

THE AUSTRALIAN METROLOGIST

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**Grand Mercure Hotel
Gold Coast
Venue of MSA-2001
Biennial Conference
2–4 October**

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.

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All editorial copy should be sent to the editor by the middle of the month prior to publication, or such other date as may be advertised in column two of this page.

Further information regarding the Metrology Society of Australia may be found on the Information Page.

From the Editor

This issue gives information about the Biennial Conference in October. However, I have limited the amount given to avoid confusion. Due to the variety of offerings - lectures, workshops, golf days etc, I could have filled this issue with advertisements and application forms!

But within the conference schedule the MSA Annual General Meeting is being held, and we will be electing a new committee, with the secretariat to move to Victoria. Avail yourself of the opportunity to nominate someone to the committee either as an officer or ordinary member, and of course don't forget you may appoint a proxy to vote on your behalf at the AGM.

This is again a thin issue, with Jeff Tapping and Marian Haire the main providers. Please send contributions for the next issue as soon as you can to allow me to get publication dates back on track.

- Maurie Hooper

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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

Enclosures can be included with TAM for a cost of 20 cents per A4 insert or 25 cents for A3 (folded to A4) size. Larger items may be considered - POA.

Closing date for copy to be received for the next issue of TAM is 1st September 2001.

Contact the TAM editor for further details.

Note: 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.

Metrology Society of Australia Incorporated

Notice of Annual General Meeting

Members are advised that the Annual General Meeting of the Metrology Society of Australia Incorporated will be held in the Grand Mercure Hotel, 81 Surf Parade, Broadbeach Queensland on Wednesday October 3, 2001 at 5 pm. This meeting includes election of Officers for the coming year. Members are reminded that written nominations for the committee positions are to be in the hands of the Secretary not less than 7 days prior to the meeting.

L Besley, Honorary Secretary

From the President

Despite the fact that the sun is slowing down and the occasional leap second has to be added to keep our seasons synchronised, time seems to flow faster and faster. Here it is July, and deadlines loom for the MSA conference in October. In fact one of the bugbears for the conference organisers is that deadlines for papers have been largely ignored (the usual problem of finding time under a busy schedule) and this has complicated setting the program, but progress has been made never-the-less and a successful conference is predicted. You all can do your part by attending for a few days of interaction with your colleagues in metrology.

The Annual General Meeting of the society will be held during the conference (see separate notice in this issue) and we are looking for the core of the committee to be based in Victoria, so our 'mexican' members might consider how they could contribute, and be rewarded by the interaction at the same time. The constitution is written to encourage change to keep the society fresh. I guess from the perspective of our northern states, all the rest of us are mexicans. One of the successes of this last committee has

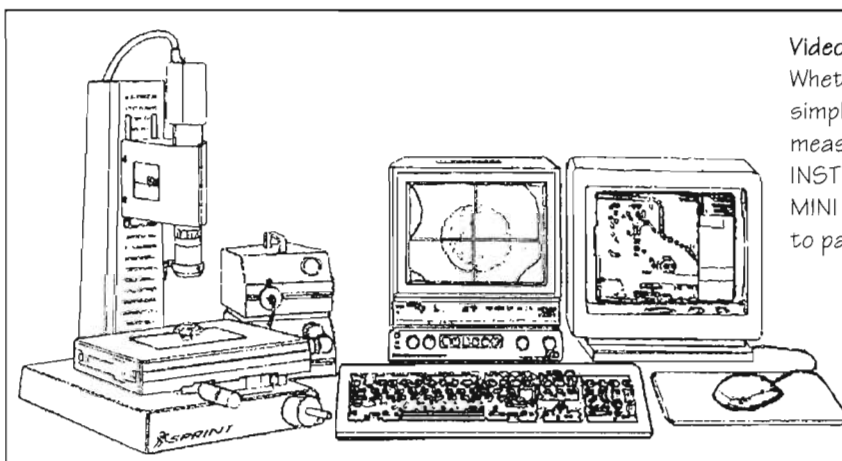
been tele-conferencing, with committee representatives in four states and hence much better communication with state branches, as befits a national body.

A reminder too of the MSA award - another of those deadlines. If you are aware of a member whose work would qualify, I'd urge you to either nominate them or urge them to enter. Think of the satisfaction to be gained from peer recognition. Nomination need not be time consuming - a brief summary of achievements is all that is required.

This will be my last column, as I intend to stand down in October to pursue the blue skies of retirement. I'd like to thank the members for their support, the committee(s) that I've worked with for their interaction, and particularly Laurie Besley and Marian Haire. Nominally secretary and treasurer for the past 4 years, they have transcended those administrative roles to both guide the Society forward and to set procedures in place to make operation on a national basis easier.

