

THE AUSTRALIAN METROLOGIST

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GPS Surveying: A Traceable Chain with a Missing Link?

Responses on "Uncertainty"

Metrology and Evidential Breath Analysis in Australia



Christmas Greetings

The Australian Metrologist

is published four times per year by the Metrology Society of Australia Inc., an Association representing the interests of metrologists of all disciplines throughout Australia.

Normal dates of publication are mid-month in February, May, August and November.

All editorial copy should be sent to the editor by the middle of the month prior to publication.

Further information regarding the Metrology Society of Australia may be found on page 20.

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From the Editor

As our President said in his remarks to the AGM - "Another year gone by leaving many of us wondering where all that time disappeared." I conclude that metrologists are busy people when I see that so much of the MSA work is shouldered by so few. As editor I almost despair when the deadline for each issue arrives because I know that I will have received so little from which to construct it.

You will find two more reprints from the last conference in this issue - there were some interesting articles submitted, but nowhere near sufficient to fill out the issue. Hopefully you will find something here to interest you.

I take this opportunity to wish all members and their families a safe and happy Christmas and New Year break.

I want to look to a positive year ahead - one where I am printing the type of material that most members want. Write to me - I'd love to hear your thoughts on TAM - what's right with it, and what's wrong with it.

Over to you.

- Maurie Hooper

2000/01 Advertising Rates for The Australian Metrologist

Space A4 page	One issue issue	Two issues issues	Three/Four issues
Full page	\$400	\$750	\$1050
1/2 page	\$225	\$425	\$600
1/3 page	\$150	\$130	\$400
1/4 page	\$115	\$215	\$290
1/8 page	\$ 60	\$110	\$150

Closing date for copy to be received for TAM is the 15th of the month preceding publication.

Contact the TAM editor for further details.

Camera ready artwork is to be supplied. Size and specifications are available from the editor. If extra typesetting etc is required an extra charge will apply. MSA members receive a 10% discount when they place advertisements in TAM.

President's Column October 2000

By the time you read this, the AGM will have passed. This is a relatively low-key affair in the between-conference years, with only the committee positions and the vice-president up for re-election unless other of the executive resign. I hope that those of you within reach of the AGM attended and voiced your opinion on the operations of the MSA in the feedback session. A full report of the year's activities will have been presented to the AGM and appear in the next issue of TAM. Please give a thought to the elections in a year's time, when the committee is likely to require wholesale changes as those who have worked on your behalf begin to flag, and the MSA would benefit by a move away from Sydney. The usual democratic process will probably apply at that time, ie arm-twisting and cajoling to fill the numbers. How strange this must seem to those in eastern Europe experiencing democracy for the first time.

MSA have a number of members retired from the workforce, many of whom continue to work in their old fields of interest. One such is Philip Ciddor (one

time "Mr. Length" in Australia), who has developed an understanding of air refractive index values now applied by surveyors around the world. The MSA recently nominated Philip for a "Senior Australian of the Year Award" based on his continuing achievements.

Finally, let me comment on the continuing push for efficiency, particularly in the Government-funded laboratories which are currently squeezed for funds and subjected to various efficiency measures, usually estimated at the start of the push and the money withdrawn rather than wait to see what the effect is for real (maybe the finance branch believes our treasurer's signature, "You cannot manage what you cannot measure"). A common theme in industry and commerce is to work to the 80-20 rule. Get 80% right and the rest is not important. Not so for metrologists - an appropriate rule here would be 95-5, given the universal push to 95% confidence limits. Not as tough as the old 99-1 work ethic which applied in measurement some years ago, but still difficult to achieve in hard times.

- Jim Gardner

MSA Nomination for Senior Australian of the Year, 2000

In August the MSA nominated Mr Philip Ciddor for this award, which is bestowed annually by the National Australia Day Council. The MSA Committee felt that Philip well met the specified award criteria. *"Nominations for the Award should be Australian citizens aged 60 years or over. He or she should be a person of exceptional exceptional achievement, who has made a significant contribution to the welfare of the nation, present a significant positive image of ageing and be an outstanding role model to the wider Australian community."*

The MSA wishes to nominate one of its members each year for this award. Members are invited to propose nominations for the Year 2001 awards by notifying the MSA Secretary.

The following is the nomination for Philip as submitted by the MSA:

Mr Philip Ciddor worked as a scientist at the CSIRO National Measurement Laboratory and its predecessor organisations for a period of some 38 years. During this time he built up an outstanding international reputation in the field of measurements using optical techniques. He retired from his official position in the Laboratory in May, 1994 at the age of 64.

This retirement, however, marked the end of only his official work. In the six years since his retirement Philip

has continued his work in CSIRO in an honorary capacity (i.e no-one pays him!) and has continued to make important contributions to his cherished field in a number of different areas.

1. Modern surveying techniques for distance rely on measuring the time to return a pulse of light; this in turn requires detailed knowledge of the properties of the components of air.

P.E. Ciddor has been making a detailed study of the literature on measurements of the refractive index of air, in collaboration with a staff member of the US National Oceanic and Atmospheric Administration. They have made recommendations on the proper equations to use in precise geodetic measurements, particularly those for surveying using satellites and distance measurement using lasers. The International Association of Geodesy recently adopted these proposals, replacing the equation used for the last 40 years. The new equations allow calculations to astonishing accuracies - better than 1mm in 1 km; consequently Philip is constantly consulted on work by geodetic engineers from around the world.

2. Philip has continued to publish papers on aspects of optical science that are of a complex nature which those in the increasingly commercial world do not have time to consider. He is particularly concerned with the polarization properties of light, using techniques based on the little-understood "geometric phase". The results are particularly important for new developments in optical astronomy.

3. Philip plays a major role in assessing the work of others by acting as a referee of papers in optical science for a number of international journals.

Philip is an outstanding role model for younger scientists in his total commitment to his art. He is always available to counsel his less experienced colleagues and does so with considerable sensitivity, good humour

and wisdom. He is particularly gifted in the art of expressing with crystal clarity very complex ideas and is often sought for advice in this regard. In summary, Philip Ciddor's work in his post-retirement years has shown all of us how an acutely active mind and accumulated experience can bring a special perspective to the solution of practical problems.

From the NSC

OUR NEW WEBSITE

www.nsc.gov.au

Over the past few weeks the Commission has been working with a web designer to redevelop our web site. The new site will focus on providing information about the work carried out by the Commission in a user friendly and customer focused manner. It will incorporate best practice and the standards developed through the Government on line policy for all Commonwealth government agencies web sites. The Prime Minister has made the commitment that all appropriate services will be available online by 2001. The new site will work better with search engines, be accessible to people with disabilities or who have older technologies and have all forms available on line. Most documents will be available as downloadable PDF and MS Word files.

An action plan has been developed to assess which of the Commission's services are appropriate. The action plan is available on our web site and all comments are invited. The following time line outlines the new services that the Commission plans to include as on line services by early next year.

Services appropriate to provide online by 2001 and the proposed time-frames for implementation are:

1. Provide Metric Conversion - December 2000
2. Publish Verification and re-verification procedures and Commission Standards - February 2001
3. Publish latest Pattern Approval Certificates - February 2001
4. Publish Measurement in Sport Students Booklet - December 2000
5. Provide all Brochures and Forms - December 1, 2000
6. Post meeting dates and agendas for all consultative meetings. - December 1, 2000

At this stage the Commission will not be providing an

e-commerce facility, as most of our publications will be available free from the web site. You can still purchase documents if you would prefer to receive a hard copy from the Commission.

Certificates of Approval will still be available on CD-ROM as a subscription. Each month new certificates will be posted to the web site in pdf format only. This will eliminate the need to email new certificates to subscribers. Subscribers will then be able to go to the web site and download only those certificates that they require. The web site will only contain certificates not included in the CD-ROM.

The new web site has six main sections as follows:

About Us - Tells you about the Commission in general, provides annual reports, strategic outline, online action plan, glossary of terms, working at the Commission and links to related organisations.

National Measurement System - explains this system, legal metrology, authorities, trade measurement, OIML and what training the Commission provides.

Policy Development - explains the committee structure the Commission uses as part of the consultative process of policy development.

Industry Services - outlines the services provided by our laboratory, the certificates issued by the Commission and how to obtain a list of approvals.

Information Services - provides access to information leaflets, publications produced by the Commission and frequently asked questions. This section will also contain a What's New section which will point to new items on the web page.

Site Map - gives an overview of how the site is organised.

The new site will be available by October 31, 2000. You should be able to get the information you require in three clicks or less. Try it and send us your comments so we can improve our service to you.

FIRST CALL FOR PAPERS - MSA 2001

SIMPLY METROLOGY

A Vital Cog in the Wheels of Industry

October 2nd - 4th

Grand Mercure Hotel, Broadbeach, QLD

The Metrology Society of Australia will stage its 4th Biennial Conference on Queensland's Gold Coast, at one of Australia's premier holiday resorts. We are taking advantage of the fact that this will be during school holidays for all states, save Victoria, and a University common week. October 1st, the preceeding Monday, is also a public holiday in three states.

So, we are hoping to achieve two things : putting the MSA on a more solid membership base in Queensland while allowing all of our members the opportunity of combining a family holiday with attendance at our major event.

