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INDEX

ON THE ACCURACY OF EDM

by D.J. Parker B.Sc (R.M.I.T.)

Abstract

This paper is the result of an investigation into the apparent conflict in the use of the various statistical terms, by the manufacturers of electromagnetic distance measuring equipment, to describe the accuracy of their instruments. From a statistician's point of view standard deviation, standard error and even accuracy have significant differences in meaning and when these are all used to mean essentially the same thing it is time to have some uniformity or at least an understanding of the statistical terms used.

1.0 Introduction

It was found during recent investigations using electromagnetic distance measuring equipment (EDM) that there are apparently contradictory statements made by manufacturers, regarding the accuracy of these instruments.

Generally the accuracy is given in the form $A + B.10^{-6}D$ where A is a unit of length, usually in mm, B is an integer number and D is the measured distance, in metres.

The contradictory statements occur when some manufacturers state that this is the standard deviation, some that this is simply "accuracy" and Bomford that the standard error is

$$S.E. = \pm (A^2 + (B.10^{-6}D)^2)^{\frac{1}{2}}$$

The following investigations will attempt to clarify the situation and put forward a reasonable solution, giving uniformity.

The tabulation below shows a selection of EDM with the accuracies as quoted from the manufacturer's information leaflets and instruction manuals.

Manufacturer - model	Carrier wave	Accuracy
Siemens Albis SIAL MD 60	micro wave	S.D. $\pm$ 1cm $\pm$ 3 ppm (after Met's)
AGA Geodat 120	infra red	mse $\pm$ (5mm + 7 ppm)
AGA 76	infra red	accuracy = $\pm$ (10mm + 1ppm)
AGA 10	infra red	accuracy = $\pm$ (5mm + 10 ppm)
AGA 12	infra red	accuracy = $\pm$ (5mm + 5 ppm)
AGA 14	infra red	accuracy = $\pm$ (5mm + 3 ppm)
Wild DI 10	infra red	mse (S.D.) = $\pm$ 1cm (independant of dist.)

Wild D13S	infra red	S.D.= $\pm$ (5mm + 5.10^{-6}D)
Hewlet Packard HP 3800B	infra red	mse $\pm$ (5mm + 7mm/km)
Tellurometer MRA 101	microwave	accuracy $\pm$ 1.5cm $\pm$ 4 ppm D
Tellurometer CA 1000	microwave	p.e.= 1.5cm $\pm$ 5 ppm
Tellurometer CD6	infra red	p.e.= 5mm + 5 ppm
Tellurometer MRA5	microwave	p.e.= 0.05 $\pm$ (D x 10^{-5})m
Keuffel & Esser Autoranger	infra red	rmse = $\pm$ (5mm + 6 ppm)
Keuffel & Esser Microranger	infra red	rmse = $\pm$ (5mm + 2 ppm)
Keuffel & Esser Ranger IV	Helaser	rmse = $\pm$ (5mm + 2 ppm)
Keuffel & Esser Ranger V	Helaser	rmse = $\pm$ (10mm + 2 ppm)
Keuffel & Esser Range Master II	Helaser	rmse = $\pm$ (5mm + 1 ppm)
Cubic Electrotape DM-20	microwave	accuracy=1cm $\pm$ 1 in 300,000
Cubic Cubitape DM-60	infra red	accuracy = $\pm$ 5mm + 1/100,000

2.0 The terms Used

Before proceeding with the investigation we should firstly understand the meaning, as put forward by mathematicians, statisticians and surveyors, of the terms being used by the manufacturers, so that we will be in a better position to decide the correct meaning of the statements.

Accuracy

Dictionaries (4,6) generally agree about the meaning of this word, stating that it is, correctness; freedom from error; exactness; precision.

Anyone studying a science or professions such as engineering and surveying where precise measurements are called for, will need a better understanding of accuracy than that given above.

While considering accuracy we should also study the word precision, which is often interchanged with accuracy and note that while accuracy and precision describe the correctness of a result, precision better describes (1) the care and refinement taken when making measurements so as to obtain accurate results.

Thus, with the above interpretation a series of measurements could be, precise having a very small range of values, but not necessarily very accurate.

Obviously when concerning ourselves with accuracy we are actually comparing the measured values with the true values and should call the differences, errors.

Errors and Residuals

It is convenient at this point to remember that not often is it possible to obtain the true value, the best we can get with a small number of observations being the arithmetic mean, and so the word residual is used to describe the difference between the measurements and the mean of these measurements.

When measurements are made with a high degree of precision, any errors are likely to be accidental, therefore random and Normally Distributed. The arithmetic mean then, is expected to closely approximate the true value, and using this assumption, there would be little difference between the residuals and the errors, especially when there are 20 or more measurements.

Many people do assume that the arithmetic mean equals the true value, with the consequence that they must then consider the difference between mean square error and standard deviation to be purely academic and of little concern.

It would seem therefore, that here-in lies the cause of most of the confusion that we are experiencing now, with regard to the accuracy of EDM.

For the purpose of this investigation the Normal Distribution curve can be considered to be bell shaped and not slightly skewed, as the difference will have little affect on the results. With this assumption we can use the widely accepted definitions of mean square error, standard deviation, standard error, and probable error.

Mean Square Error (mse)

This term is used as a measure of the dispersion of observations either side of the true value and is the square root of the mean of the squares of the errors and is given by

$$\text{mse} = \left(\frac{\Sigma e^2}{n}\right)^{\frac{1}{2}}$$

and refers to any single observation in the sample.

Many modern statisticians for example Walpole (7) do not mention mean square error and only consider the term standard deviation.

The term standard deviation (σ) is understood to be the square root of the function variance (σ^2), which is a measure of the dispersion of a sample and refers to a single observation of unit weight. Standard deviation is calculated from

$$\text{Varience, } \sigma^2 = \frac{\Sigma v^2}{n - u}$$

where: v = the variation of a measurement from the mean of a sample.

n = the size of the sample

u = the number of unknowns.

It can be shown statistically that the sum of the squares of the errors and the sum of the squares of the residuals are, on the average, in the ratio n/(n-1), therefore standard deviation includes the extra degree of freedom by using n-1.

When little else is known and only a small number of measurements are made, standard deviation is the best estimate of the mean square error. Because of the properties of the Normal Curve, the standard deviation lies at the points of inflection and the area under the curve, bounded by the curve up to the points of inflection and the horizontal axis, is approximately 68% of the total area. In practical terms of course this means that of the data analysed 68%, of the measurements will fall within the range $\bar{x} \pm \sigma_s$.

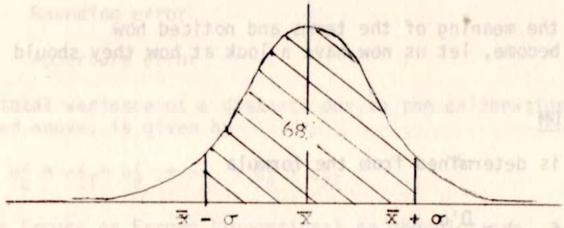

Fig.1. Normal Distribution Curve

Standard Error (S.E.) is now referred to as the standard deviation of the mean and is caluclated from $\sigma_m = \sigma_s/\sqrt{n}$

where σ_s = standard deviation of a single observation
n = number of measurements

But earlier surveyors had different meanings for the term:

Bomford (2) considers that the standard error of a single observation is

$$\text{S.E.} = \left(\frac{\Sigma v^2}{n-1}\right)^{\frac{1}{2}} \qquad *1$$

where: v = the deviation of a measurement from the mean and that the standard error of the mean is

$$\text{S.E.} = \left(\frac{\Sigma v^2}{n(n-1)}\right)^{\frac{1}{2}} \qquad *2$$

Similarly, Rainsford (5) states: " ..... the best estimate of the standard error of a single observation is given by

$$\mu^2 = \Sigma\,(x_i - \bar{x})^2/(n-1)".$$

and then goes on to say".... in survey literature the term in most general use is the mean square error; for our purposes the two are precisely the same"

Root Mean Square Error (rmse)

This is understood to have the same meaning as mean square error although strictly speaking, mse is analogous to variance.

Probable Error is a term which has little use now but was quite widely used a few years ago, to suggest that of all the measurements made in a sample, approximately 50% of the measurements will fall with the range $\bar{x} \pm 0.674\sigma_s$. Today this has little meaning statistically, has therefore fallen into disuse and been replaced by the term standard deviation.

Having had a look at the meaning of the terms and noticed how confusing it has all become, let us now have a look at how they should be used.

3.0 Sources of Error in EDM

Because any distance is determined from the formula

$$F\,(D',\, c,\, n,\lambda_{mod},f_{mod}) = \frac{D'c}{n\lambda_{mod.}\,f_{mod.}}$$

by taking the total derivative of the function, the variance for a distance will be given by

$$\sigma_F^2 = \sigma_D^2\,\left(\frac{\partial F}{\partial D}\right)^2 + \sigma_c^2\,\left(\frac{\partial F}{\partial c}\right)^2 + \sigma_n^2\,\left(\frac{\partial F}{\partial n}\right)^2 + \sigma_\lambda^2\,\left(\frac{\partial F}{\partial \lambda}\right)^2 + \sigma_f^2\,\left(\frac{\partial F}{\partial f}\right)^2 \qquad * \ 3$$

It can be seen by inspection that all terms in this expression, except the first, are a function of the distance and as is generally accepted, two main sources of error in EDM equipment exist whether, microwave, infrared or laser.

