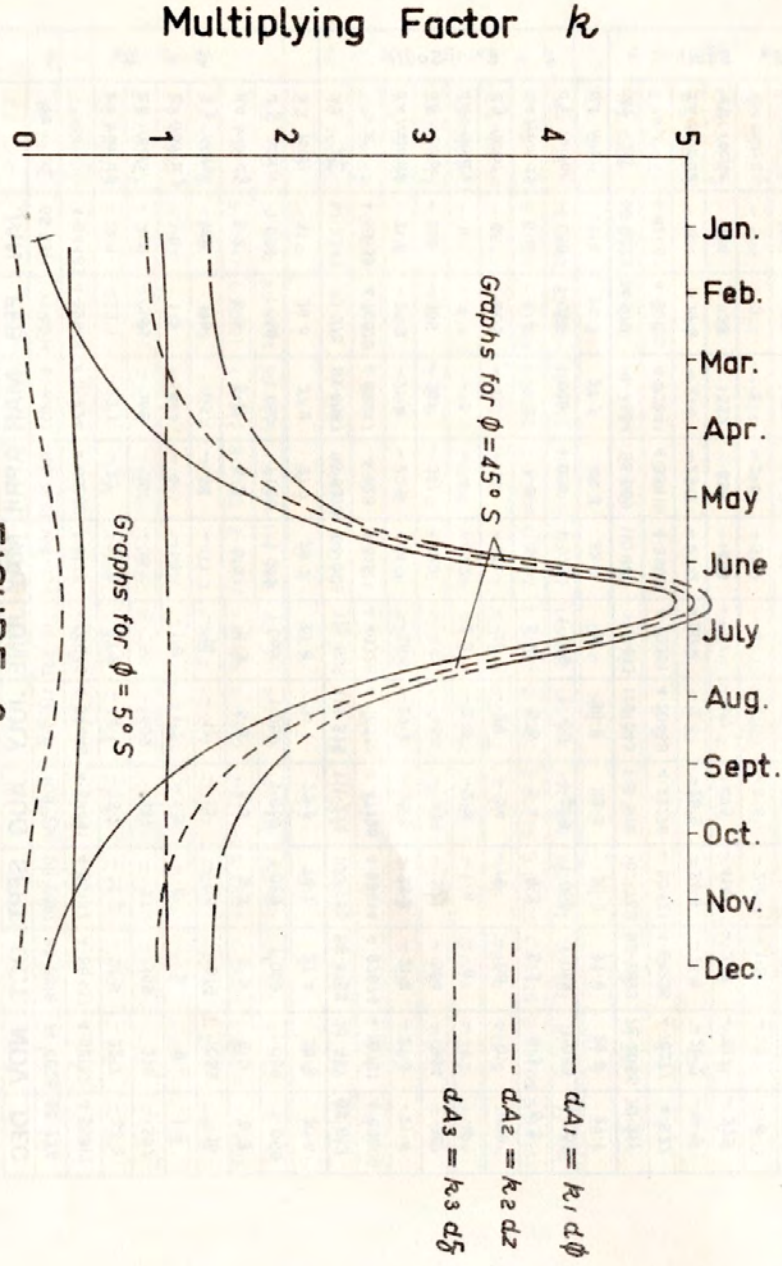
latitude south for all months of the year. dA_1 values increase with increase in latitude south except during the summer months when they decrease. The rate of decrease of dA_1 slows down, however, as the latitude increases.

Assuming that the magnitudes of the various errors to be of the same order, regardless of latitude, the analysis shows that the observation is more reliable in low latitudes.