Registration: \$A200 for members and \$A300 for non-members. Non-members can become members and take advantage of the lower price. The registration fee includes the cost of morning and afternoon teas, the conference dinner and a welcoming cocktail function on the first evening. It does not include the cost of lunch or accommodation - see below.

The Theme: It is in the title - metrology is essential to industry and both local and export markets.

Program Format: The conference will run similarly to previous years with plenary lectures commencing the first two days' sessions, with two streams of oral presentations over three sessions. There will be workshops on each day and posters will be displayed in the two lecture rooms. The actual details of the workshops and conference topics will be resolved early in 2001 and advertised accordingly. The conference content will have a similar range of topics to that of previous conferences.

Submission Guidelines: Authors are required to submit abstracts before **March 1st**, either electronically or in hard copy and should indicate their preferred form of presentation: oral, poster or workshop. Successful applicants will be advised of the required camera-ready manuscript format.

The Venue : The Grand Mercure at Broadbeach is first class with 298 rooms all with balconies and views. It has direct access to the beach via overhead walkway, monorail link to Jupiters Casino, undercover parking, health and fitness centre, spas etc. which are avail-

able to guests, two restaurants and bars but with 50 cafes, bars and restaurants within 2 minutes walk and the 110 store Oasis shopping centre adjoining.

Accommodation: We have reserved 50 rooms at the Grand Mercure at \$135 per night (single/double/twin). This means you can share with another delegate for \$67.50 pp and still have access to the swimming pools, tennis courts, parking and fitness facilities. This cost does not include breakfast but there are restaurants, both inside the hotel and in the ground floor centre, where there is also a supermarket.

For those seeking something cheaper, we will provide details for several close-by (10 minute walk) serviced or self-servicing apartments, but we recommend that you start your booking early because it will be the holiday period.

Additional: We have deliberately included the cost of the conference dinner in the registration to ensure that delegates do get to mix. We are confident that the dinner will be different and a lot of fun. Additional tickets will be available for guests. The availability of a wide variety of lunch venues, including the Grand Mercure restaurants, will give delegates the option of formal or informal networking, or even for athletic activities.

We are also hoping to organise a golf day on the Friday. The Gold Coast offers several top quality courses and for families there are plenty of local attractions such as Sea World and Lamington National Park.

We hope to have display booths from several instrument and scientific companies set up in the morning and afternoon tea area in the hotel foyer.

Ansett will be the preferred carrier and they are offering delegates cheap fares and accommodation and entertainment packages. Details will be made available early in 2001.

Enquiries: If you need any further information, please contact the Conference Coordinator, Tony Collings at 02 9413 7148 (phone), 02 9413 7200 (fax) or email tonyc@tip.csiro.au

Q&A Column

We have received two letters with questions about measurement in the Olympic Games. There must have been considerable work done on this topic for the recent games as well as in the past. If we can track down one of those involved we will see if we can get some authoritative answers. Any help in this would be appreciated.

Question 1

At the Olympics Athletics 100m, how do they time the lower places? How do they ensure that a hand going over the line first is ignored? Is there some hi-tech way of doing this, or is it just good old human observation? If so, how do they guard against human error?

Jim Miles

Question 2

I noticed that the distances during the Olympic track events were measured electronically. How does this device work - during the shotput, for example, the detection head (or is it just a mirror?) was positioned at the landing point, but any companion device was positioned off to the side of the curved perimeter. How are offsets calibrated, and how does the system measure over the range of valid angles?

In one event runners 1 to 8 were separated by only 0.6 seconds. How does the timing mechanism detect the different runners (first is easy) when a clear path over the track may be obscured by the runner in front?

Jim Gardner

Answer: The Earliest Thermometer

The general question was asked about the earliest known measuring instruments. Like many fields of measurement, thermometry evolved. It seems to have begun with toys which showed the expansion and contraction of air using bulbs with tubes attached. It was shown that if the end of the tube was immersed in water air was expelled when the bulb was warmed, and water sucked back when the bulb cooled. Galileo is attributed by many as the inventor of the first measuring instrument, a vertical glass tube with a closed, air-filled bulb at the top, and the open bottom immersed in water. This instrument would have been affected by atmospheric pressure as well as temperature. A French physician called Jean Rey seems to have been the first to make a version around 1630, using liquid expansion which would have considerably reduced the pressure effect. But reproducible and (relatively) accurate thermometry was clearly attributable to Daniel Gabriel Fahrenheit (born 1686). Thermometers virtually identical to those of Fahrenheit remained the main-

stay of thermometry until well into the 19th century.

Higher temperatures remained a problem. Around 1780 the Wedgwood the famous potter used the contraction of clay disks after exposure to a high temperature. More accurate measuring instruments did not appear until around the end of the 19th century when resistance thermometers, thermocouples and radiation thermometers were all developed in a short period.

Of course the evolution of temperatures scales is another story again, but one of my sources has an interesting side-comment. In the first half of the 20th century three scales were used in Europe, the Celsius, Fahrenheit and Reaumer scales. In Germany, the birthplace of Fahrenheit, the Reaumer scale prevailed, in France the home of Reaumer it was the Celsius scale, and in the Sweden of Celsius the Fahrenheit scale was the most used. Is there not an old saying about prophets not being recognised in their own country?

Jeffrey Tapping

Deep Thoughts from a Shallow Mind

- John Miles

I was sitting in my shed the other day contemplating the world and thinking about why it's so hard to remember how to spell MNEMONIC and if it's true that cannibals don't eat clowns because they taste funny. My thoughts typically drifted to other things, this time to modern management.

However, before I could continue my musings, I remembered that I first had to fill in my time sheet for Sunday morning thus far, namely "One hour, Shed, Contemplating the World, Code VAT 69". Failure to keep this time sheet up to date could result in a terse memorandum from She Who Must Be Obeyed, inquiring about whether I was really committed to the family's "Purpose, Vision, Values and Operating Principles". I shuddered at this, because I remembered what had happened to our cat when it received a similar memorandum. The cat was subsequently given a Myers-Briggs test and found to be of Type ISK9, indicating the need for a radical paradigm shift. The cat is now re-training as a dog.

I spent the next hour filling in my time sheet and eventually returned to thinking about modern management, specifically some of the really important management theorems and laws that have surfaced in recent years.

Management Theorems

The higher the "higher ups" are who have come to see your demo, the lower your chances are of giving a successful one.

Every task takes twice as long as you thought it would. If you double the time you think it will take it will actu-

ally take four times as long.

The first myth of management is that it exists.

Judgment comes from experience. Experience comes from poor judgment.

Build a system that even an idiot can use and only idiots will want to use it.

Dilbert is a particular favourite of mine and one of his important theorems is that

"Engineers and scientists (and metrologists) can never earn as much as business executives and sales people".

Recently I have found a startling proof for this theorem on the following web site (<http://www.uktm.external.hp.com/mikehut/humour.html>).

The proof is as follows:

Postulate 1: Knowledge is Power.

Postulate 2: Time is Money.

Proof: Everyone knows that $\text{Power} = \text{Work}/\text{Time}$ and since $\text{Knowledge} = \text{Power}$ and $\text{Time} = \text{Money}$, then $\text{Knowledge} = \text{Work}/\text{Money}$. Solving for Money gives $\text{Money} = \text{Work}/\text{Knowledge}$.

Thus, as Knowledge approaches zero, Money approaches infinity, regardless of the amount of Work done.

Therefore: The less you know, the more you make. QED.

Test Procedures

Another story from the same web site illustrates the importance of good test procedures:

In a recent issue of Meat & Poultry magazine, editors quoted from Feathers, the publication of the California Poultry Industry Federation, the following:

The US Federal Aviation Administration has a unique device for testing the strength of aeroplane cockpit windscreens. The device is a gun that launches a dead chicken at the windscreen at approximately the speed the aircraft flies. The theory is that if the windshield doesn't crack from the carcass impact, it will survive a real collision with a bird during flight.

It seems a British company were very interested in this and wanted to test the windscreen on a brand new, high speed train they were developing. They borrowed the FAA's chicken launcher, loaded the chicken and fired. The ballistic chicken shattered the windscreen, broke the driver's chair and embedded itself in the back wall of the cab. The British were stunned and asked the FAA to recheck the test to see if everything was done correctly.

The FAA reviewed the test thoroughly and had one recommendation:

First, thaw the chicken.....

Questions, Questions!

Anyway, my time allocation for contemplation is up and I need to move on to Garden Maintenance and Relations, Visiting. Out the window, I see the cat is chasing cars again, so I leave you with some really important questions, some of which have answers!

1. Which city burned in "Gone with the Wind"?
2. What wouldn't come back for Charlie Drake?
3. Who created the first pair of bifocal lenses?
4. For how long was Michael Faraday, the famous chemist and physicist, reputedly dead at his club before someone lifted the newspaper from over his face?

5. In Thomas Hardy's poem, he writes:

Had he and I but met
By some old ancient inn
We should have sat us down to wet
Right many a nipperkin!

But ranged as infantry,
And staring face to face,
I shot at him as he at me,
And killed him in his place.

How many millilitres are there in a nipperkin?