They are:

(i) Errors due to uncertainties in the calibration of the instrument and its components, which may or may not be cyclic and are included in the element

$$\sigma_D^2\,\left(\frac{\partial F}{\partial D}\right)^2, \qquad * \ 4$$

the first part of the expression for the variance.

(ii) Scale errors due to uncertainties in the true atmosphere along the line, the speed of electromagnetic waves in a vacumm, the wave length and the frequency.

3.1 Calibration Uncertainties

When considering the errors due to calibration uncertainties it should be possible, by analysing the various components, knowing their design characteristics and applying the Law of Propogation of Variances, to determine the accuracy of the instrument.

The calibration uncertainties can reasonably be stated as being

(i) Cyclic errors due to non-linearity fo phase detector.

(ii) Centring errors of instrument and target.

(iii) Pointing error

(iv) Zero error

(v) Rounding error

(vi) Apperture error

The total variance of a distance due to the calibration uncertainties listed above, is given by

$$\sigma_A^2 = \sigma_c^2 + \sigma_{IT}^2 + \sigma_p^2 + \sigma_Z^2 + \sigma_R^2 + \sigma_{AE}^2 \qquad *5$$

3.2 Scale Errors or Errors Proportional to the Distance

These errors are primarily caused by inadequate knowledge of the atmosphere and frequency of modulation, and have the affect of either lengthening or shortening the distance.

Errors due to uncertainties in speed of electromagnetic waves have now been reduced so as to be completely negligible.

The refractive index n is given by the function

$$n = F(e,T,p)$$

and the total derivative by

$$\sigma_n^2 = \left(\frac{\partial F}{\partial e}\right)^2 \sigma_e^2 + \left(\frac{\partial F}{\partial T}\right)^2 \sigma_T^2 + \left(\frac{\partial F}{\partial p}\right)^2 \sigma_p^2 \qquad *6$$

where: e = vapour pressure

T = absolute temperature

p = atmospheric pressure

It can be shown that uncertainties in the determination of the humidity have a significant affect, especially on microwave EDM measurements.

The refractive index uncertainties could be caused by assuming that on long lines, the atmosphere at one end is representative of the true atmosphere along the whole line, or by inaccurate measurement of the pressure and temperature.

Errors due to uncertainties in the modulation frequency f_{mod}, are caused by crystal aging or extremes of temperature. The best method to determine the correct frequency is by a use of an electronic counter capable of a precision of at least 1 ppm.

4.0 What then is meant when EDM accuracy is quoted in so many different ways?

As most manufacturers quote the accuracy in a similar form regardless of what it is called, we can only assume that its elements are all based on the same principles and that the understanding of the statistical terms has been influenced by particular schools of thought, probably dependant upon the country of origin.

Based on the definitions given earlier which are recognised by mathematicians, statisticians and surveyors alike, it would be incorrect to state that the standard deviation, mean square error, root mean square error, or even probable error are of the form + (A + Bppm). Where the terms 'accuracy' and 'probable error' have been used instead of standard deviation or mean square error, then they too, must be taken to have similar meanings.

As has been seen, every source of error has its variance whether known, capable of estimation or neither and as the terms are independant, the law of Propogation of Variances applies. Therefore in theory at least, any expression such as standard deviation or mean square error which are measures of dispersion of results, should only be shown, for example in this case, as

$$\sigma_S = + (\sigma_A^2 + \sigma_A^2)^{\frac{1}{2}}$$

Where: σ_A^2 = sum of the variances which are independant of distance (refer 3.1 Calibration Uncertainties)

σ_B^2 = sum of the variances which are distance dependant (refer 3.2 Scale Errors)

To obtain the standard deviation of a measurement, the figures (A and B) supplied by the manufacturer should be squared before addition,

that is $\sigma_S = \pm (A^2 + (B.10^{-6} D)^2)^{\frac{1}{2}}$

By accepting that the standard deviation of a single measurement is given by $\pm (\sigma_A^2 + \sigma_B^2)^{\frac{1}{2}}$ then obviously there must be an error incurred when $\pm (A + B.10^{-6}D)$ is used.

The magnitude of this error is given by

$$\Delta\sigma_S = (2A^2 + 2(B.10^{-6}D)^2 + 2A\,(B.10^{-6}D) - 2(A + B.10^{-6}D)(A^2 + (B.10^{-6}D)^2)^{\frac{1}{2}})^{\frac{1}{2}}$$

and when A = 0.005m, B = 5, D = 2km

$$\Delta\sigma_S = 0.004\text{m}$$

Not an insignificant amount!

5.0 Estimation of Standard Deviation

The standard deviation of a single measurement can be predicted by estimation of the variances of the various sources of error while an instrument is still in the design stage. Later when the EDM has been used in typical working conditions, the standard deviation as predicted could be either accepted or revised.

When a number of measurements are made of lines of varying lengths and the mean of these taken as the best available estimate of the distance, the standard deviation of the mean as described previsouly, will be given by

$$\sigma_m = \pm (\sigma_s^2/\sqrt{n})^{\frac{1}{2}} = \pm \frac{(\sigma_A^2 + \sigma_B^2)^{\frac{1}{2}}}{\sqrt{n}} \qquad *7$$

or using the manufacturer's figures

$$\sigma_m = \pm \frac{(A^2 + (B.10^{-6} D)^2)^{\frac{1}{2}}}{\sqrt{n}} \qquad *8$$

This value for σ_m will of course be the best estimate of the mean square error of a single measurement. The affects of uncertainties in the atmosphere along short lines (<500m) are negligible and be due entirely to calibration uncertainties, and equal to σ_A^2 only.

Repeated measurements of longer lines will then yield that part of the standard deviation which is proportional to the distance.

6.0 Conclusion

From the foregoing it would seem that the expression for the accuracy of the EDM equipment has in the past been given a fairly low order of priority by many manufacturers, especially with respect to the accepted statistical meaning of the terms used.

A convenient way of expressing the accuracy of any instrument uniformly and statistically correct, to reduce confusion, must require little change from that used at present.

A suggested form for expressing the standard deviation is:

$$\sigma_s = \pm (A^2 + (Bppm)^2)^{\frac{1}{2}} \qquad *8$$

Where: A is given in millimetres
B is an integer number
σ_s is the standard deviation of a single measurement

Therefore using the figures for A and B as given by the manufacturer, the standard devaition of a single measurement for the instruments quoted in the Introduction, has been listed in the annexure for comparison.

By employing the expression given above, rigorous survey adjustments whether of traverses or geodetic networks can include more accurate weights for the lengths fo the lines.

Manufacturer	Model	Carrier Wave	Standard Deviation of a single measure	Short Range		Medium Range	Long Range
				1km (±mm)	2km (±mm)	10km (±mm)	30km (±mm)
Siemens Albis	SIAL MD60	microwave	$(10^2 + (3ppm)^2)^{\frac{1}{2}}$	10	12	32	91
Aga	Geodat 120	infra red	$(5^2 + (7ppm)^2)^{\frac{1}{2}}$	8	15	70	210
Aga	76	infra red	$(10^2 + (1ppm)^2)^{\frac{1}{2}}$	10	10	-	-
Aga	10	infra red	$(5^2 + (10ppm)^2)^{\frac{1}{2}}$	11	21	-	-
Aga	12	infra red	$(5^2 + (5ppm)^2)^{\frac{1}{2}}$	7	11	-	-
Aga	14	infra red	$(5^2 + (3ppm)^2)^{\frac{1}{2}}$	6	8	-	-
Wild	DI 10	infra red	$(10^2 + (10ppm)^2)^{\frac{1}{2}}$	10	-	-	-
Wild	DI 3S	infra red	$(5^2 + (5ppm)^2)^{\frac{1}{2}}$	7	11	-	-
Hewlett Packard	HP3800B	infra red	$(5^2 + (7ppm)^2)^{\frac{1}{2}}$	9	15	-	-
Tellurometer	MRA101	microwave	$(15^2 + (4ppm)^2)^{\frac{1}{2}}$	16	17	43	121
Tellurometer	CA1000	microwave	$(15^2 + (5ppm)^2)^{\frac{1}{2}}$	16	18	50	151
Tellurometer	CD6	infra red	$(5^2 + (5ppm)^2)^{\frac{1}{2}}$	7	11	-	-
Tellurometer	MRA5	microwave	$(50^2 + (10ppm)^2)^{\frac{1}{2}}$	51	54	112	304
Keuffel&Esser	Autoranger	infra red	$(5^2 + (6ppm)^2)^{\frac{1}{2}}$	8	13	-	-
Keuffel&Esser	Microranger	infra red	$(5^2 + (2ppm)^2)^{\frac{1}{2}}$	5	6	-	-
Keuffel&Esser	Ranger IV	Helium Laser	$(5^2 + (2ppm)^2)^{\frac{1}{2}}$	5	6	21	60
Keuffel&Esser	Ranger V	Helium Laser	$(10^2 + (2ppm)^2)^{\frac{1}{2}}$	10	11	22	61
Keuffel&Esser	Range Master II	Helium Laser	$(5^2 + (1ppm)^2)^{\frac{1}{2}}$	5	5	11	-
Cubic	Electrotape DM20	microwave	$(10^2 + (3ppm)^2)^{\frac{1}{2}}$	10	12	32	91
Cubic	Cubitape DM60	infra red	$(5^2 + (10ppm)^2)^{\frac{1}{2}}$	11	21	-	-

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PROFESSIONAL EDUCATION - DEPARTMENT OF SURVEYING

PNG UNIVERSITY OF TECHNOLOGY

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"Land is the only thing worth living for
Land is the only thing worth working for
Land is the only thing worth fighting for
Land is the only thing worth dying for
For Land is the only thing that lasts for ever and ever"

Sir John Guise
Chairman, National Emergency Commitee

Abstract

This paper reviews the past and present courses being presented and outlines revised and new courses.