Cheers,

Jim Gardner



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Metrology Society of Australia

Fourth Biennial Conference - Gold Coast - 2nd to 4th October 2001

Everyday Metrology

"A vital Cog in the Wheels of Industry"

The 4th Biennial Conference

The 4th Biennial conference will review the role of Metrology in the Wheels of Industry. Metrology, the vital cog in the wheels of industry, is present in every activity performed. From driving, purchasing supplies, making a coffee, metrology is everywhere. Metrology ensures:

- ◆ Consistency in product and service,
- ◆ Efficiency by lowering costs through increased reliability of equipment, and
- ◆ Consistency of measurements made with those made elsewhere.

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 preceding Monday, is also a public holiday in three states.

The Venue

The Grand Mercure, 81 Surf Parade at Broadbeach, is the venue for the conference, direct access to the beach, monorail link to Jupiter's Casino, undercover parking, health and fitness centre, spas etc makes this an excellent venue for both mind and body. For further details on the Grand Mercure see the web page below.

<http://www.grandmercure.com.au/> Phone (07) 5592 2250

Program Format

The conference will run similarly to previous years with plenary lectures covering topics on Electrical, Chemical, Temperature, Mass, Uncertainties and much more. A list of paper titles is available from the MSA website. In addition there will be a full day workshop on Tuesday October 2 for certifiers of Non-automatic weighing instruments and series of workshops for end users of Metrology on Wednesday October 3. Day registration available for both of these workshops.

Golf Day

Keeping with the mind and body theme, the MSA of Queensland will host a Golf Day at Paradise Springs Golf Course at Robina on the Gold Coast (approx 20 min from Grand Mercure). This is one of the most spectacular courses on the Gold Coast. The web page below gives you a brief description of the course. Registration forms for the Golf are available from the Conference Web Page.

<http://www.paradisegolftours.com.au/ParadiseSprings.html>

Conference Dinner

The Conference dinner will be held at the Grand Mercure. All going to plan, the poolside dinner in the beautiful Queensland weather should be magnificent. Do not forget your bathers. The cost for the dinner is included in your 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 are available for \$50.00 each.

Accommodation

The Grand Mercure is offering accommodation at \$135 per room per night, single, double or twin share. This does not include breakfast. There are many apartments within walking distance (less than 1500 m) of the hotel. These include :

Victoria Square Apartments	07 5592 1794	King Tide	07 5531 7124
San Mateo	07 5561 0444	La Grande	07 5592 5350
Cascade Gardens	07 5592 0567	Old Burleigh Court	07 5570 2211

The Grand Mercure has provided booking forms which are available on the MSA Web Page. If you wish to use other accommodation please contact them directly. Please remember this is school holidays so please book early to ensure your accommodation. It is the responsibility of delegates to arrange their own accommodation.

Trade Exhibitions

The following organisations are exhibiting at the conference. We thank them for their support.

ADI Fluke Australia Mettler Toledo National Instruments Sartorius

If you wish to exhibit at the conference please contact Tony Collings. Contact details are at the bottom of the page.

Corporate Pass

Available for companies who wish to send a different delegate each day. Please complete a separate form for each name and indicate the appropriate day.

Technical Visits

We have not organised technical visits for this conference.

Air Travel

Ansett Australia is the official carrier for the conference. They have offered us a terrific deal, which is 50% of the full economy class airfare or, alternatively, the "Best Fare of the Day". To avail yourself of this offer, phone Ansett Sales **13 13 00** and quote the Masterfile No. **MC01388**.

Sydney-Gold Coast Return	\$321 +Tax +GST
Melbourne-Gold Coast Return	\$466 +Tax +GST
Adelaide-Gold Coast Return	\$491 +Tax +GST
Perth-Gold Coast Return	\$761 +Tax +GST

Sponsorship

We would like to thank the following organisations for their support.

- ◆ **National Standards Commission**
- ◆ **Sartorius**
- ◆ **CSIRO-National Measurement Laboratory**

Enquiries

If you need any further information, please contact the

Conference Coordinator:

Tony Collings	02 9413 7148	02 9413 7200 (fax)	e-mail:	tonyc@tip.csiro.au
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Committee:

Marian Haire	02 9856 0353	02 9856 0399 (fax)	mhaire@nsc.gov.au
Shane Brann	07 3344 1866	07 3344 1777 (fax)	shane@vms.net.au

How to register

Complete the registration form (photocopy page 6 or download a form from the website) and send with enclosed cheque payable to Metrology Society of Australia to:

* MSA Conference Secretariat

C/- National Standards Commission

PO BOX 282 North Ryde 1670

or you may use fax or e-mail if you include your credit card details

Fax completed registration form with credit card details to: Marian Haire at 02 9856 0399, or

E-mail completed registration form with credit card details to: mhaire@nsc.gov.au

Visit the Conference Web Site <http://www.metrology.asn.au/msa2001.htm>

METROLOGY SOCIETY OF AUSTRALIA

4th Biennial Conference
Gold Coast
2-4th October 2001



Conference Registration Form

ABN 802 123 257 48 - the society is not registered for GST

Please indicate your options on the registration form. Photocopy and fill in separate registration forms for each delegate. The registration fee quoted includes conference proceedings, welcome cocktails, morning and afternoon teas, and the conference dinner. **Lunches not included.** Several excellent venues for lunch are available within a few hundred meters of the conference venue.