6. Would a fly without wings be called a walk?
7. If the cops arrest a mime, do they tell him he has the right to remain silent?
8. Why is it that when you transport something by car, it's called a shipment, but when you transport something by ship, it's called cargo?

- John R Miles

The answers to selected questions are:

1. Atlanta
2. His boomerang
3. Benjamin Franklin
4. 2 days
5. About 70 ml

FROM THE ANNUAL GENERAL MEETING

MSA President's Report - November 2000

Another year gone by leaving many of us wondering where all that time disappeared. So what have your committee been up to?

The last year has seen our geographic base broadened with members in SA and Qld regularly participating in meetings, via a phone conference. This has been a successful way of keeping members away from NSW, the current power base, better connected to MSA interests. Of course, TAM and the web site continue to provide the main information contact to members, thanks to the efforts of editor Maurie Hooper and webmaster Mark Thomas.

As in most similar societies this information flow is mostly outwards, much to the despair of the committee. Feedback was provided, of course, through the survey of members, with only some 8% of members providing a return. The common theme of the returns was the importance of TAM, particularly to have a technical content, and for the state committees to be active in MSA matters. The committee have borne these comments in mind during its deliberations. The other key member contact comes through the 2-yearly conferences. MSA 2001 is on track for Queensland in October, guided principally by Tony Collings, Shane Brann and Brian Phillips. We are hopeful that it will demonstrate that the states with few members can still hold a conference by concentrating on local issues - relevance, visits, venue - while as much as possible is handled by a remote crew. Communication is the important point here.

Other matters:

Membership and interaction with the International Measurement Confederation (IMEKO) continues to concern the committee. Members will soon be asked to comment on the value of MSA being the Australian representative.

Philip Ciddor was nominated for a Senior Australian of the Year award based on his continuing contributions to metrology in "retirement" - metrology has no age barriers.

Very successful (especially from the treasurer's view point) seminars were run on geometric tolerancing, in 3 states - the MSA network was vital to organise these at short notice. The Education sub-committee has moved into limbo, its job largely completed with assistance and advice helping Swinburne get a metrology course of the ground. No doubt the group will need resurrection at some time, as education in me-

trology matters has languished in the past, largely because of the field's diversity. This diversity presents a large problem to the MSA, with the temptation for members to concentrate on their own technical interests and overlook the common themes.

Where to now? The current committee and executive shall have been in place with only minor changes for 4 years by MSA 2001. It is my personal view that the MSA will remain most vibrant by changing its operations to a different base on about that 4 year cycle - in fact this is the intent written into the constitution. The reality is then that we should expect the base to return to Melbourne after MSA 2001, and I encourage the Victorian members to consider what roles they could take to continue the success of the society.

Finally, thanks to the committee for their time and efforts this last year, particularly Secretary Laurie Besley and Treasurer Marian Haire, who bear the brunt of the load.

- Jim Gardner

MSA Treasurer's Report

This financial report represents a period of 12 months from July 1, 1999 to June 30, 2000. The Balance Sheet reflects a healthy financial state showing the society has assets of \$ 58,034. The Profit and Loss for the period shows a loss of \$ 3,861.57. This is due to the fact that close to \$ 9,000 of the MSA'99 conference expenses in excess of MSA'99 income are shown within this period. The conference made an overall profit of \$ 8,769.88.

Subscription fees received remain constant even though there was an increase in fees last year. The cost of producing TAM has increased. The committee agreed to make TAM bigger by providing more articles of a technical nature. Your feedback on how successful this has been would be most appreciated. For the society to grow and mature it needs direction from its members on how best to serve their needs. If you are getting value for your money let us know this too.

MSA now has an Australian Business Number but is not GST compliant. As long as turn over is less than \$100,000 we can continue not to charge GST. This will be reviewed at the end of the next financial year. Our accounting system has been upgraded to the latest version of Quicken. This will allow for more detailed reports to be developed and allow us to cope with GST when the need arises.

I would like to thank the MSA executive committee for their support during the past year. Special thanks to our honorary auditor Bryce Thornton, who is guiding

the development of sound financial reporting systems that will stand the Society in good stead as it grows in strength.

- Marian Haire, October 24, 2000

METROLOGY SOCIETY OF AUSTRALIA

ABN 802 123 257 48

Annual Financial Report 99 - '00

Balance Sheet Comparison as of June 30, 2000

ASSETS July '99 - June '00 July '98 - June '99

ASSETS Current Assets

MSA Conference	5,776.93	0.00
MSA No.1	25,372.68	34,462.54
MSA No.2	0.00	11,519.57
Term Deposit 1	16,618.45	15,913.56
Term Deposit 2	10,266.04	0.00
TOTAL ASSETS	58,034.10	61,895.67

LIABILITIES & EQUITY

EQUITY

Opening Bal Eq'ty	35,150.46	29,366.58
Retained Earnings	26,745.21	-96.00
Net Income	-3,861.57	32,625.09
TOTAL LIABILITIES & EQUITY	58,034.10	61,895.67

MSA'99 Conference Receipts and Expenditure

Income

MSA 99 Income	
Bank interest	21.27
Registration	52,929.40
Sponsorship	19,600.00
Trade Displays	6,250.00
Total Income	78,800.67

Expenses

MSA99 Exp	
Bank Fees	1,237.23
Handouts	10,206.15
Merchandising	300.00
Publicity	15,511.21
Social Events	27,412.20
Speakers	5,362.00
Venue Hire	10,002.00
Total Expenses	70,030.79
Net Income	8,769.88

Statement of Receipts and Expenditure For year ended 30 June,

July '99 - June '00 July '98 - June '99

Income		
CMM Activities	<u>0.00</u>	<u>13,753.20</u>
Fees		
Annual	13,345.00	195.00
Debts	30.00	0.00
Nominating	1,240.00	225.00
Fees - Other	0.00	13,793.69
Total Fees	<u>14,615.00</u>	<u>14,213.69</u>
Interest	<u>1,119.72</u>	<u>41.90</u>
MSA 2001 income		
Interest	5.17	0.00
Total MSA 2001 income	<u>5.17</u>	<u>0.00</u>
MSA 99 Income		
Bank interest	18.30	2.97
Registration	35,079.40	17,850.00
Sponsorship	12,800.00	6,800.00
Trade Displays	3,750.00	2,500.00
Total MSA 99 Income	<u>51,647.70</u>	<u>27,152.97</u>
Other	<u>35.00</u>	<u>0.00</u>
TAM income		
Advertising TAM	799.00	0.00
Subscriptions TAM	60.00	0.00
Total TAM income	<u>859.00</u>	<u>0.00</u>
Total Income	<u>68,281.59</u>	<u>55,161.76</u>
Expenses		
CMM	<u>0.00</u>	<u>3,760.55</u>
MSA 2001		
Bank Fees	12.12	0.00
MSA 2001 - Other	724.70	0.00
Total MSA 2001	<u>736.82</u>	<u>0.00</u>
MSA99 Exp		
Bank Fees	1,184.73	52.50
Handouts	10,206.15	0.00
Merchandising	300.00	0.00
Publicity	7,420.31	8,090.90
Social Events	26,412.20	1,000.00
Speakers	3,112.00	2,250.00
Venue Hire	9,502.00	500.00
Total MSA99	<u>58,137.39</u>	<u>11,893.40</u>
Society		
Bank Fees	255.64	150.30
Disbursements	178.33	578.05
Meetings	1,149.38	0.00
Office	1,087.60	1,310.95
Other	2,069.43	1,039.14
Total Society	<u>4,740.38</u>	<u>3,078.44</u>
TAM	<u>8,528.57</u>	<u>3,804.28</u>
Total Expense	<u>72,143.16</u>	<u>22,536.67</u>
Net Income	<u>-3,861.57</u>	<u>32,625.09</u>

INDEPENDENT AUDIT REPORT

To the members of Metrology Society of Australia

Scope

I have audited the attached annual financial report comprising the Statement of Cash Balances and the Statement of Cash Payments and Cash Receipts of Metrology Society of Australia for the year ended 30 June 2000. The Committee of Management is responsible for the financial report and has determined that the accounting policies used are consistent with the financial reporting requirements of the Metrology Society's constitution and are appropriate to meet the needs of the members. I have conducted an independent audit of the financial report in order to express an opinion on it to the members of Metrology Society of Australia. No opinion is expressed as to whether the accounting policies used are appropriate to the needs of the members.

The financial report has been prepared for distribution to members for the purpose of fulfilling the Committee of Management's financial reporting requirements under the Society's constitution. I disclaim any assumption of responsibility for any reliance on this report or on the financial report to which it relates to any person other than the members, or for any purpose other than that for which it was prepared.

My audit has been conducted in accordance with Australian Auditing Standards. My procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial report. These procedures have been undertaken to form an opinion whether, in all material respects, the financial report is presented fairly in accordance with the cash basis of accounting whereby revenue is recorded when it is received, expenses are recorded when they are paid, and no assets or liabilities, other than cash and bank balances, are recorded. Accounting Standards and other professional reporting requirements (UIG Consensus Views) are not applicable to the cash basis of accounting adopted by Metrology Society of Australia.

The audit opinion expressed in this report has been formed on the above basis.