Introduction

This paper outlines a new undergraduate course structure for surveying, survey drafting and cartography and proposed graduate courses in land studies.

COURSE HISTORY

THE PAST

Prior to 1973 the following courses were run by various government departments to meet their own specific requirements.

- Diploma in Cartography (3 years post grade 10) at the Forestry College, Bulolo
- Surveying Certificate (1 year post grade 10) at Rabaul
- Diploma in Valuation (3 years post grade 10) at Rabaul

In 1973 these courses were then transferred to the then P.N.G. Institute of Technology. Initially the following courses were run at the Institute.

- Certificate and Degree in Surveying (completely separate courses)
- Certificate and Diploma in Cartography
- Diploma in Valuation

In 1977 and 1979 the present course structure for surveying and survey drafting/cartography respectively were established. The main reason for the changes appear to have been

- o upgrading of the Certificate in Surveying
- o integration of certificate and degree and introduction of a Diploma in Surveying so that students could reach their own level of effectiveness
- o introduction of a direct entry year in Surveying to cater for those with higher than Grade 10 entry
- o introduction of a certificate in Survey Drafting, in place of cartography to provide survey examiners for which there was and still is a shortage
- o introduction of Diplomas in Survey Drafting and Cartography to meet the needs of two sections of industry.

THE PRESENT

The Department conducts the following courses:

- o Certificate, Diploma and Degree courses in Surveying - these are integrated courses with year 1, 2 and 3 (practical) comprising the certificate, year 4 the diploma and year 5 the degree
- o Certificate course in Survey Drafting - two years theory and one year practical, year one is nearly identical with the surveying certificate
- o Diplomas in Survey Drafting and Cartography - one year post certificate in Survey Drafting
- O Diploma in Valuation - a three year course.

The present and proposed course structure are shown in figure 1.

PROBLEMS OF EXISTING COURSE STRUCTURE

As with any courses there are problems which are not seen at the design stage. The following problems have been identified:

- o Grade 10 and 12 students are placed together in the first year of survey drafting
- o A student must choose surveying or survey drafting on his entry to the University. He cannot change streams. This problem is exacerbated as the majority of our students do not put our courses as their first preference and while they may have a vague idea of surveying, the words survey drafting/cartography have no meaning.

- There is no common year for surveying and survey drafting even though much of the material is common
- The content of one subject SV 121 Computations I (is also taught in the second semester of MA 150)
- Many topics in the surveying and survey drafting course are common but they are taught in different subjects in different years so that there is no economy of scale.
- The surveying direct entry year for Grade 12 is not academically sound as it is not structured in a logical learning sequence.
- The numbers in survey drafting/cartography are very small; 5, 9, 10 for 1st, 2nd, 3rd years respectively.
- Until June 80 each course had a different entry standard.
- The 3rd year of survey drafting/cartography is a Diploma in either. Now present number of students prevent the formation of two groups.
- Survey drafting/cartography have as their terminal qualification a Diploma. This does not prepare them for the higher professional appointments in industry or government and does not give them access to courses overseas.

REVISED COURSE AIMS

The revised course structure (figure 1) seeks to overcome the problems and has the following aims:

- To provide courses that meet the needs of industry
- To have common entry standards for surveying, survey drafting and cartography
- To have a preliminary year for Grade 10 entry. In the future when there are sufficient Grade 12 entry, this year can be dropped if necessary
- To have a common preliminary year and common first professional year. The first professional year to be the entry point for Grade 12
- Remove duplicated teaching without detriment to students and hence achieve some economy
- To provide an integrated course structure so that a student can advance to his own level of effectiveness
- To allow students in survey drafting/cartography to advance to a degree if required.

The course structure is shown in figure 2. Details on individual subjects have not been included but are available on request.

This revised course structure saves the deparment approximately two staff members who are now available to address the continuing education needs of the profession i.e. run short courses etc.

Course Length and Awards

If the profession is to attract and hold students, then the profession must be attractive to them. In the first instance the student may well judge a profession by what award he gets for a certain length of study compared to others and what it pays at the end. In the past, we have not come out too well in this comparision. In surveying we gave a certificate after 3 years post grade 10/12. In the department of Accounting and Business Studies the Grade 12 got a degree. We are the only department in the University that gives a certificate.

Figure 3 shows how we now compare with other University departments. I believe we now look as attractive as most and better than some, so we are not starting at a disadvantage. One of our strong "selling" points should be our integrated award system where it is not a case of one award with pass/fail after several years of study but that we are an industry where there are several levels and people can find their own level based on their ability and willingness to work.

A close examination of the course structure shows that at each level we are aiming to turn out a person who can take his place in the work force at the level to which he has been trained.

THE FUTURE

What is Our Line of Business

If this question was posed to me my answer would be "land education". By this I would consider land appraisal, measurement, evaluation, depiction, tenure, use, valuation and economy. To be effective in our chosen business we should be a regional centre of excellence which undertakes under-graduate, post-graduate and continuing education for those concerned with land, together with the provision of staff and facilities for the carrying out of applied research which results in direct benefits to the region.

If the above is "our business' then at the present stage of our development we have not yet addressed the following area in a concerted fashion

- land appraisal, tenure, economy and use
- post-graduate and continuing education'
- regional centre of excellence
- regional research centre

If "our business" is acceptable and meets the needs of our client (the country) then we must look to implementing the above. If it is not done at the University of Technology there seems to be no other suitable place.

Land appraisal, Tenure and Economy

I feel there is a need for training in the following: land use mapping and land evaluation; environmental base line studies; environmental monitoring and impact statements; use of remote sensing techniques; a greater awareness of land and the role it plays in the P.N.G. society together with the social issues involved and the role of customary land ownership.

Post-graduate and Continuing Education

Very few graduates have proceeded to higher studies; those who have, attended University College London, ITC, South Australian Institute of Technology, Cambridge University and The University of Papua New Guinea.

Because the cartographers' and survey draftsmans' terminal qualification has been a diploma, they cannot enter a post first degree course overseas.

Valuation is a little different but there are still problems. If these professions have as a terminal attainment, a diploma, they will not be trained sufficiently to perform effectively in high professional posts in government, industry and education. Consequently, the ability to effectively localise will be reduced. Also as other professionals have the openings to proceed to a degree there will (unfortunately) be the tendency to look down on the professional who has only a diploma. Indeed some would say that a diplomate is not a true professional.

I wish to make it quite clear that I am not advocating the abolition of certificates and diplomas and that everyone should get a degree. I am saying that there should be an avenue for those that require it and have the ability, to undertake post diploma education to fit them for the higher professional posts.

There also seems to be a need to conduct continuing education. Technology, skills, methods and ideas are constantly changing. This information can be trasmitted via short courses, seminars etc.

The necessity for post-graduate and continuing education has been discussed by the Departments' Advisory Board and at the recent CASLE conference and there seems to be no doubt that there is a need. To meet this need the department has put forward the following proposal.

POST GRADUATE/CONTINUING TRAINING

Our courses have been continuously amended and refined in order to respond to the demands of industry. The courses have been designed to provide the academic and professional training necessary for a young man or woman to embark upon a professional career.

It is generally accepted that our courses DO NOT:

(a) develop a student to an internationally accepted standard, nor do they,

(b) allow a graduate to undertake graduate studies abroad with any reasonable expectation of success, nor do they,

(c) prepare a graduate for the wider issues of land management which are encountered in middle and senior management positions.

The following proposal is seen as a means of overcoming these deficiencies in our programmes.

PROPOSAL

The Department of Surveying proposes to offer, to selected students, a programme of continuing education which can lead to the award of

(a) a Post-graduate Diploma in Land Studies, (Stage 1), and subsequently to

(b) a Master of Technology in Land Studies, (Stage 2).

AIM OF THE COURSE

The overall aim of the course is to eliminate or at least diminish the deficiencies in our existing programmes.