	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
$\phi = 0^\circ$												
Az Δ	65.3311	71.4314	81.8907	94.7858	106.034	113.537	114.701	109.256	98.8687	86.6618	74.6628	66.734
H.A.	4.54483	4.59968	4.65424	4.66236	4.6172	4.56645	4.54449	4.59441	4.65182	4.66457	4.62152	4.5593
dA from d ϕ	-24.1	-23.1	-22.1	-22	-22.8	-23.9	-24.1	-23.2	-22.2	-21.9	-22.7	-23.8
d ϕ factor	-.402	-.385	-.369	-.367	-.38	-.399	-.402	-.387	-.37	-.365	-.379	-.397
dA from d δ	1.6	1.2	.5	-.4	-.11	-1.6	-1.7	-1.3	-.6	.2	.9	1.5
d δ factor	.159	.119	.05	-.04	-.11	-.16	-.17	-.13	-.06	.019	.089	.15
dA from d ξ	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
d ξ factor	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059
dA total	31	29.6	27.9	27.7	29.2	30.8	31.1	29.8	28.1	27.4	28.9	30.6
$\phi = 5^\circ$ South												
Az Δ	67.2243	73.273	83.6887	96.6379	108.005	115.639	116.829	111.278	100.755	88.4753	76.487	68.613
H.A.	4.69139	4.70578	4.69647	4.629	4.51511	4.40385	4.38353	4.47126	4.59414	4.67874	4.70731	4.69609
dA from d ϕ	-21.5	-21.3	-21.4	-22.6	-24.7	-26.8	-27.2	-25.5	-23.3	-21.8	-21.2	-21.4
d ϕ factor	-.359	-.355	-.357	-.377	-.412	-.447	-.454	-.425	-.389	-.364	-.354	-.357
dA from d δ	.5	.1	-.5	-1.4	-2.2	-2.8	-2.9	-2.4	-1.6	-.8	-.1	.4
d δ factor	.05	.009	-.05	-.14	-.22	-.28	-.29	-.24	-.16	-.08	-.01	-.039
dA from d ξ	5.3	5.3	5.3	5.3	5.4	5.4	5.5	5.4	5.3	5.3	5.3	5.3
d ξ factor	1.059	1.059	1.059	1.059	1.079	1.079	1.100	1.079	1.059	1.059	1.059	1.059
dA total	27.3	26.7	27.2	29.3	32.3	35	35.6	33.3	30.2	27.9	26.6	27.1
$\phi = 10^\circ$ South												
Az Δ	68.9223	74.979	85.4554	98.563	110.16	118.013	119.243	113.519	102.752	90.2893	78.2055	70.311
H.A.	4.82667	4.80135	4.72841	4.58415	4.38885	4.23391	4.20458	4.33276	4.52421	4.68236	4.78277	4.822
dA from d ϕ	-19.4	-19.8	-21.1	-23.7	-27.2	-30.4	-3.1	-28.5	-24.8	-21.9	-20.2	-19.5
d ϕ factor	.324	.33	.352	.395	.454	-.507	-.517	-.475	-.414	-.365	-.337	-.325
dA from d δ	-.5	-.9	-1.5	-2.4	-3.3	-4	-4.1	-3.6	-2.7	-1.8	-1.1	-.6
d δ factor	-.05	-.09	-.15	-.24	-.33	-.4	-4.1	-.36	-.27	-.18	-.11	-.06
dA from d ξ	5.3	5.3	5.3	5.4	5.5	5.6	5.6	5.6	5.4	5.3	5.3	5.3
d ξ factor	1.059	1.059	1.059	1.079	1.1	1.119	1.119	1.119	1.079	1.059	1.059	1.059
dA total	25.2	26	27.9	31.5	36	40	40.7	37.7	32.9	29	26.6	25.4