Qualification

During the financial year the Victorian Branch conducted a number of Dimensional Tolerancing Seminars which with other activities of the Victorian Branch resulted in total expenditure of \$39,486.68 and receipts of \$47,923.43 through the branch bank account between 15 September 1999 and 30 June 2000. A final payment of \$8,223.72 was receipted to the National account in July 2000, after the end of the financial year. As a result the consolidated statement of receipts and expenditure for the year significantly under esti-

mate the activity level of the society as a whole.

I note the Management Committee of Society has subsequently established budget and accounting procedures to cover significant events that may be run by a branch that will ensure the provisions of the MSA Constitution in relation to overall management and accounting control will be complied with in future.

Audit Opinion

In my opinion the financial reports of the National Office and the 1999 Conference presents fairly in accordance with the cash basis of accounting, as described above, the payments and receipts of the Metrology Society of Australia for the year ended 30 June 2000 and its cash and bank balances as at that 30 June 2000.

Date 23 October 2000

BF Thornton CPA
26 Penrith Avenue,
WHEELER HEIGHTS NSW 2097

South Australian Meetings

Members in Adelaide have enjoyed a couple of meetings with an unusual format. Instead of a speaker passing information in diode-mode (that is, in one direction only), we have had free-flowing discussions with anyone speaking who had a contribution to make. One or two speakers initially launched discussion to get members warmed up, but from there on the floor was open. Topics have been subjects that affect many metrologists, but often in different ways, so each could learn something from the others.

The first topic was measurement uncertainties, perhaps a predictable one, but second was more innovative. The discussion was on environmental temperature control, a problem that affects many but is understood by few. Experiences were shared on measurement, sources of heating and cooling, cycling, diurnal changes, laboratory layout, humidity and quite a bit more. Within the heading of cycling there were concerns on the amplitude, period and character of the variations. One big problem for many who use simple heating and cooling systems is, what to do as outside ambient passes from below to above the control point. Only sophisticated and expensive control systems allow heating and cooling at the same time, so some juggling is needed during the change of seasons. And of course the vexed question of the effects of all of these on uncertainties came up.

The format was very successful, and we can recommend it to others if you want to try something new.

- Jeffrey Tapping

Responses on the State of Uncertainties

- Jeff Tapping

tapping@ozemail.com.au

I was very curious to see how much response would be generated by my provocative letter about uncertainty calculations in the last issue of TAM. The answer is, not much. At the time of writing there were five responses, all printed below. This answers in the negative the question whether there is widespread concern out there in measuring land, but leaves open whether things are actually satisfactory. Perhaps in the light of the comments below others may like to add their wisdom to the pool of information.

There was one outcome satisfying to me. MSA member Richard Duncan is now on TAG4, the committee responsible for The Guide, and at a recent meeting he showed other committee members an early draft of my letter. So at least they have been prompted to think about the issue and it may have some small influence on things.

The mention by Bob Frenkel of Bayesian Statistics interests me. I stumbled across this topic recently and realised that the philosophy of it is a strong influence behind The Guide. Is there a reader who would like to write a short piece on it?

The replies were:

No. 1

Previously statistics and metrology merely dated each other, but now the ISO Guide to the Expression of Uncertainty in Measurement is the marriage document that has wedded them firmly together. However, it is written in a language that only one of them understands well. So the training courses now offered on the GEUM are a healthy and, in my view, effective response to this difficult situation.

This is not to deny that misunderstanding and confusion still exist. Jeff Tapping's suggestion (TAM, August 2000) of an inquiry into the detailed needs of the measurement community therefore has merit. But we might do well to consider first how the National Physical Laboratory of the UK tackles the same set of issues through its Software Support for Metrology club (<http://www.npl.co.uk/ssfm>). Many industries in the private sector and many national measurement institutes, including our National Measurement Laboratory, are members. The SSfM does not restrict itself to software, but produces both "public" and "members-only" papers on statistical topics for discussion and on statistical methods for particular applications. Perhaps the MSA should consider applying for membership (110 pounds a year).

As a further point, the GEUM will itself need to be

revised from time to time. Not all of its recommendations are beyond question, although this is partly explainable by its focus on relatively simple and mathematically tractable metrological cases. (Section G.1.5 in the GEUM mentions the exceptions that may arise). For example, we may expect to see a reassessment of the Welch-Satterthwaite formula. More radically, statistics based on Bayesian inference, as well as on sampling or "frequentist" principles as at present, may eventually be introduced to metrology. Bayesian inference already plays a well-established role in such diverse areas as quality control, medical diagnosis and criminal trials. Its metrological application is more controversial, but an increasing number of papers in recent years in Metrologia and other journals have addressed the topic. If the MSA is to conduct an inquiry, therefore, this would probably be best done by examining how other countries such as the UK are meeting the need for the high degree of statistical literacy that is implied but should not necessarily be bounded by the GEUM.

Bob Frenkel

National Measurement Laboratory
Sydney.

No. 2

I was interested to read your contribution to the Australian Metrologist journal, even heartened, to learn that I am not alone in my doubts about my ability to put down meaningful (realistic?) uncertainty budgets. A relative newcomer to the metrology business, I endeavoured to learn from an ISO published "Guide to the Expression of Uncertainty in Measurement" and found this to be, to myself anyway, a good handbook on uncertainties for those that already had a grasp of the subject, but a little bit on the academic side for those starting out to learn.

However, I did manage to find some notes put out by NATA which were of benefit and together with a University text book on statistics, led me back to believing once again that I was of average intelligence.

Calspec does not yet have NATA accreditation and the thought of their assessment of my uncertainty budgets does have me slightly worried. I may be able to argue a case on my understanding of uncertainties but, as you pointed out in your letter to the editor, my understanding may differ markedly from theirs.

Being in Tasmania imposes an added financial burden should I decide to enrol in a workshop on uncertainties as they appear to be always held in a mainland state (understandably so).

As an aside, having spent time learning about the "art" of uncertainties, I find that the bulk of the calibration work I do is for companies who do not understand what an uncertainty or 'k' value is, and in most

cases do not give a hoot about it anyway.

I agree with what you had to say in your letter and would like to see the field of uncertainties addressed in a practical form that would be an aid not only in standardising the requirements but also in education.

Kevin O'Brien
Co-Proprietor Calspec

No. 3

I enjoyed reading your letter re the Uncertain State of Uncertainties when looking through the August issue of "Metrologist". In response to the questions you pose, I would like to respond as follows:

...SO WHAT DO YOU THINK?... - I think it proper to assess and register laboratories on their record of accuracy and precision achieved in adequately regular proficiency tests, and methods of tests should meet quality systems management requirements. I have a negative level of confidence in the assumption that estimating uncertainties adds anything of value to the assessment of measurement process but would be willing to be "enlightened sometime in the future..."

...DO YOU ALSO SEE A PROBLEM OUT THERE?... - Yes I believe there is a problem because I estimate that a significant proportion of the measurement community is not convinced that estimating uncertainties is a useful activity in the striving to achieve acceptably accurate and precise measurement,

...IS AN INQUIRY A WASTE OF TIME?... - Not if it elicits and establishes the views of the measurement community (by workshops, symposia) on what is the preferred approach and reports with clarity and honesty, and recommends a uniform approach based on simply stated technical reasons which can be clearly seen to lead to a succinctly stated objective,

...WHO SHOULD BE RESPONSIBLE?... A committee chaired by an eminent metrologist

...WHO SHOULD BE REPRESENTED?... - NATA, Department of Industry Science and Technology, MSA, and perhaps some professional institutions such as IEAUST, RACI, etc.

I hope this vital subject that you have raised receives the attention that it deserves from the measurement community and that the issue is resolved as soon as possible

Wally Iwanicki
Adelaide

No. 4

Thanks for your email and my apologies for the delay in a response but I have been on an extensive amount of travel lately. I understand your concern about the

uncertainty issue, as there are similar problems here in the US.

One issue that needs to be clarified is the distinction between product acceptance / rejection and measurement uncertainty. These are two completely different issues, the former being a business decision which is captured by a "decision rule", the latter being a technical issue involving the measurement process. In the US there is a draft standard under formation which helps clarify these differences (ISO 14253-1 does not do a good job of this since the default case ties the decision rule directly to the measurement uncertainty). Whenever a decision is made, e.g. as in a testing lab where a product is declared to be "good", the measurement uncertainty needs to be assessed and the decision rule stated.

My personal opinion is that too much complexity is often associated with evaluating measurement uncertainty. The GUM clearly states (paraphrasing) that the uncertainty is an interval about a measurement result that has a large probability of containing the true value. If you can generate this interval, and satisfy the conventional default requirements, e.g. "large probability" is around 95%, then I believe you have done the job.

There tends to be too much emphasis on the "measurement equation" approach that involves taking partial derivatives; while this is not big deal to national lab folks it tends to throw many practitioners into a panic. The GUM also clearly states (e.g. 4.1.2) that the measurement equation may not even exist in some cases, nevertheless that an uncertainty evaluation can proceed without hindrance. I think that more emphasis and examples on this later point are needed, i.e. one can do a perfectly good job of evaluating measurement uncertainty without ever taking a derivative.

I would be interested in any developments that might be taking place in Australia.