The course will be mounted in such a manner as:

(a) to provide a programme of continuing education for members of each profession concerned with land studies, and

(b) to raise the standard of members of the land oriented professions to an internationally recognised level, and

(c) to enrich the students professional knowledge to enable him to proceed to graduate studies abroad;

and by adopting a flexible format, be able,

(d) to meet the specific needs of industry as they arise.

COURSE STRUCTURE (Stage 1)

The format of the course is designed to provide maximum flexibility and is to be "tailor made" to suit the particular requirements of individuals having regard to their academic strengths, current specialisations and the needs of their sponsors. It is proposed to adopt a credit point (cp) system whereby one hour of lecture/tutorial will equate to 4 cp's and that 180 - 200 cp's must be achieved (45 - 50 hours).

The course structure for Stage 1 and Stage 2 is provided in figure 4.

The enrichment of professional knowledge is seen as the most urgent need and it is proposed that students seek credit points in this area in the first instance. In addition, employer bodies have intimated that they would prefer to release staff to attend such a programme over short periods rather than one extended period. It is therefore proposed that courses in professional subjects will be run as short intensive courses of from 1 - 3 weeks duration. It is proposed to offer, in 1981, four such courses providing an equivalent of 8 semester hours per semester (32 credit points).

It is apparent that a student will need to complete a minimum of one semester of full-time study in order to satisfy the requirements for broadening professional and general studies. It is envisaged that a student, having over a period of short courses satisfied the cp quota for professional subjects, would probably receive sympathetic consideration from his employer should he seek to complete his programme by a period of full-time study.

The aims and structure of the proposed course have been examined and approved by Professor D. O'Connor, Dept. of Surveying External Consultant.

ENTRY REQUIREMENTS

The proposed course is primarily designed for

(a) Surveying Graduates, and

(b) Registered Valuers, however

graduates in other land associated disciplines will be eligible, subject to their having a suitable academic and work experience background.

Students may also be admitted to individual subjects even though they have no real intention of completing the entire programme. The Department of Surveying will thus be able to meet specific training requirements of industry in specialist areas.

COURSE STRUCTURE (Stage 2)

Students having successfully completed stage 1 will be eligible to proceed to Stage 2.

Stage 2 will be offered in a similar manner to Stage 1 with, however, much greater emphasis on a research project. As for Stage 1 there is no additional equipment, staffing or financial implications.

NEED FOR COURSE

Employers of graduates in each of the surveying disciplines have continuously stressed the urgent need for a programme of continuing education. This need has similarly been voiced by the Department of Surveying Advisory Board and by the Commonwealth Association of Surveying and Land Economy. The proposed course is seen as a very real response to the expressed needs of industry and the professions.

Regional Centre of Excellence and Research

A centre will only become accepted as a centre of excellence if it is able to produce results. Our results will be judged upon the quality of the graduates we produce and the applied research output tailored to the region's problems. This is not achieved quickly, is hard to gain, easy to lose and depends entirely on the quality of the centre's staff, its ability to teach, its dedication, standing in the eyes of the profession and interaction with industry and government.

If a centre is seen to be alive, doing tasks and well thought of, good staff will tend to be attracted and a snow ball effect is generated.

Given academic conditions in Australia, New Zealand and Britain, staff recruitment should not be a great problem. A good staff will not be satisfied only to teach, they will want to solve problems and carry out research.

We are fortunate in P.N.G. that there is a lot of interesting applied research to be done. Some investigations under way in the Department at the moment are shallow water mapping from Landsat data, route location by Fourier series, a generalised volume compuation program, hand held multi-band photography for land use mapping, land records and small business management for the private national surveyor.

CONCLUSION

It is always easy to have pipe dreams and be seen to be an empire builder. The future as presented above, represents the collective thoughts of our Department as advised by the Advisory Board: these thoughts are subject to close investigation and advice from all interested parties. However, like any other business we must have a corporate plan, aim to achieve it and constantly review it. Given the funds that are provided for tertiary education and all the other projects that compete for scarce government funds, it is essential that our corporate plan be soundly based and that we show a high return on the investment.

SPECIFIC NOTES

(1) Previous optional topics included as core units. More time to be spent on certain topics (ratio, trig, length, area). DMR trig tables to be used. The object is to make the grade 10 students the same standard as grade 12.

(2) These units are designed so that a student has departmental contact in his preliminary year.

(3) The requirement for a first aid certificate always existed. It has now been formalized by the allocation of a subject number.

(4) In the previous course structure the following subjects relating to cadastral surveying were taken.

Surveyors		Survey Drafting	
SV 204	Property Survey	SV 262	Survey Drafting VI
SV 403	Cadastral Surveying I	SV 403	Cadastral Surveying I
SV 516	Laws & Regulations for Surveyors	SV 516	Laws & Regulations for Surveyors
SV 232	Drafting for Surveyors IV	SV 360	Survey Drafting VIII

These have been recast to obtain more effective teaching with regards to content and structure.

(5) Customary Land Tenure was not covered to sufficient depth before

(6) This subject is based on the old MA 352

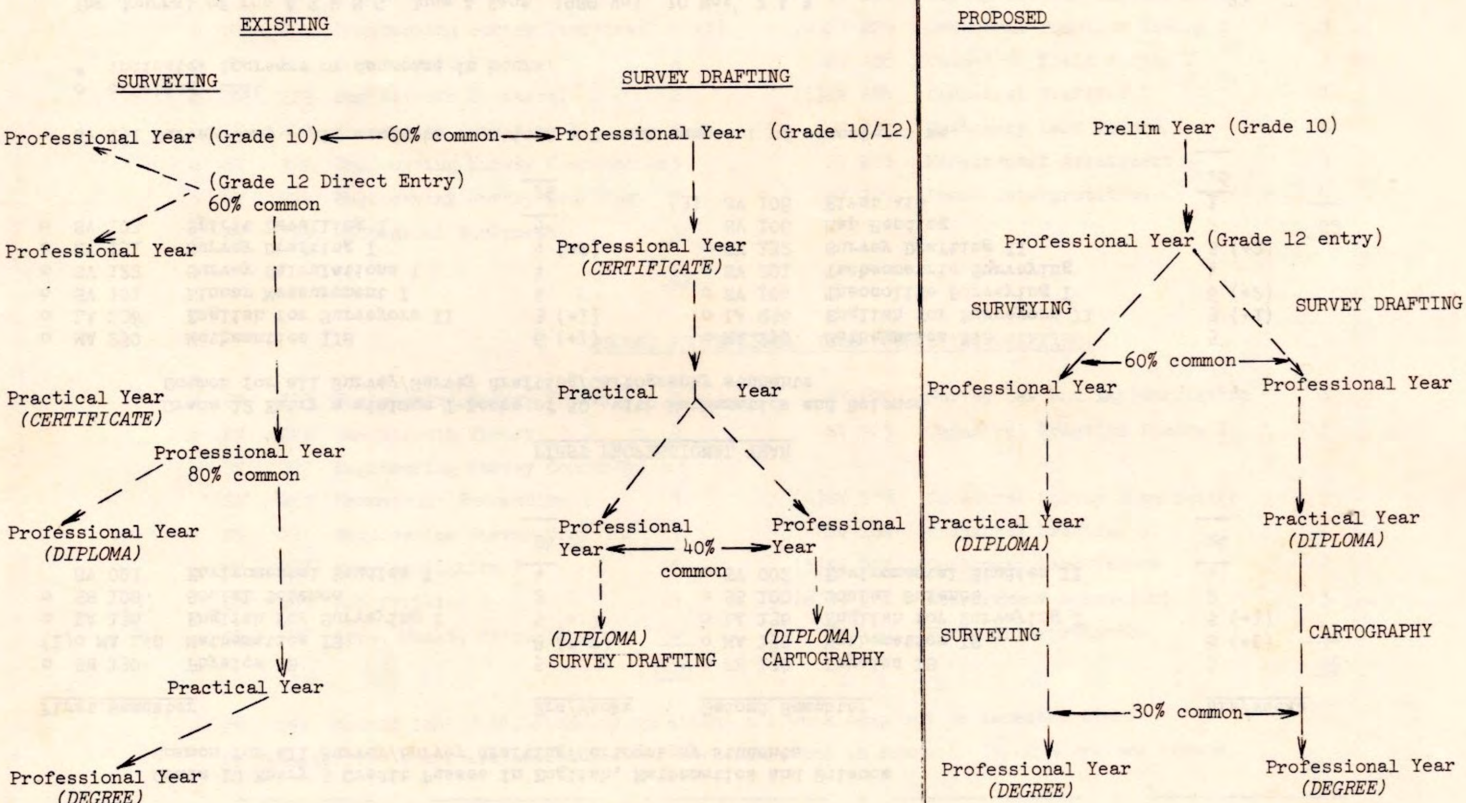
(7) The majority of cartographic and survey drafting subjects had a high number of hours. The opportunity has been taken to break the large subjects into smaller clearly defined subjects and to align the subjects with the skills the student requires at various levels.

GENERAL NOTES

Old subject numbers have been retained to avoid confusion. However some subjects titles have been changed to more accurately reflect the content of the subject i.e., SV 401 Surveying VII is now SV 401 Control Surveys I.