	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
$\phi = 35^\circ$ South												
Az Δ	75.2464	82.3058	94.7288	110.898	126.302	137.933	139.907	131.106	116.3	100.59	86.0987	76.8589
H.A.	5.40417	5.16058	4.72553	4.1142	3.44298	2.85226	2.7434	3.20896	3.89099	4.51186	5.02936	5.34842
dA from d ϕ	-11.6	-16	-25.4	-39.5	-58	-79.2	-83.9	-65.7	-45.2	-30.1	-19.1	-12.7
d ϕ factor	-.194	-.27	-.424	-.659	-.967	-1.32	-1.399	-1.095	-.754	-.502	-.319	-.212
dA from d δ	-6.3	-6.6	-7.4	-8.9	-11.4	-14.5	-15.2	-12.5	-9.7	-7.9	-6.8	-6.4
d δ factor	-.63	-.66	-.74	-.89	-1.14	-1.45	-1.52	-1.25	-.97	-.79	-.68	-.64
dA from d ξ	6.1	6.2	6.4	6.9	7.7	8.9	9.2	8.1	7.1	6.5	6.3	6.1
d ξ factor	1.219	1.239	1.279	1.379	1.539	1.779	1.839	1.619	1.419	1.3	1.259	1.219
dA total	24	29.2	39.2	55.3	77.1	102.6	108.3	86.3	62	44.5	32.2	25.2
$\phi = 40^\circ$ South												
Az Δ	76.1469	83.6684	96.9521	114.477	131.757	145.782	148.312	137.385	120.442	103.282	87.715	77.864
H.A.	5.51125	5.21225	4.68256	3.93864	4.10272	2.31847	2.16407	2.80025	3.66423	4.42326	5.05206	5.44259
dA from d ϕ	-10.1	-16.4	-28.2	-47	-74.3	-112.8	-123.2	-87	-55	-34.4	-19.9	-11.6
d ϕ factor	-.169	-.274	-.47	-.784	-1.239	-1.88	-2.054	-1.45	-.917	-.574	-.332	-.194
dA from d δ	-7.8	-8.1	-8.9	-10.9	-14.5	-20.3	-21.9	-16.4	-11.9	-9.5	-8.3	-7.9
d δ factor	-.78	-.81	-.89	-1.09	-1.45	-2.03	-2.19	-1.64	-1.19	-.95	-.83	-.79
dA from d ξ	6.5	6.6	6.9	7.6	8.9	11.4	12.1	9.7	7.9	7.1	6.7	6.5
d ξ factor	1.3	1.319	1.379	1.519	1.779	2.279	2.419	1.939	1.579	1.419	1.339	1.3
dA total	24.4	31.1	44	65.5	97.7	144.5	157.2	113.1	74.8	51	34.9	26
$\phi = 45^\circ$ South												
Az Δ	76.9217	85.0453	99.4529	118.814	138.989	158.236	162.737	146.139	125.592	106.357	89.4221	78.7753
H.A.	5.61947	5.25691	4.61742	3.71193	2.64537	1.47196	1.17672	2.22778	3.37067	4.30378	5.06336	5.53602
dA from d ϕ	-8.5	-16.8	-32.2	-58	-102.3	-209.2	-266.7	-128.7	-69.2	-40.4	-21.3	-10.4
d ϕ factor	-.142	-.28	-.537	-.967	-1.705	-3.487	-4.445	-2.145	-1.164	-.674	-.355	-.174
dA from d δ	-9.5	-9.8	-10.8	-13.5	-19.5	-36.1	-45.5	-23.4	-15	-11.5	-10	-9.5
d δ factor	-.95	-.98	-1.08	-1.35	-1.95	-3.61	-4.55	-2.34	-1.5	-1.15	-1.0	-.95
dA from d ξ	7.1	7.2	7.5	8.5	11	18.8	23.3	12.8	9.1	7.8	7.2	7.1
d ξ factor	1.419	1.439	1.5	1.7	2.2	3.759	4.659	2.559	1.819	1.559	1.439	1.419
dA total	25.1	33.8	50.5	80	132.8	264.1	335.5	164.9	93.9	59.7	38.5	27

FIGURE 6



Worst Possible Case $\xi = \text{North } 23^\circ 26.6'$ June 21st.