Steve Phillips
NIST

No. 5

How Uncertain is the Question of Uncertainties?

I read with a great deal of interest Jeffrey Tappings thoughts on the question of uncertainties. As one who has been active in our profession since 1977 and witnessed this debate over that period of time I am not amazed that this issue still rages. Here we are in the year 2000 and the same arguments exist. Yes I agree that there are different groups and these groups see things very differently. The problem as I see it is with the amount of training that has been gained by each Metrologist. Those of us who gained their qualifications through the RAAF with the "old course" have a firm understanding of uncertainties. Unfortunately

when the RAAF course ended it also ended the opportunity for metrologists to gain a good understanding of uncertainties. I know that those of us who are still practicing metrologists are only too willing to pass our understanding of the subject to those who haven't had the opportunities we have had. If there are metrologists out there who feel they have a good understanding of the subject but are reluctant to pass on the information they hold, I urge them to have empathy for those who don't and pass on this information for the good of our profession.

Australia is very young when it comes to metrology in industry and we all need to work together to ensure that our country is seen as a world leader. Whether a committee of enquiry is required is a debatable point. However, it is necessary to get as many metrologists as possible to understand the importance of uncertainties and have our measurement community feel that the "fiery dragon" has been conquered. It is high time that Guide 25 was given a decent burial and the ISO 17025 adopted. Guide 25 has served us well over many, many years but time has taken its toll and the tyranny of distance has been beaten with the advent of advanced communication making guide obsolete. Australia is now a part of the rest of the world and we are being forced to compete on the world market.

Lets not put this issue in the round file but actively debate this subject.

Glen Hay

From the NSC

WEIGHING AWARDS

At the recent annual general meeting of the Weighing Industry Association of Australia, Adrian Caster and Bill Wedderburn were awarded life membership of the Association.

Adrian has recently become a member of MSA. He has also recently taken up the post of Manager of the Industry Services Group within the Commission. Bill Wedderburn has been a commissioner since 1994.

It is great to have formal recognition of Adrian and Bill's contribution and commitment to the weighing industry. Congratulations to you both.

NSC'S NEW WEB SITE

Over the last few months the Commission has been working with a web designer to redevelop our web site.

The recently launched site focuses on providing information about the work carried out by the Commission in a user-friendly and customer-focused manner. It incorporates best practice and complies with the standards developed through the Government on-line policy

for all Commonwealth government agencies web sites.

The new site also works better with search engines, is accessible to people with disabilities or who have older technologies and all forms are available on-line. Most documents will be available as downloadable PDF and MS word files. The timeline for this is February 2001.

An action plan (available on our web site) has been developed to assess which of the Commission's services are appropriate, and by early next year we plan to have the following on-line:

- * metric conversion ready reckoner (see below);
- * publications;
- * latest pattern approval certificates;
- * students booklet for Measurement in Sport;
- * brochures;
- * forms;
- * dates and agendas for consultative committees.

At this stage the Commission will not be providing an e-commerce facility, as most of our publications will be available free from the web site. You can still purchase documents if you would prefer to receive a hard copy from the Commission.

Certificates of Approval

Certificates of approval will still be available on CD-ROM as a subscription. Each month a list of new certificates will be posted on the web site in pdf format only. This will eliminate the need to email new certificates to subscribers. Subscribers will then be able to go to the web site and download only those certificates that they require. The web site will only contain certificates not included in the CD-ROM.

Structure of Web Site

The new web site has six main sections as follows:

* About Us

Tells you about the Commission in general; provides access to our annual reports, strategic outline, on-line action plan, a glossary of terms and links to related organisations; and gives details about working at the Commission.

* National Measurement System

Explains and defines the national measurement system, legal metrology, trade measurement, authorities and OIML. It also tells you what training the Commission provides.

* Policy Development

Explains the committee structures the Commission uses as part of the consultative process of policy development.

*** Industry Services**

Outlines the services provided by our laboratory, the certificates we issue and tells you how to obtain a list of approvals.

*** Information Services**

Provides access to our information leaflets, publications and frequently asked questions. This section will also contain a What's New section which will point to new items on the web page.

*** Site Map**

Gives an overview of how the site is organised.

You should be able to get the information you require in three clicks or less. Try it and send us your comments so we can improve our service to you.

ASIA-PACIFIC LEGAL METROLOGY FORUM

The Seventh Asia-Pacific Legal Metrology Forum was held in Chinese Taipei in October. The conference was opened by Ruey-Jong Chen (Vice-Minister of the Ministry of Economic Affairs) and it was chaired by Neng-Jong Lin (Director General of the Bureau of Standards, Metrology and Inspection).

Fifty delegates and observers from thirteen Asia-Pacific economies attended the conference, as well as Mr Magana (BIML and WELMEC), Gerard Faber (CIML), Dr Eberhard Seiler (PTB) and Nigel Jou (CNLA and APLAC).

Priorities

Reports were presented and a work program was endorsed (see the Forum's web site on <http://www.aplmf.org>). It was agreed that priority be given to:

- * developing mutual recognition arrangements;
- * producing and conducting training courses, particularly one on the verification of fuel and liquefied petroleum gas dispensers; and
- * conducting intercomparisons (in particular complete the one on load cells and begin the intercomparisons on mass standards and and master meters).

Major Issues

One of the major issues discussed was the transfer of the presidency and secretariat from Australia. Japan agreed to accept responsibility from 1 January 2002.

Another significant development was in-principle agreement for the introduction of a new membership fee structure.

Working Group Meetings

As has become normal practice, working group meetings were held in association with the conference. This year working group meetings were held on mutual recognition arrangements, training, utility meters, goods packed by measure, medical measurements, rice moisture measurements, taximeters, and intercomparison calibration and testing.

SEMINAR ON LEGAL METROLOGY

As a follow up to the seminar on legal metrology which was held in Thailand in 1999, a second seminar was held in association with the Seventh Asia-Pacific Legal Metrology Forum.

Having outlined the aims and objectives of the seminar and identified developments in their legal metrology systems, delegates identified the following priorities for regional cooperation:

- * the need to establish a forum or body on legal metrology in ASEAN;
- * the importance of training;
- * the harmonisation of legislation and administration systems; and
- * the development of an ASEAN mutual recognition arrangement..

The seminar was a joint APLMF-ASEAN project, chaired by John Birch (President of APLMF) and opened by Neng Jong-Lin, Director General of the Bureau of Standards, Metrology and Inspection, Chinese Taipei.

GLOSSARY

APLAC	Asia-Pacific Laboratory Accreditation Cooperation
APLMF	Asia-Pacific Legal Metrology Forum
ASEAN	Association of South-East Asian Nations
BIML	International Bureau of Legal Metrology
CIML	International Committee of Legal Metrology
PTB	Physikalisch-Technische Bundesanstalt (Germany)
WELMEC	European Cooperation in Legal Metrology

METROLOGY AND EVIDENTIAL BREATH ANALYSIS IN AUSTRALIA

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Clinical Forensic Medicine Unit,

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151 Goulburn Street,

SURRY HILLS N.S.W. 2010

(Reprinted from the MSA Conference Proceedings
"Metrology for a Sustainable Future" 1999)

Introduction

Evidential breath analysis has advantages in law enforcement in that it is non invasive, fairly hygienic and a result is gained almost immediately. This method for analysing alcohol has developed over approximately 50 years beginning with chemical testing and moving into infra-red light absorption. In Australia evidential breath analysis was introduced over 30 years ago and it has progressively assisted in playing a major role in attacking the problems associated with alcohol and driving in an epidemiological manner. The road deaths on New South Wales roads fell from 20 per 100,000 in 1950 to 9 per 100,000 in 1996. While this process has met with some success it is recognised that the use of breath analysis instruments will need some modification to meet with certain obligations placed upon the by the introduction of an international standard. This paper is not presenting any new scientific material but it is attempting to outline the development of evidential breath analysis in Australia and suggest the direction it will be taking to accommodate some of the recommendations in the international standard.

Alcohol and Driving

The impact of alcohol upon the impairment of driving performance has been obvious since before the introduction of the motor vehicle - indeed it was obvious even in the days of ancient Egypt. Since the introduction of the motor vehicle the problem for law enforcement officers was proving that alcohol was involved in the impairment of driving ability.

In the past it meant that there was a need for the law enforcement officer to make a subjective judgement about a driver and then support that subjective judge-

ment in a court of law while under examination and cross examination. This often meant that many police officers were tied up at the courts for lengthy periods and also the argument about intoxication could take up much of the time of the court.

Pharmacology of Alcohol

There was a lot of knowledge about the pharmacology of alcohol as it is a very simple molecule with a molecular weight of 46. This makes it much smaller than almost every other drug and allows it to act very effectively in the body. When ingested alcohol can be found anywhere in the body where water can be found as its low molecular weight allows it to travel directly through the pores of the cells with no need to rely upon active transport systems for absorption or conjugation in the blood circulation for distribution about the body. Alcohol is one of the few drugs which when it enters the body is excreted, to some extent, by the lungs.

Alcohol Analysis

During this century there have been developments of various analytical laboratory techniques which have made it possible to measure blood alcohol levels with considerable accuracy. This was very useful as a forensic tool in many situations where it was practical to take a blood sample from a subject however there were certain short comings when it was applied to traffic.