FIGURE 1

COURSE STRUCTURE



COURSE STRUCTURE

FIGURE 2

PRELIMINARY YEAR

Grade 10 Entry 3 Credit Passes in English, Mathematics and Science
Common for all Survey/Survey drafting/Cartography students

First Semester		Hrs/Weeks	Second Semester		Hrs/Weeks
o PH 130	Physics IS	5	o PH 130	Physics IS	5
(1)o MA 150	Mathematics IS	8 (*+2)	o MA 150	Mathematics IS	8 (+2)
o LA 136	English for Surveying I	5 (+1)	o LA 136	English for Surveying I	5 (+1)
o SS 100	Social Science	2	o SS 100	Social Science	2
. SV 001	Enviromental Studies I	4	o SV 002	Enviromental Studies II	4
		24			24

FIRST PROFESSIONAL YEAR

Grade 12 Entry a minimum T-Score of 50, with Mathematics and Science
Common for all Survey/Survey drafting/Cartography students

o MA 250	Mathematics IIS	6 (+1)	o MA 250	Mathematics IIS	5
o LA 236	English for Surveyors II	3 (+1)	o LA 236	English for Surveyors II	3 (+1)
o SV 101	Linear Measurement I	4	o SV 104	Theodolite Surveying I	6 (+2)
o SV 122	Survey Calculations I	4	o SV 201	Tacheometric Surveying	4
o SV 131	Survey Drafting I	4 (+2)	o SV 132	Survey Drafting II	5 (+2)
o SV 103	Spirit Levelling I	5	SV 106	Map Reading	2
		26	(3) SV 108	First Aid	1
					26

SV 151 Survey Camp - All students to attend a 2-week camp out of semester time.

o existing unit
* indicates increase or decrease in hours.

SECOND PROFESSIONAL YEAR (SURVEYING)

o SV	203	Engineering Survey Theory	3		SV 224	Survey Law and Implementation	3
o SV	205	Engineering Survey Practical	4(+1)	(4)	SV 225	Cadastral Practise Theory I	3
o SV	221	Sun Azimuth Theory	2		SV 226	Cadastral Field Survey I	3
o SV	223	Sun Azimuth Practical	2	(5)	SV 284	Cadastral Drafting I	7
o SV	202	Theodolite Surveying II	5		SS 201	Customary Land Tenure	2
o SV	222	Engineering Survey Computation	5		SV 228	Measurement Assessment	3
o SV	231	Engineering Survey Drafting	3		SV 229	Photo Interpretation	4
o SV	292	Mechanical Equipment	1				25
			25				

SECOND PROFESSIONAL YEAR (SURVEYING DRAFTING)

o SV	203	Engineering Survey Theory	3		SV 224	Survey Law and Implementation	3
o SV	221	Sun Azimuth Theory	2		SV 225	Cadastral Practise Theory I	3
o SV	222	Engineering Survey Computation	5				
SV	281	Manuscript Retouching I	1	(4)	SV 282	Cadastral Survey Examination	3
o SV	231	Engineering Survey Drafting	3		SV 284	Cadastral Drafting I	7
SV	283	Map Compilation I	5	(5)	SS 201	Customary Land Tenure	2
(7) SV	285	Map Scribing I	3	(6)	SV 228	Measurement Assessment	3
SV	287	Type, Masks, Retouching	4		SV 229	Photo Interpretation	4
			26				25

SV 251 SURVEY CAMP - All students to attend a 2 week camp out of semester time.

In Semester I, 8 hours are common between both years and in Semester II, 22 hours are common.

SV 300 INDUSTRIAL EXPERIENCE

THIRD PROFESSIONAL YEAR (SURVEYING)

o	MA	351	Mathematics IIIs	4	o	SV	421	Calculator Programming	4
o	AR	360	Urban Planning	3	o	AR	360	Urban Planning	3
o	LA	436	English for Surveying III	2	o	LA	436	English for Surveying III	2
o	SV	506	Geodetic Computations I	4	o	SV	508	Geodetic Computations II	4
o	SV	401	Control Surveys I	4	o	SV	402	Control Surveys II	4
o	SV	404	Cadastral Project	4	o	SV	521	Adjustment Computations I	3
o	SV	501	Photogrammetry I	4	o	SV	346	Valuation for Surveyors	4
						SV	322	Flight Planning	2
				25					25

THIRD PROFESSIONAL YEAR (CARTOGRAPHY)

o	AR	360	Urban Planning	3	o	SV	421	Calculator Programming	4
o	LA	436	English for Surveying III	2	o	AR	360	Urban Planning	3
o	SV	506	Geodetic Computations I	4	o	LA	436	English for Surveying III	2
o	SV	381	Carto Reproduction I	3	o	SV	508	Geodetic Computations II	4
	SV	383	Carto Design & Layout	3		SV	382	Cartographic Reproduction II	5
	SV	385	Derived Mapping I	4		SV	384	Map Editing I	3
o	SV	387	Production Control I	2		SV	388	Production Control II	2
o	SV	501	Photogrammetry I	4		SV	322	Flight Planning	2
				25					25

SV 351 CAMP - All students to attend a 2 week camp out of semester time.

In semester I, 11 hours are common between both years and in Semester II, 16 hours are common.

Figure 3

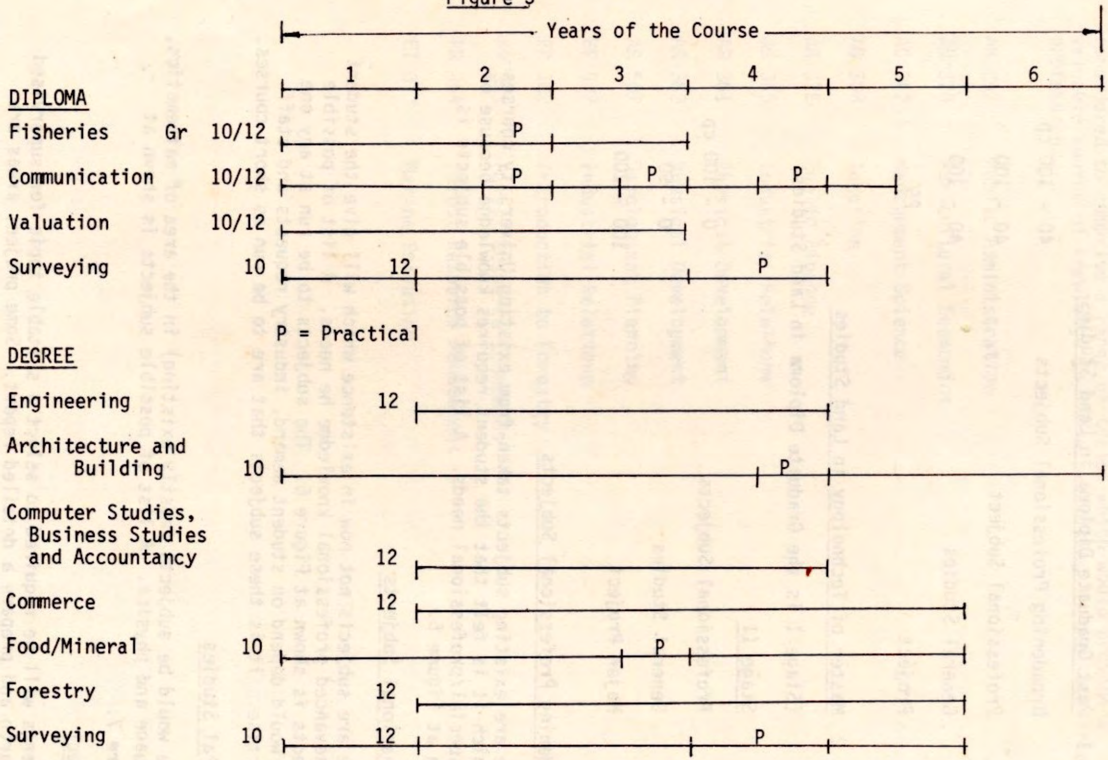

Years of the Course
1
2
3
4
5
6
DIPLOMA
Fisheries Gr 10/12
Communication 10/12
Valuation 10/12
Surveying 10 12
P
P = Practical
DEGREE
Engineering 12
Architecture and Building 10
Computer Studies, Business Studies and Accountancy 12
Commerce 12
Food/Mineral 10
Forestry 12
Surveying 10 12

FIGURE 4

COURSE STRUCTURE

Stage 1	Post Graduate Diploma in Land Studies	
	Broadening Professional Subjects	40 - 100 cp
	Professional Subject	40 - 100
	General Studies	40 - 100
	Project	25
Stage 2	Master of Technology in Land Studies	
	(Stage I is the Graduate Diploma in Land Studies)	
	Stage II	
	Professional Subjects	0 - 100 cp
	General Studies	0 - 50
	Major Project	100 - 200

Broadening Professional Subjects

These are existing subjects taken from existing University courses in which it is felt that the student requires knowledge because of his special/professional needs. A list of possible subjects is shown at Figure 5.

Professional Subjects

These are subjects not now in existence which will give the student the advanced professional knowledge he needs. A list of possible subjects is shown at Figure 6. The subjects to be run at any one time would depend on student demand, industry requests and staff expertise. It is these subjects that are to be run as short courses.