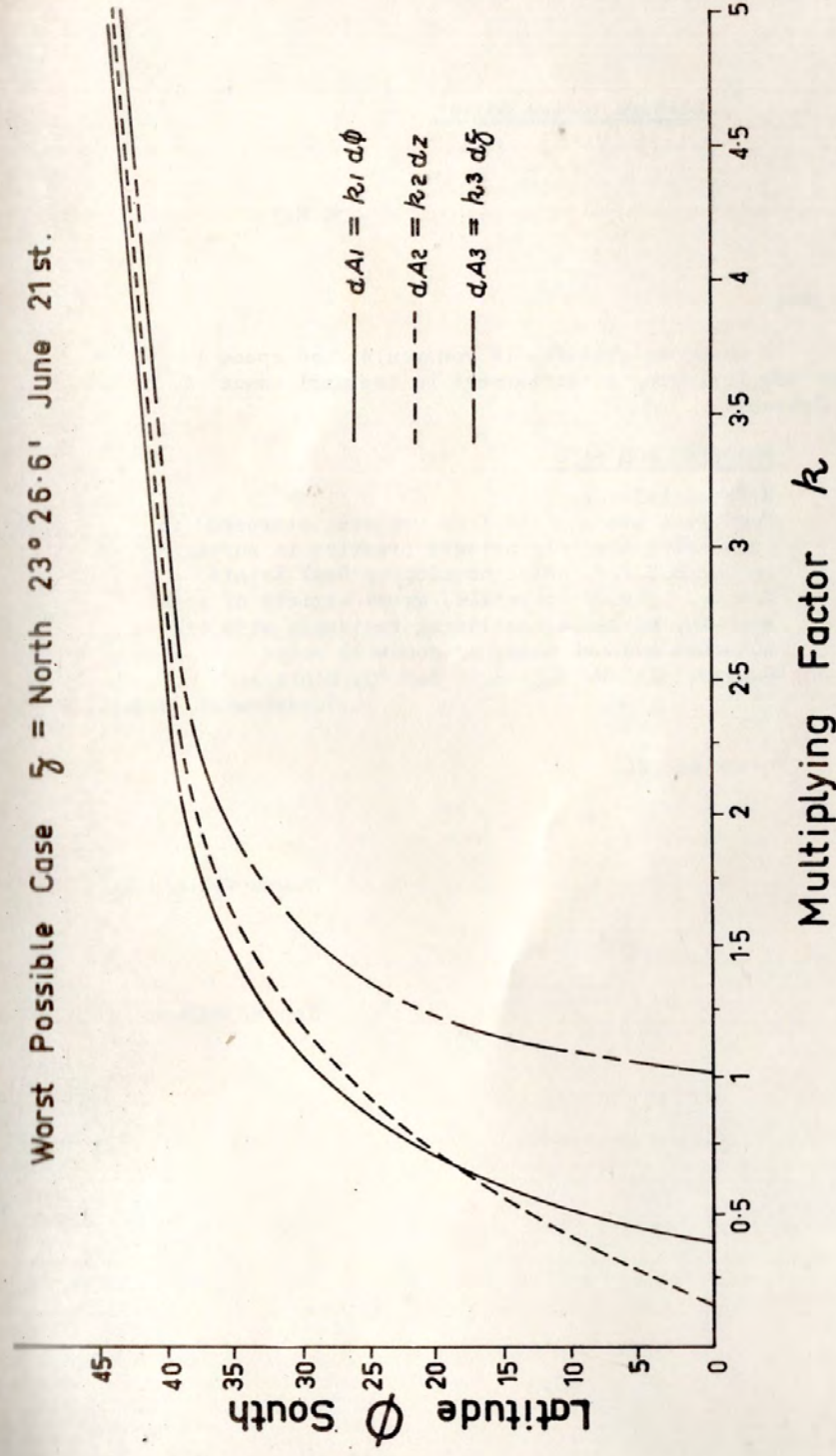


FIGURE 7

Letters to the Editor

10/8/73

Dear Sir,

I would be grateful if you would find space to insert the following advertisement in the next issue of your Journal.

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Thanking you,

Yours faithfully,

Ian W. Robins.

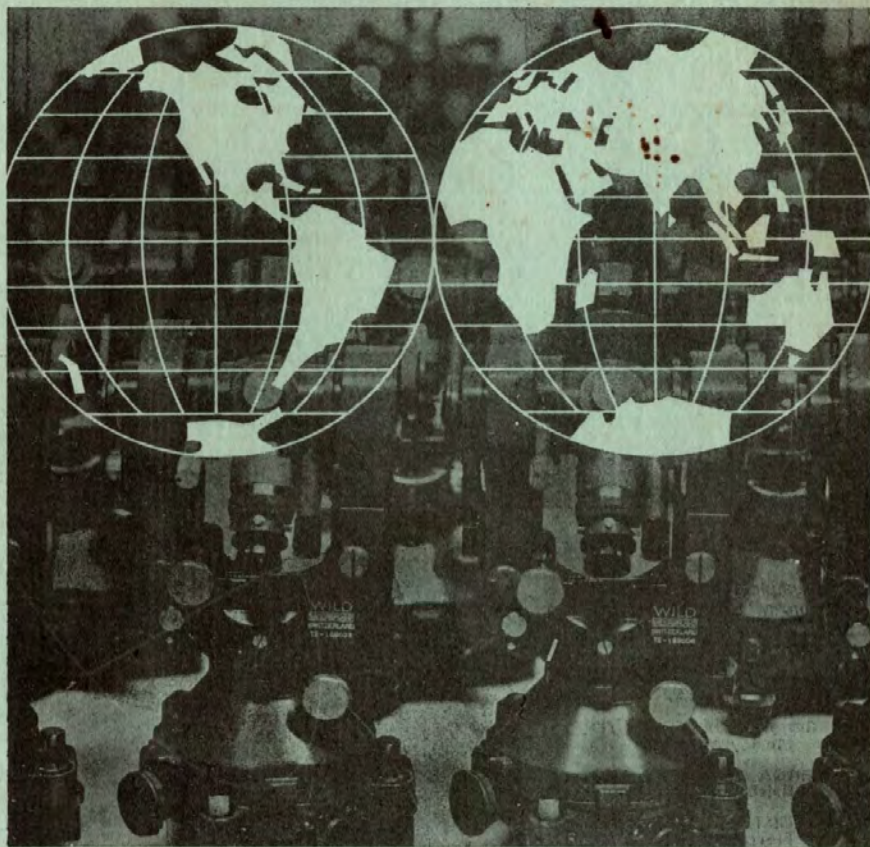
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