Where the subject was being dealt with in a hospital or clinical situation it was not difficult to take a blood sample. The situation by the road side or in a police station could present some problems. The taking of a blood samples is an invasive procedure and the subsequent analytical result is usually not available for some days.

In the past in Australia authorities were aware of these particular short comings where the blood samples were concerned and were also aware that the taking of blood samples required the consent and cooperation of the subject.

Breath Analysis, Alcohol and Road Crashes

During the 1930's through to the 1950's much research and development had taken place in the area of breath analysis for the purposes of measuring the levels of al-

cohol in the blood. It was known that alcohol was a volatile substance therefore it would be excreted in part via the breath. By using this method it was thought that it would be possible that blood alcohol levels might be determined almost immediately and without there being the necessity for an invasive procedure.

In 1964 Professor Borkenstein from the University of Indiana published the results of extensive research carried out in the town of Grand Rapids, Michigan between 1959 and 1963 [1]. In this research he was able to demonstrate a correlation between the blood alcohol concentration of a driver and the risk of a single-vehicle crash. It was shown that as the blood alcohol concentration of the driver increased the risk of a single vehicle crash increased exponentially.

This led to thinking by the legislators that they could allow for an epidemiological approach to be taken in forming traffic law relating to alcohol and driving. The states began to think of legislating in a way that related specific driving offences to particular blood alcohol level.

In the early 1950's the same Professor Borkenstein from the University of Indiana developed a breath analysis instrument based upon the principles of chemical testing using a photovoltaic cell. This instrument was patented as the Breathalyzer(r). It was this breath-analysis instrument which made it practical for the Grand Rapids study to be carried out. Like all evidential breath analysis instruments at that time it gave a result which was read in grams of alcohol in 100 millilitres of blood. This situation which had its origins in the 1960's.

"Under the Influence of Alcohol"

At that time the states in Australia all possessed a law which was worded in one way or another to make it an offence to drive while "under the influence of alcohol". Experience had shown this to be of limited use in law enforcement when it came to securing convictions in the courts.

The law enforcement officer found it necessary to report on observations of impaired driving as well as observations of signs and symptoms of alcohol intoxication. In court there would be a strong argument that the impaired driving as well as the signs and symptoms did not exist and if they did they were caused by something other than alcohol.

This meant that there was much time spent with law enforcement officers being at the courts dealing with legal arguments which could be lengthy and complicated.

Evidential Breath Analysis In Australia

Several versions of the Borkenstein Breathalyzer(r) were created from the early 1950's but when they were introduced into Australia in the 1960's it was the Breathalyzer(r) 900 or Breathalyzer(r) 900a which was most widely used in most states although the Australian Capital Territory used the Breathalyzer(r)1000.

The use of breath analysis for evidential purposes was introduced in most states in the late 1960's or early 1970's and became quite valuable when attacking the problem of alcohol and driving as it was at that time. Suspects could be stopped and tested for alcohol within a couple of hours. The offence was not one of driving a vehicle when "under the influence of alcohol" but "driving a motor vehicle while there is present in the blood the prescribed concentration of alcohol".

This approach by the Australian states and territories in using evidential breath analysis was radical for its time. Although some law enforcement agencies in the United States were using evidential breath analysis at this time it would not be used in Europe until the 1980's and is still not used in some parts of Europe up to this time.

The accuracy of the Breathalyzer(r) 900 was often challenged at court. It was necessary for those involved in the breath analysis procedure to be able to support the accuracy of the instrument.

The most common challenges were over the manner of use of the instrument by the certified operator. At this time the operators of this instrument were put through a four week training course which covered studies in physics, chemistry, physiology, pharmacology and the law. These operators were then examined on these subjects and were required to reach a satisfactory standard before being granted certification to operate the Breathalyzer(r) 900.

This instrument was a portable type and the operator travelled from one location to another testing subjects as required. This meant that the operator was trans-

porting and carrying not only the not only the Breathalyzer(r) 900 instrument but also a case containing standard alcohol solutions, ampoules of potassium dichromate, a transformer and many other articles. It was not only a cumbersome activity for the operator but also one which had its share of hazards in the area of occupational health and safety.

Challenges at the courts also were about the instrument itself. As the instrument used chemicals to test for alcohol there were sometimes arguments about the purity and the measure of the potassium dichromate in the prepared ampoules used to test the alcohol. As this instrument had to be calibrated before and following each test there was often argument about the accuracy of the standard alcohol solutions used in the procedure.

This meant that those involved in preparing the potassium dichromate solutions and the standard alcohol solutions had to be able to attest to the quality and accuracy of those substances.

At that time to concept of relating these materials used in the preparation of these substances to metrological standards was not considered. It was not that the preparations of these standards was poor.

In New South Wales the ampoules of potassium dichromate were usually purchased from a regular local supplier and each batch was tested at the Division of Analytical Laboratories for its quality. It has to be stated that the local product was always found to be of the appropriate quality.

The Police Department and the division of Analytical Laboratories were jointly responsible for preparing the standard alcohol solutions. This meant that a certain weight of pure alcohol was added to a certain quantity of distilled water. The new solution was then analysed by the laboratory (using gas chromatography) to check the accuracy of the solution at a certain temperature. This solution when used in a Breathalyzer(r) 900 at a specific temperature was meant to give a specific reading of a blood alcohol concentration on the instrument.

The standard of these materials was very high and this was often displayed in the courts to the extent that the instrument and the procedure surrounding its use became regarded as forensically sound. Despite the methods used in the past to support the accuracy of

the Breathalyzer(r) 900 by today's approach to the use of metrological relationships there may have been some disquiet.

In Australia in the late 1980's and early 1990's the chemical testing process of the Breathalyzer(r) 900 was replaced by electronic breath analysis. This method uses the principle of the absorption of infra-red light at a wave length of 9.5 micron by alcohol in a sample of air. The amount of the infra-red light absorbed is used to measure of the alcohol in that sample. The instrument used in Australia is the Dräger Alcotest 7110. This instrument was released in the early 1980's and was the first of the breath-analysis instruments utilising infra-red light absorption to use the 9.5 micron wave length instead of the 3.4 micron wave length.

By using infra-red light absorption at a wave length of 9.5 instead of 3.4 micron there is far less risk of the instrument registering a reading on interfering substances such as acetone. The instrument used in the Australian states was designed and manufactured in Germany and Australia. Each state has its own software for the instrument.

The use of electronic instruments has many advantages over the manual chemical testing types. Most of its operation is automatic and not so labour intensive. It is therefore more far more difficult to manipulate by the operator. This has lead to fewer challenges to the instrument on the basis of the manner of its operation.

Like all evidential breath analysis instruments in Australia it gives a result which reads in grams of alcohol in 100 millilitres of blood. This is a situation which has its origins in the 1960's.

At that time the states in Australia all possessed a law which was worded in one way or another to make it an offence to drive while "under the influence of alcohol". Experience had shown this to be of limited use in law enforcement when it came to securing convictions in the courts.

Epidemiological Approach

Following upon the research of Borkenstein the states and territories of Australia decided upon an epidemiological approach to the use of alcohol while driving. Some states introduced a blood alcohol concentration of 0.050 grams of alcohol in 100 millilitres of blood

while others introduced a blood alcohol concentration of 0.080 grams of alcohol in 100 millilitres of blood. At present all states have similar laws about blood alcohol levels and the low range begins at 0.050 grams of alcohol in 100 millilitres of blood.

The approach taken by legislators at the time was one where it was considered important to control the behaviour of motorists (to stop them from driving) at a particular blood alcohol concentration and above. By doing this it was felt that there would be more control over the risk of a crash of a motorist at a particular blood alcohol concentration and that this would lower the road toll. While this had some impact on the road toll its full effect was not felt until the introduction of random breath testing. Basically it has been an exercise in attempting to keep persons with a particular blood alcohol concentration and above off the road. In doing this it was attempting to keep those drivers with a high crash risk off the road.

Blood-Breath Ratios

The use of breath analysis to measure the blood alcohol concentration has come under scrutiny in recent years. Since the introduction of evidential breath analysis the result has been given as a blood alcohol concentration. This is as a consequence of the implementation of the Grand Rapids research into legislative practices. In the 1960's the message was to relate a blood alcohol concentration to a crash risk.

The breath analysis instrument in those early years gave its results in blood alcohol concentrations rather than breath alcohol concentrations because it was considered that the public would understand them more clearly. Since researchers were discussing crash risks with various blood alcohol concentrations it seemed appropriate to have the Breathalyzer(r) 900 give the result of a breath analysis as grams in 100 millilitres of blood.

In 1956 the National Safety Council in the United States (through its committee on alcohol and drugs) made a recommendation that the blood-breath ratio should be accepted as 2100:1. This was based on research by Harger, Forney and Baker [2] so that this value was not only accepted in the United States but also in other parts of the world including Australia. Since the mid 1970's a ratio close to 2300:1 has become accepted by nearly all researchers as being a more realistic figure [3] [4] [5]. Since the introduction of evidential breath analysis into Australia a conversion fac-

tor of 2100:1 has been used. From a forensic perspective it gives some benefit to the subject and minimises the risk of the instrument over reading the true blood alcohol concentration.