General Studies

These would be subjects (mostly existing) in the area of mathematics, language and physics. A list of possible subjects is shown at Figure 7.

Project

Students will be required to select a suitable topic for supervised research and prepare a detailed report. Some project areas are indicated at Appendix IV.

FIGURE 5

BROADENING PROFESSIONAL SUBJECTS

The list of possible electives given below is not exhaustive, but is considered to comprise a range of topics which would provide a valuable source of knowledge to those practising in the land oriented professions.

AB 257	Public Administration
AB 328	Agricultural Economics
AB 347	Management Science
AB 308	Taxation
AB 325	Public Finance
AB 355	Industrial Relations
AR 361	Physical Development
AR 362	Physical Development
AR 507	Development Planning
BE 577	Industrial Relations
FR 102	Introduction to Forestry
FR 362	Forest Resource Economics
FR 464	Forest Resource Management
FT 317	Marine Pollution

FIGURE 6

PROFESSIONAL SUBJECTS

The list of possible electives given below is not exhaustive and the offering of any subject will depend on demand and on the availability of staff having the required specialist expertise.

It is intended that these subjects will be offered as short intensive courses.

SV 503	Astronomy I
SV 504	Astronomy II
SV 502	Photogrammetry II
	Aero-triangulation
	Survey Adjustments
	Remote Sensing
	Hydrographic Surveying
	Computer Programming
	Thematic Mapping
	Land Appraisal
	Land Use Control
	Land Tenure and Land Reform
	Compensation for Compulsory Acquisition
	Geological Mapping
	Environmental Impact Assessment
	Advanced Map Editing

Formal approval of a specific subject outline will be sought from Courses Committee prior to the offering of any short course.

Figure 7

GENERAL STUDIES

The list of possible electives given below is not exhaustive and may be added to from time to time depending on the availability of courses being conducted.

LA 001	Introduction to Pidgin
LA 011	Intermediate Pidgin
LA 002	Introduction to Hiri Motu
EE 430	Oral Communication
AB 350	Persuasive Communication
MA 337	Introduction to Statistics
MA 611	Advanced Statistics
MA 617	Mathematical Programming
CE 401	Computing (Intro. to BASIC)
PH 530	Optics and Electronics for Surveyors

CHAIN STANDARDISATION

BY: B.J. MENNIS FAS(PNG) MIS(AUST)

In the process of examining several cadets at their final practical examination it became obvious that chain standardisation is not fully understood. The purpose of this article is to try to present a method of standardisation.

While there are several different methods of determining errors in the chain, and allowing for those errors, the method mainly used in the Department of Lands is a straight forward comparison, resulting in the determination of a temperature at which the chain is exactly 100.000 metres. This method, which uses the form shown in the Survey Directions, is the one that will be described.

FIELD:

1. The first requirement is to locate a flat, reasonably level piece of ground 100 metres long, that will be in COMPLETE shade at the time of comparison. If there are any patches of sunlight the temperature of the chains will not be constant and erroneous readings will result.

2. Place a dumpy in the ground at the 000 point and mark the top with a pencil cross. One arm of the cross should run along the line the chain is to be run out, the other at right angles.

3. Run the standard chain out, with the 000 end of the chain being left at the 000 dumpy. Lay the chain flat on the ground and use normal methods to make it as straight as possible.

4. With a chainman holding the 000 mark on the 000 dumpy, the surveyor pulls up the nominated tension at the 20 mark, and places a dumpy. Line is not very important and it is not necessary to align the dumpies with a theodolite.

5. Lay the thermometer on the ground.

6. Pull the nominated tension again, and mark the top of the dumpy, being careful with parallax. The chainman at 000 should be carefully instructed on how to avoid parallax. With a ruler now rule a line, 15-20mm long, across the line of the chain, but <u>NOT</u> at right angles.

7. This line should be skewed such that the distance from the 000 dumpy would vary by about 2-3mm at each end.

8. Pulling the tension again, the standard is moved until the 20.000 mark is exactly over a point on the cross line. This point is marked, and a line is drawn in the direction the chain is laying.

9. It is helpful if another chainman is available to pull the tension. This will enable the surveyor to concentrate on avoiding parallax.

10. Temperature is noted, and booked. Note that it is ground temperature that is used, not air temperature.

11. Now proceed to the 40, 60, 80 and 100 points on the standard, and repeat steps 4 to 10 at each one.

12. Roll up the standard, and run out the chain to be tested, again keeping the 000 end at the 000 dumpy.

13. With the chainman holding the 000 mark on the chain on the 000 dumpy now MEASURE to the 20 dumpy. Do this just exactly as you would do a normal measurement.

14. DO NOT attempt to say your chain is so much longer or shorter than the nominal 20 metre length as I can assure you that you will only succeed in creating a lot of confusion.

15. In making the measurement, use a pencil to mark the brass number mark and use an offset tape to make the fine measurement.

16. Note the temperature.

17. Now proceed to the 40, 60, 80 and 100 dumpies and measure the distances to them from the 000 dumpy repeating steps 13 - 16 at each one.

18. Set pickets over the 000 and 100 marks and measure the 0-100 distance in full suspension. Make sure the chain is clear of the ground. This distance is entered on the bottom line.

19. Referring to the form, we would now have columns 3, 7 and 8 completed.

CALCULATION:

20. The first calculation that can be done is to subtract the distances in column 7 for 100 from the distance for 100 in full suspension. This gives the sag over 100. For a 1/16" chain at 7kg it is usually around 0.035.

21. From the Standardisation Certificate, obtain the figures for column 2 and fill in.

22. Columns 4, 5 and 6 are worked out in the normal manner for temperature corrections.

23. Column 6 figures are the true distances from the 000 dumpy to the dumpies as laid in by the standard.

24. Now subtract the figures in column 7 from those in column 6. The results are put into column 9. Be careful to watch the sign, but it is most unlikely to come up negative, unless there is something wrong with the chain.

25. Convert this difference into an equivalent temperature difference for the relevant distance. i.e. .004 for 40 metres is the temperature correction that would result from a temperature difference

of 8^{0} over 40 metres.

26. Enter this into column 10. Again be careful with sign.

27. Now subtract the equivalent temperature in column 10 from the observed temperature in column 8. The resultant goes into column 11 and is the temperature that the chain is standard at for that particular distance.

28. Strictly speaking, we should now use the standard temperature for all measurements at the various distances. However, a few degrees one way or another makes virtually no difference, particularly at short distances, therefore we take a figure for the standard temperature over the whole length, based on those for 80 and 100. Do not just average out all five as this will not be correct, but pick a figure which is close to those for 80 and 100. As you cannot measure temperature with the usual chainage thermometer to better than one degree nor is it necessary to do so, select your standard temperature at an even degree.

    In the example 22^{0} has been selected.

29. We now find out what errors we get by accepting that temperature.

30. Column 12 is the difference between observed and selected temperature, Column 13, the normal correction, and Column 14, the resultant calculated distance.

31. Column 14 is then compared with the true distances from Column 6, and the errors, caused by adopting one standard temperature, determined.

    In the example, all are acceptable and, as such accuracies are not attainable in any practical measurement, may be ignored.

32. If however, the errors at 80 and 100 were significant, an amendment should be made to the temperature and errors re-computed.

33. If there were odd + and - errors of some magnitude, it could indicate that there was perhaps a piece missing out of the chain.

While the foregoing seems to be a long complicated procedure, it takes far less time to do than appears at first glance and a standardisation can be quite easily completed in an hour.

STANDARD CHAIN						TESTED CHAIN								
STANDARD Nº 567						HELD BY SK NIOLOWAN				Nº 1				
LAID OUT BY SKN				ON 10/5/80		RESULT	Standard at 22 °C 7 Kg							
Nominal Length	Standard Chain Length at 20 °C 7 Kg	Temp	Temp diff.	Corr'n	True dist. of Base (2 + 5)	Base Measures	Temp.	Diff. (6−7)	Equiv. Temp diff.	Chain Corr At	Assume Chain Standard for full length at °C: Temp. diff.	Corr'n.	Result	Error
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	19·999	31	11	003	20·002	19·999	31	003	12	19	9	002	20·001	−001
40	40·000	31	11	005	40·005	40·001	31	004	8	23	9	004	40·005	—
50														
60	59·999	31	11	008	60·007	60·000	31	007	10	21	9	007	60·007	—
80	80·001	31	11	010	80·011	80·004	31	007	8	23	9	008	80·012	+001
100	99·998	31	11	013	100·011	99·999	31	012	10	21	9	011	100·010	−001
100	In full Suspension					100·035	Difference = Sag for 100 = 0·036							

2. Obtained from Standardisation Certificate.
3. Temp. at time standard laid out
6. True dist. of base after temp. corr.
7. Measurement of base by tape under test
8. Temperature at time of test
9. Difference between columns 6 and 7
10. Temp. difference corresponding to 9
11. Tape would be correct at temp. of 8-10
12. Temp. difference, 8-assumed std.
13. Correction that results from 12
14. The resultant distance using a mean temp.
15. The error that results from assuming a mean temperature for the full length.