The evidential testing of subjects by breath analysis is quite a unique situation. It requires the subject not only to cooperate with the tester but also to become actively involved in the procedure. If the subject does not freely offer a sample of expired air the test can not be carried out. The sample of expired air will give a more accurate reflection of the blood alcohol concentration if it comes from deep within the lungs where there is free passage of alcohol across the alveolar wall. Any alcohol in expired air which comes from the airways rather than the alveolus will be less. It will be progressively less as that part of the airways is progressively distant from the alveoli.

Future Directions

This procedure has been appropriate for many years however there are now some suggestions that the measurement of an evidential breath analysis should no longer be expressed in terms of a blood alcohol concentration. A recent meeting of the Working Party on an Australian Standard for Evidential Breathalysers was held at the office of the National Standards Commission in April. At that meeting the units of measurement were discussed. There was a consensus that the preservation of the 0.050 unit is most valuable as the public is familiar with this figure in relation to alcohol and driving. It was considered that the units used in an evidential breath analysis should be 'x grams of alcohol in 210 litres of breath'. In this manner while members of the public may not be too familiar with the units used it would still understand that the actual figures would be unchanged.

The type of breath sample offered to an evidential breath analysis instrument is important. Many of the states have a different requirement with regards to the amount of expired air necessary for the instrument to record that the minimum specified amount of expired air has been exhaled into the instrument. In New South Wales it is 500 millilitres, in Victoria it is 1 litre while other states have other amounts. While it would be ideal if all subjects could exhale into the instrument to the extent that they would have emptied their lungs of air thus giving a true sample of deep lung air this is not going to happen. What becomes a proper breath sample for forensic purposes usually falls short of what would be a proper breath sample for scientific purposes. In these situations the evidential breath analy-

sis instrument under reads the true blood alcohol concentration so the subject is at an advantage.

In the late 1980's the Organisation Internationale de Métrologie Légale (OIML) (International Organisation of Legal Metrology) released a draft copy of its Recommended International Standard for Evidential Breath Analysers. This has been examined in many countries including Australia. Many recommendations for various refinements to this standard have been put forward including some from Australia. At the last meeting of the Working Party on an Australian Standard for Evidential Breathanalysers 16 recommendations for changes to the International Standard were recommended and have been submitted to the secretariat of the international body.

The direction of the Working Party in Australia at this time is not to adopt the OIML Recommendations on Evidential Breath Analysis Instruments but to adapt the Recommendations with a view towards developing an Australian Standard. In attempting to achieve this it will require the states and territories to review their legislation and logistics. There will have to be an examination of test procedures for these instruments and it will be necessary to properly identify the laboratories which can carry out those tests. There will have to be a thorough process of approving the instruments.

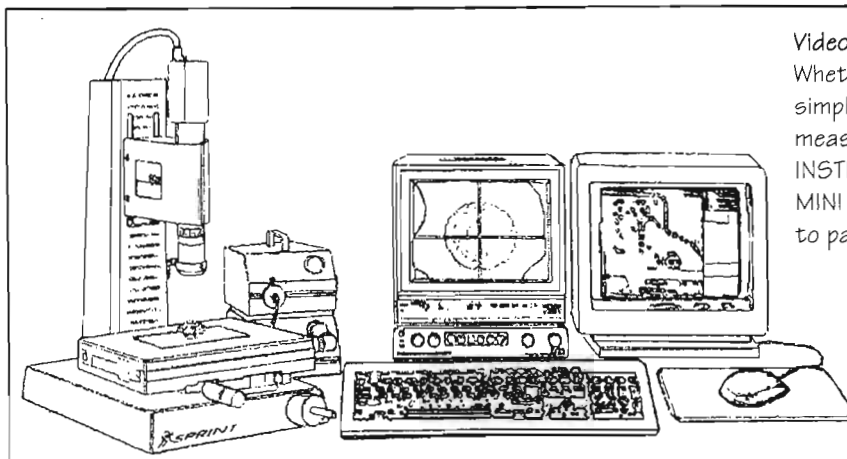
Conclusions

It is expected that future breath analysis legislation in Australia will insist that evidential breath analysis instruments comply with an Australian Standard. These instruments will have to go through a rigorous testing procedure before they would be certified for use in law enforcement.

As matters stand at present the standard of evidential breath analysis is very high and there is virtually no risk of an instrument over reading the true blood alcohol concentration of the subject. This ensures that by the use of evidential breath analysis no person will be unfairly convicted of driving with a blood alcohol concentration which is lower than the reading recorded on the instrument.

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GPS SURVEYING: A TRACEABILITY CHAIN WITH A MISSING LINK?

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ABSTRACT

Traceability is now a familiar concept in metrology, but it presents special problems when some components of the traceability chain are not accessible to Australian authorities or users. This is the case for the Global Positioning System (GPS), which is increasingly used by land surveyors. This paper explains why land surveys must be made traceable to the National Standards of Length and/or Time, and the difficulties that arise in establishing suitable procedures.

In the 1980s there was a similar need to make surveys made by Electronic Distance Measurement (EDM) legally traceable. This was achieved by establishing a system of EDM calibration baselines that were traceable to national standards of length and/or time [1,2]. It is not obvious that a similar method would be applicable to GPS [3], especially because of the unique feature that major components of the GPS system reside in space or in the USA. This paper describes several proposed schemes, and in particular, one that involves the introduction of the concept of position as a measurable physical quantity.

1.

INTRODUCTION

The concept of traceability is now well established in metrology, in the sense of establishing a continuous, documented chain of calibrations between a physical standard and a particular device or artefact. *Legal traceability* is an extension of this idea to calibrations that meet legally required specifications for each stage of the traceability chain. In Australia, the National Measurement Act (1960) applies to any measurement that is used for any legal purpose, including contracts, government regulations, or court proceedings. The Act specifies that the results of any such measurement must be stated in Australian legal units, if such exist. The associated Regulations specify such things as permissible departures and uncertainties at various levels in the chain. It follows that cadastral surveys in Australia, that is, surveys of parcels of land, must be made traceable to national standards because they relate to sales or contracts.

Until about the late 1970s surveys were mostly carried out with tapes that were calibrated against reference tapes, which in turn were related to a State standard tape, and ultimately to the Australian standard of length. With the advent of Electronic Distance Measurement (EDM), a new hierarchy was developed, in which surveyors' EDM instruments were calibrated against standard baselines, which were in turn calibrated by high precision EDM instruments whose characteristics could be determined by direct measurement against national standards of length and/or frequency. This system worked well, but EDM is now being replaced by new techniques based on the Global Positioning System (GPS, Fig.1).

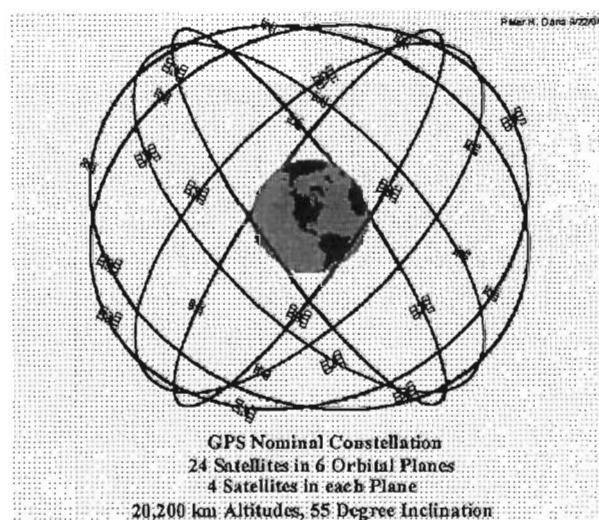


Figure 1 The GPS Constellation

This system of satellites in 12-hour orbits at an altitude of about 20 000 km was intended by the US military to provide positional information to its forces, at any time and place. The surveying profession saw its potential as a set of very high "trig points", and rapidly developed a variety of ingenious ways of deriving very precise positional data from it, even in the presence of several deliberate spoiling tactics. GPS has many ad-

vantages: it is very fast, requires minimal staff, can measure distances between points that have no line-of-sight connection, and simultaneously measures positional differences in all three dimensions. Unfortunately, for use in legally traceable surveys, it presented some significant problems. The first of these was that the primary output of the GPS observations is a position, whereas surveyors frequently require distances, such as the length of a boundary line. The instrument industry soon produced specialised survey receivers and software to derive distances from positions. A second, and major, problem was how to make the result of a survey traceable to Australian national standards, given that the satellites (the space segment of the system) are inaccessible and the master clocks and controllers (the control system) are in the hands of US government authorities. This is the "missing link" in the chain.

2. GPS – BASIC PRINCIPLES

Each GPS satellite carries several precise atomic clocks, and broadcasts several microwave signals that report both the time as kept by its clocks and the latest data on its orbital parameters. These parameters are determined by tracking stations and are up-loaded to the satellite on each pass over the master control station in the USA. From the broadcast information a GPS receiver can determine the position of each satellite and the time reported by it. The receiver also contains a clock, and means for determining the time-difference between the satellite and the receiver. Software can then calculate, at various levels of precision, the range from the receiver to each of several satellites, usually four or more (Fig.2).

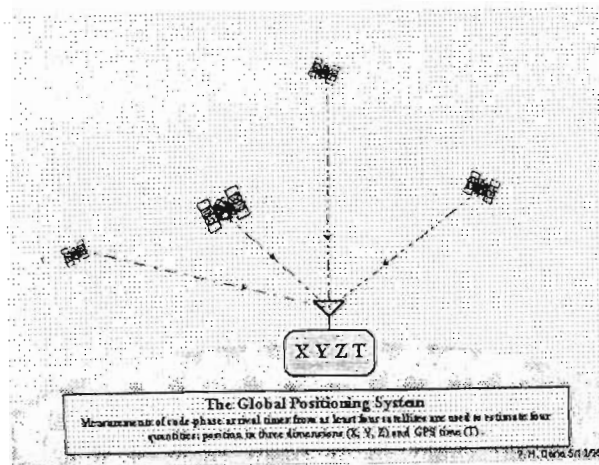


Figure 2 Ranging from satellites

A least-squares fit to this redundant data provides a measure of the position of the receiver in the coordinate system used by the GPS. There are refined procedures that minimise the effects of errors arising from the clocks and other sources, but they need not concern us here, except to notice that these procedures themselves have limited accuracy. In land surveying, two receivers are used to determine the positions of the end-points of a line, and standard algorithms are used to derive the distance between them. In most cadastral work, where the distances are small, surveyors conventionally adopt the "flat-earth" theory, and project all points on to a local plane at sea level. Geodesists, who are concerned with precise details of major features of topography, project the positions onto a conventional ellipsoid of best fit. The parameters of this ellipsoid are specified as part of the GPS coordinate system.

3. ROUTES TO ESTABLISHING TRACEABILITY

The National Standards Commission (NSC), which is the body responsible for legal aspects of metrology, responded to the second problem by setting up a Working Party, which included representatives of the Australian Land Information Group (AUSLIG) and the National Measurement Laboratory, and specialist consultants. (A similar group had developed the procedures for EDM in the mid-1980s.) The West Australian Department of Land Administration (DOLA) initially proposed the establishment of an extended set of baselines, analogous to those used for EDM calibrations, but with longer component distances, and laid out in three dimensions to test the receiver's ability to determine directions as well as distances. This scheme is still favoured by some State authorities, but the Working Party currently prefers an alternative scheme [4] that was developed by the Intergovernmental Committee on Survey and Mapping (ICSM)

4. POSITION AS A STANDARD

This scheme proposed that a set of positions be established by very accurate and repeated determinations by several different techniques, and that these should be declared as what are known as a Recognised Value Standard (RVS). This term means that for legal purposes the values of the RVS may be assumed known (to some specified accuracy). Any other determination of a position relative to these known positions would then be legally traceable. Of course, surveyors often require distances between points, rather than positions, but these are readily derived as indicated above. There are two prerequisites for the success of

this scheme for traceability, one conceptual and the other technical:

- * position must be accepted as a "physical quantity" that comes within the scope of the National Measurement Act 1960; and
- * the reference positions must be known, with adequate accuracy, in a well-defined coordinate system.

The first condition is really a matter of legal terminology. The intention was that the position of a point would be defined by the length and direction of the vector joining the origin of the GPS coordinate system (i.e. the centre of mass of the Earth) to that point. However, government legal authorities objected that vectors were not physical quantities within the meaning of the Act, because they could not be ranked or compared numerically. In response, the proponents (ICSM and NSC) argued that other quantities, such as force, acceleration, and magnetic fields, were also vectors, although measurement reports commonly only stated the magnitude of the vector. In fact, if one were testing, say, a dead-load tester, an important parameter would be the direction in which the force was applied. The conceptual objection was withdrawn, and position was added to the list of physical quantities covered by the Act, just as time-of-day had recently been added.

The second condition was met by determining a set of about 80 points distributed over Australian territory, by one or more of several precise techniques. These include Very Long Baseline Interferometry (a radio-astronomical technique), Laser Satellite Ranging, and extended observations by GPS. A vast amount of data was acquired and statistically adjusted to establish these positions in the GPS coordinate system to within 3 cm horizontally and 5 cm vertically. Ten of the points, at locations that had been determined by multiple techniques were gazetted as the Australian Fiducial Network (AFN, Fig.3).



Figure 3 The Australian Fiducial Network
(points at Cocos & Macquarie Is. not shown.)

Precision GPS receivers continuously monitor these ten points. The rest, which are spaced at about 500 km intervals, will be used as secondary standards, forming the Australian National Network (ANN). The ANN will be monitored against the AFN from time to time by travelling GPS instruments. It is intended that each State or Territory will establish subsidiary networks, tied to the ANN by incorporating at least three ANN points. Lower-level networks may be introduced where required to make them more accessible to surveyors, who will have to incorporate at least three traceable points into their actual field surveys. This hierarchy will ensure that any cadastral or other survey is traceable to the national standards, as required by the Act.

This scheme has the great advantage that it tests, at the time of the survey, all aspects of the surveyor's GPS equipment, including the atmospheric and ionospheric models, the conversions from position to distance that are built in to the software, and the sensitivity of the receivers to the local topography. Unless the surveyor can recover the pre-established relative positions of three (or more) standard points that are included in a field survey, the survey will not be traceable.

There is another feature of this scheme that complicates the assignment of uncertainties at each level in the hierarchy. In surveying, redundant observations of networks of points are adjusted by least squares techniques to minimise the overall misfits of their observed relative distances and relative directions. If some of the points are to be held fixed, we must decide whether to exclude their known separations from the adjustment or to allow them to float in the adjustment, perhaps within their assigned uncertainties or by amounts that are weighted by their uncertainties. These alternative procedures are well known to surveyors, but if legal traceability is to be achieved, one of them must be specified unambiguously.

It should be mentioned that the basic results of a GPS observation are the length and direction of the vector joining the centre of the Earth to the point of interest, but surveyors find it more convenient to express the position in terms of a latitude, longitude, and normal height above a defined ellipsoidal surface (the reference ellipsoid). The origin and the coordinate system are explicitly defined as part of the description of the GPS system (Fig.4). Such transformations of the components of a vector are quite standard, and do not affect the significance of the results. The satellite clocks are driven by reference to atomic clocks at the US Naval Observatory that are tied to the SI second and Universal Time. Therefore transit times of the satellite signals to the receivers may be directly converted to ranges in SI metres.

7. CONCLUSION

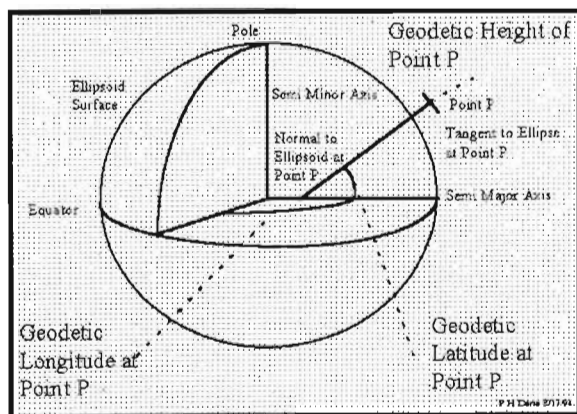


Figure 4 GPS Coordinate System

5. QUALITY CONTROL

The space segment of the GPS is subject to faults such as clock errors and electronic malfunctions. Each satellite in its broadcast message in fact reports its state of health, and users can exclude a sick satellite from their observations. The controllers also distribute such information, but they also sometimes deliberately falsify the clocks or orbital data, or encode some of the data stream, to exclude non-military users. It is essential that someone should continuously monitor the system and advise users. In Australia this task is undertaken by AUSLIG (The Australian Land Information Group), which maintains the monitoring stations at the AFN sites, and provides warning messages by radio and the Internet. In terms of more common fields of metrology, this would be akin to visually checking the condition of a gauge block or a weight before using it as a standard, to ensure that it has not suffered damage that would invalidate its calibration.

6. ALTERNATIVE SOLUTIONS

Although the AFN has been gazetted and the ANN will be issued with appropriate certificates under the National Measurement Act, there is still some discussion on alternative routes to traceability. As mentioned above, there is still support for the use of calibration baselines that would be linked to the hierarchy of length standards by calibrations with certified EDM instruments. Apart from the debate about the adequacy of such a calibration to test fully the performance of the GPS equipment, there are considerable difficulties in carrying out the calibration of longer baselines by currently available EDM instruments. Another proposal [5] is to rely entirely on establishing traceability of the time standards.

Although several details of the procedures are still being resolved, there seems to be no doubt that proper legal traceability of land surveys made with GPS equipment can be established. This will place such surveys firmly within the structures required by Australian legislation, while at the same time making all positional information consistent with the GPS coordinate system. The local press has recently alerted Australians to the fact that this will involve a shift of map coordinates by about 200 metres, roughly north-east. In fact, GPS surveys are so accurate that they allow us to measure the systematic continental drift that carries Australia about 6 cm to the north each year. Adjustments to the absolute positions assigned to the AFN will need to be made every few decades. The ANN may require additional adjustments to reflect any distortion of the continent itself.

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