°C	20	40	50	60	80	100
2		001	001	001	002	002
4	001	002	002	003	004	005
6	001	003	003	004	006	007
8	002	004	005	006	007	009
10	002	005	006	007	009	012
12	003	006	007	008	011	014
14	003	006	008	010	013	016
16	004	007	009	011	015	019
18	004	008	010	013	017	021
20	005	009	012	014	019	023

TO STANDARDIZE A CHAIN

1. Lay out standard in a place that has COMPLETE shade. Patches of sunlight will cause your result to be in error. A very heavily overcast day is ideal. The ground should be regular and reasonably level.

2. Using the tension nominated in the standardisation certificate, lay in DUMPIES at the distances required, with the chain flat along the ground.

3. Note the temperature at each distance and enter it.

4. Using your chain, now MEASURE to each dumpy from the start in the normal manner, flat along the ground. DO NOT ATTEMPT to say your chain is so much shorter or longer than the marks, as this only causes confusion.

5. Note the temperature at each distance and enter it.

6. Then follow the form above to determine the standard temperature.

7. In computing the standard temperature, the temperature in column 11 for 80 and 100 must be given precedence, and the final result should be no more than about 1 degree from these.

8. If the result exceeds 25°C there is a strong possibility a piece is missing out of your chain. Over 30°C the result is definitely unacceptable.

SURVEY DIRECTIONS 1980.

The Surveyor General advises that the new edition of the Survey Directions is expected off the press in mid-June, and if these expectations are realized, will become effective on 1st August 1980.

Copies will be sent automatically to Registered Surveyors who are known to be resident in Papua New Guinea. Copies will be sent to non-resident Registered Surveyors on request.

They will be in a loose leaf format, and at some stage in the future, will have various other Instructions, etc etc added in the same format.

The main changes in the new Directions are the changes brought about by the adoption of a UTM 6° Zone as the basis for Survey Integration. Another result of Integration is the production of a new plan form, to be used for surveys commenced after the effective date of the new Directions.

Plan forms are now available from the Regional Offices. Copies of the Directions are available from the Surveyor General at a cost of K3 each.

SURVEYORS DO'S DON'TS

DO fill in your iron pin holes as soon as you finish with them, and certainly every afternoon.

DO take out your pickets as soon as you finish with them, and certainly every afternoon.

DO use your field book for direct entry of field observations at the time they are made.

DO measure level on short lines and offsets wherever possible.

DON'T bend traverses unnecessarily.

DON'T chop down ornamental hedges unless it is completely unavoidable.

COMPUTING SERVICES AT UNITECH

The Surveying Department at UNITECH has a number of computer programs running on the DEC PDP 11/34A computer. These include:

ADJUST A horizontal control adjustment program which accepts UTM coordinates, direction, angle, distance and azimuth observations in any combination and can adjust up to 25 new stations in a single pass. Output includes a detailed statistical summary, standard and relative error ellipses and a full station summary.

SIMUL8 A simulation version of the above program which is very useful for designing a horizontal control network to meet a set of specifications.

COGO A set of cadastral/engineering computation routines run by COMMANDS given by the user. Useful for subdivision design, engineering comps and cadastral p.o. comparison.

CONTRL A suite of plotter programs for plotting control or PSM networks to any scale on any projection. The system uses coordinates of the points to be plotted and will only join the stations on lines that are intervisible.

VOLUME A suite of programs for reducing STADIA, EDM or RDS observations taken on stock piles or mine pits. These programs are highly interactive and provide extensive editing input values, a plot of the data accepted and then the volume between the data surveyed and any natural surface data.

HYDR. A suite of programs which will take digitised data from an echo sounding chart together with vessel fixing data, and produce a fully anotated Hydrographic chart.

In addition the University offers consulting services to government and private survey organisations on computer system design and programming. For more details contact Geoff Bebb at the Unitech Surveying Department.

PERSONAL NOTES

If anybody said old Blaikey is based in Port Moresby with Works and Jerks they could be excused for looking doubtful. He either seems to be going to Goroka or coming from Canberra. Somebody looking for accomodation found his "donga" vacant, informed Urban Development who after checking decided Ken was a phantom employee of Works, changed the locks and installed a new tenant. Blaikey soon fixed that they say!

Betting was never one of Mick Larmer's serious pastimes. He once backed "Aba" for the World Title, lost of course but then wanted to get some of his money back with a small wager that "Aba would easily get up in 60 seconds. He lost that too. Taureka Waterhouse the Boroko bookie heard about this and moved quickly to establish a new shop directly underneath Larmer's office. The first bet they offered Mic was that the March Journal would be out on time, offering tremendous odds of 10/1. He took it they say!

John Kronenburgh gets to go on fewer "orchard" hunting trips these days. With only 18 months to go he has started doing a stocktake of what he has got. No doubt before he departs there should be a good job to investigate up at "orchard village" in the Southern Highlands.

El Presidento Steve Low won himself a stint on a non existing road in New Britain. (East or West we are not sure which but it is thought he is trying to join them up.)

Squash has really got to Lionel Paisawa; two or three times a week he is on the court when in Moresby. Along with John Naime he is in New Britain with Steve. Fly by night camp sites and heavy terrain they should come back a fit bunch.

Post and Telegraph's revenue people rub their hands with glee whenever Clive Carson and Tony Erickson get on the phone together. The word is also out that Clive is getting a Lands Department job.....er..... ..no he's not.....er.....yes he is.....er.....no he's not!

After 10 years Tony Quick has discovered there are more pleasant places than Lae! He is currently working around Goroka with a survey hand with long blond hair. Hope you are paying her the appropriate rates Tony!

Kila O.Ranu phoned in the other day but it was hard to hear him above the roar of the mosquitoes! He and Selan Pambuai are enjoying the climate at Angoram on the Sepic River.

WE understand that Dave Forster is planning a Dynasty of Forster squash players in a bid to dominate the Moresby scene. His only comment was "I'll do surveying as long as it does not interfere with my squash!"

Gairo Wai was last seen defending Barclay's camp near Kundiawa from the local rascals who left him with the clothes he was wearing and his calculator. A & L immediately airfreighted a new plumbob so that work could continue.

Allan Bale decided there's no place like home and is now established in Rabaul and working down on the Warangoi River. Zacharias Wanakari is down there too tackling the jungle. Inflation has certainly hit that area; it seems that a casual labourer has to be paid K6 per day now!

There has been no word from Joe Wolfe for some time. He was last seen heading south from Kundiawa towards the Tua River with a "gumi" under his arm. A search will shortly be organised in the Gulf Province.

Our man in Rabaul tells us that Clive Bassett is looking so prosperous these days that nobody is bothering to pay his accounts.

PRELIMINARY NOTICE

SIXTEENTH SURVEY CONGRESS

to be held at

LAE

7 - 11 September 1981

THEME: SURVEY TRAINING AND TECHNOLOGY IN THE SOUTH PACIFIC

This will be followed by a Seminar on "Small Business Management for Surveyors" to be held on 12 - 13 September 1981.

more information in next issue

SURVEYING EDUCATION CORNER

In response to the expressed and urgent needs of industry and the profession for a program of continuing education, the Department of Surveying at the P.N.G. University of Technology is contemplating to offer in 1981 short courses of - 3 weeks duration. These courses are mainly aimed at people in the National and Provincial government and private enterprise to provide them with specialized training in the various surveying disciplines.

The list of courses below are by no means comprehensive. Readers who feel that there are other courses which may be required by employers but are not included, are invited to write to the Head of Surveying Department, P.O. Box 793, Lae. The Department likewise invites comments and suggestions on the program before 31st January 1981.

1. Survey examiners' course
2. Introduction to basic programming
3. UTM Computation
4. Implementation of Survey Directions
5. Map Production Planning
6. Map Reading
7. Land Tenure Systems
8. Customary Tenure Systems in Papua New Guinea
9. Operation of Photogrammetric Plotters
10. Photo Interpretation Applications

1. SURVEY EXAMINER's COURSE LECTURER: M DAY

This course would provide the participants with a good knowledge of:

(i) the administrative and practical role of the examiner,
(ii) submission requirements for examination,
(iii) techniques in examinations of field book,
(iv) techniques in examination of plan,
(v) examination reports,
(vi) requisitions and rejection
(vii) survey certifications and freehold land, and
(viii) finalization of plans and files.

2. INTRODUCTION TO BASIC PROGRAMMING LECTURER: G BEBB

After completion of this course, the participant would be able to prepare interactive BASIC Plus programs to:

(i) compute co-ordinates from bearing and distance,
(ii) calculate the bearing and distance between sets of co-ordinates,
(iii) perform a traverse closure,
(iv) adjust a traverse by BOWDITCH,
(v) compute areas of a traverse by co-ordinates,
(vi) compute intersections and resections, and
(vii) solve simultaneous equations using matrix notation.

3. UTM COMPUTATIONS LECTURER: G BEBB

The topics to be covered by this course are:

(i) introduction to projections,
(ii) the Universal Traverse Mercator (UTM) projections and Australian Map Grid (AMG),
(iii) convergence calculation
(iv) given easting and northing of A, grid or plane bearing and projection or spheroidal distance to B, calculate easting and northing of B and reverse grid bearing,
(v) given easting and northing of two points calculate forward and reverse bearing and distance.

4. IMPLEMENTATION OF SURVEY DIRECTIONS LECTURER: G BEBB

This course would deal on the practical application of the Survey Directions as applied to PSM traverses and connections. These would help surveyors in the field to appreciate WHY they are required to connect this survey to PSM's, WHAT the long term plan is and HOW their work fits into the overall scheme of things.

5. MAP PRODUCTION PLANNING LECTURER: PROF. K LYONS

This course would provide the participant with a good knowledge of :

(i) the mapping system and necessity for quality and production control,
(ii) production control procedure for plotting machines, compilation, scribing, typing editing and despatch for printing,
(iii) detailed duties of supervisors,
(iv) flow diagrams for production control - their construction and how to read them,
(v) planning and managing tasks by use of check lists and flow diagrams,
(vi) security control,
(vii) managing the worker.

6. MAP READING LECTURER: M DAY/M BRAUND

The following topics are covered by this course:

(i) UTM projection,
(ii) map coordinates,
(iii) recognition of land forms,
(iv) intervisibility,
(v) gradient.

7. LAND TENURE SYSTEMS LECTURER: DR A CHAPPELLE

After completing this course, the participant would have a basic understanding of the ways man has devised to regulate his behaviour towards land and moderate his territoriality. The topics to be treated are:

(i) the concept of territoriality,
(ii) the importance of land rights to man's survival,
(iii) types of rights,
(iv) methods of distributing those rights,
(v) the maintenance of rights,
(vi) essential differences between customary and written law tenure systems, descriptions, limitations and advantages,
(vii) role of the surveyor.

8. CUSTOMARY TENURE SYSTEMS IN PAPUA NEW GUINEA LECTURER: DR A CHAPPELLE

This course would provide a basic understanding of the systems under which more than 90% of land in Papua New Guinea is held. The topics covered are:

(i) descriptions of selected Papua New Guinea customary tenure systems,
(ii) attitudes towards customary land during the colonial period,
(iii) attempts at tenure conversions,
(iv) the recommendations of the 1973 Commission of Inquiry with regard to customary land,
(v) current debates relating to customary land, particularly the issue of registration,
(vi) development strategies and their implications for the customary tenure systems,
(vii) the surveyor and customary systems.

9. OPERATION OF PHOTOGRAMMETRIC PLOTTERS LECTURER: S BALASUBRAMANIAM

The course would suit persons with some Surveying and Survey drafting experience, who are keen to take up a profession in photogrammetric course. It would be an introductory training course on the use of photogrammetric plotters, covering the aspects of orientation of models, and plotting of maps. Training would be on WILD B8S, B9 Aviographs and Kern PG.2. Photogrammetric theory would be kept down to the barest minimum.

10. PHOTO INTERPRETATION APPLICATIONS LECTURER: S BALASUBRAMANIAM

This introductory course on photogrammetry and photo-interpretation is likely to be very useful to various users of aerial photographs and other remote-sensing data. Interpretation areas to be covered include forestry, agriculture, geology, land-valuation, and bathymetric mapping. The first part of the course would be common to all participants, while the latter part divided into sections to cater for different fields of applications.

In the March 1975 issue of this journal, this column predicted the day when women of Papua New Guinea would step forward to join a profession which was once considered for men only. The first to come forward is Miss Meralyn Tito who hails from Kavieng. Early this year, she enrolled in the Certificate of Surveying course and from all indications she is performing extremely well.

For more than two years, the Surveying Department was without a Professor, but this year Dr Ken Lyons was appointed Professor and Head of Department.

His professional experience can be traced back from 1964, when he joined with the Royal Australian Survey Corps, carrying out 1st, 2nd, 3rd and 4th order controls and topographic mapping at scales 1:25,000 to 1:250,000, all over Australia. He spent one year in Vietnam doing engineering surveys, map revision, control and producing maps in support of the Army. He left in 1971 to join a private enterprise engaged in photogrammetric mapping for a mining development project. It was in 1972 when he started his academic career with the Western Australian Institute of Technology where he taught subjects in survey degree, remote sensing and planning at post graduate Diploma and Masters level. He is active in the Mapping and Charting committees of the Institution of Surveyors, Australia. His special interests are in Mapping, Remote Sensing, Planning and Economics and Charting.

Three new staff members also arrived at about the same time as Dr Lyons, bringing with them a wealth of experience and expertise:

(1) Geoff Bebb, Senior Lecturer, started his professional career in 1963 with the Australian Government. He was engaged in cadastral surveys, engineering surveys for large engineering works, control surveys, alignment surveys, network adjustment, roads and railways, astro-fixes and La Place observations.

He then worked for IBM Australia Ltd as systems engineer in 1968-1970. Early in 1971, he went into private practice and had accepted contracts in topographic/engineering mapping by aerial/terrestrial photogrammetry, subdivisions, engineering construction, and computer simulations. He started his academic career in 1975 when he taught Astronomy, Computer Programming and Survey computations to final year students in Surveying at W.A.I.T. In 1976-1979 he joined Perth Technical College to teach computer programming. He is a member of the Institution of Surveyors, Australia. His main interests are control surveys, mapping, adjustment, simulation and automated cartography.

(2) Graeme Wright, Lecturer, started as a cadet with a private survey firm while undertaking studies in Surveying at W.A.I.T. He was involved in cadastral, engineering and hydrographic surveys. In 1977-1979, he was employed by Murdoch University (Western Australia) to teach Surveying subjects in the

Department of Environmental Science. He is an Associate Member of the Institution of Surveyors (Australia) and his special interest lies mainly in the application of remote sensing to environmental problems.

(3) Derek Gibbs, Senior Technical Officer, started his surveying career in 1964 having worked for government departments in South and Western Australia, carrying out 2nd and 3rd order control, geophysical surveys and road surveys. In 1967-1969 he worked with American companies in Western Australia, who were engaged in iron-ore development. He was in the United Kingdom in 1970 and 1971 carrying out surveys for motorways, bypass and bridge construction. He was articled pupil and instrument hand at the Highways Department, South Australia, in 1972-1974. In 1975, he worked with a private surveyor involved in cadastral surveys. He went on to complete his Bachelor of Applied Science (Surveying) at W.A.I.T. in 1976-1978, followed by a year's full time study to obtain a graduate diploma. His experience includes part-time tutoring for one year at W.A.I.T. His special interests are computer and calculator programming and practical surveying.

RELEVANT F A C T S FOR THOSE

CHOOSING SHORT RANGE E.D.M. INSTRUMENTS

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K & E, America's leading surveying equipment house, established in 1867, manufactures the world's most extensive and modern range of e.d.m. instruments. Seven models, all with direct digital readout, cover various ranges up to 60km.

MODEL	TO 1 PRISM	TO 3 PRISMS	VOLTS	WEIGHT	WEIGHT OF BATTERY	MEASUREMENTS FROM BATTERY	AUDIO	ACCURACY
AUTORANGER 1	1000M	2000M	12	2.4Kg	0.9Kg	1000	YES	± (5+6ppm)
AUTORANGER S	2000M	4000M	12	2.4Kg	0.9Kg	1000	YES	± (5+6ppm)
AUTORANGE 11	2000M	4000M	12	3.1Kg which includes built-in battery.		500	YES	± (5+6ppm)

Important Features of K & E Autorangers.

All K & E Autorangers are instruments for the 1980s. Naturally, each model can either be mounted on a theodolite telescope, theodolite standard or into a tribrach. When mounted on the theodolite standards, the theodolite telescope can be plunged and no wear occurs to the trunnion axis. They are all 12 Volt systems. BUT, the most important feature is the fact that all AUTORANGERS can be attached to the K & E VECTRON electronic theodolite with 1200 line, alpha-numeric solid state field recorder and pre-programmed computer weighing 1.2Kg. The X,Y,Z co-ordinates of the instrument station are fed into the VECTRON and, once the measurement is completed, the X,Y,Z co-ordinates of the object station are displayed and recorded. The field recorder is fed into the office computer for automatic processing and plotting.

COMPARISION OF AUTORANGER WITH OTHER MAKES.

From AGA

MODEL	TO 1 PRISM	TO 3 PRISMS	VOLTS	WEIGHT	WEIGHT OF BATTERY	MEASUREMENTS FROM BATTERY	AUDIO	ACCURACY
AGA Model 10	700	1400	6	2.5Kg	1.8Kg or 3.6Kg	250 & 500	YES	± (5+10ppm)
AGA Model 12A	1000	2000	6	2.5Kg	1.8Kg or 3.6Kg	250 & 500	YES	± (5+5ppm)

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Eldi 3	*400(I) or 700 (II)	700(I) or 1000 (II)	5	3.8Kg includes battery	1000	NO	*Eldi accuracy in ranges:- I:±(5-10MM);
Eldi 2	700(I) or 1000 (II)	1000(I) or 1500(II)	5	4.2Kg includes Battery	1000	NO	II:±(10-20MM)

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