Delegates Details

Title:	
Given Name:	
Family Name:	
Preferred Name for Badge:	
Organisation:	
Postal Address:	
Telephone:	Fax:
Email:	

Registration

	Before 1st Sept	After 1 st Sept
MSA Members/Speakers	☐ \$200	☐ \$250
Non-Members	☐ \$300	☐ \$350
Full Time Students (attach proof of enrolment)	☐ \$175	☐ \$200
Corporate Pass (max 1 delegate/day)	☐ \$250	☐ \$300
Copy of Proceedings (if not attending)	☐ \$50	
Additional dinner tickets	☐ \$50 each	

One-Day Workshop Program Members \$100 Non-members \$150 (\$25 late fee after Sept 21)

- ☐ October 2, Verification of Non-automatic weighing instruments
☐ October 3, Everyday Metrology

Total Amount Payable: \$.....

Cheques should be made payable to: Metrology Society of Australia

Method of Payment

☐ Cheque ☐ Mastercard ☐ Visa ☐ Bankcard
 Card Number: Exp date:

Card Holders Name:.....Signature:

Mail to: MSA Conference Secretariat, C/- NSC, PO Box 282, North Ryde, NSW 1670

Fax to: (02) 9856 0399 Email to: mhaire@nsc.gov.au

Certification of Non-automatic Weighing Instruments

Training Opportunity



Tuesday October 2, 2001
Grand Mercure
81 Surf Parade, Broadbeach
Queensland

This course presented by the Commission will provide you with the opportunity to update your skills as a certifier of non-automatic weighing instruments. The procedures contained in the Uniform Test Procedures for non-automatic weighing instruments will form the basis of this very practical hands on course. Each procedure will be discussed in detail giving you the opportunity to share your experience with others.

These test procedures meet the requirements of the Uniform Trade Measurement Act and the National Measurement Act (1999). They have been designed to ensure that licensed certifiers carry out their role in a uniform manner across Australia. They are in line with international recommendations as set out in OIML R 76-1.

About the Trainers

Adrian Caster: Business Manager, NSC Industry Services Group. Adrian has many years experience in the weighing industry and was recently honoured for his commitment to the Weighing Industry Association of Australia by being made a life member.

Marian Haire: Training Officer, NSC. Marian has many years experience in education both as a secondary science teacher and science consultant.

The course will cover the following topics:

- ✎ Uniform Test Procedures, changes in terminology
- ✎ Maximum Permissible Errors
- ✎ Single interval, multi-interval and multiple range instruments
- ✎ Accuracy of zero-setting test
- ✎ Discrimination test
- ✎ Eccentricity test
- ✎ Repeatability test
- ✎ Weighing test with and without substitution load
- ✎ Tare test
- ✎ Supplementary test
- ✎ Suggested sequence for testing
- ✎ Evaluation report

This opportunity is being presented in conjunction with the Metrology Society of Australia and Queensland Trade Measurement. If you wish to register please return a completed registration form. For further enquiries please contact Marian Haire Phone: (02) 9856 0353, Fax: (02) 9856 0399 or Email: mhaire@nsc.gov.au

From Brazil

The following letter has reached the Editor from the President of the Brazilian Metrology Society.

Rio de Janeiro, RJ/BRAZIL, 22 June, 2001

Dear Editor of TAM,

This is to acknowledge you that the **Brazilian Metrology Society** (SBM) has received a copy of The Australian Metrologist (TAM, issue no. 24, of March 2001), published by the **Metrology Society of Australia**. Congratulating our Australian partners for the quality of this interesting publication, we were extremely pleased to find on page 3 the transcription of our Agreement of Cooperation signed in Brazil during the international event **Metrologia-2000**. As kindly quoted by MSA's Honorary Secretary Laurie Besley during the official opening ceremony of the event held in Brazil, there are many possibility for cooperation among our brother organizations.

Closely linked by the same "south hemisphere metrology motivational forces" we also strongly believe on the effective outcome of this agreement. Making public our recognition, we deeply thanks MSA for the interesting lecture given by Laurie Besley, which can be considered the very first action of our cooperation.

On behalf of the Brazilian Metrology community let me congratulate with all Australian Metrologist. To our understanding, based upon the signed agreement, which we are extremely proud of, all MSA members have also been considered members of our SBM and are very welcome to our events and activities, benefiting from the same privileges given to our Brazilian members.

Working towards the construction of our fruitful cooperation and intending to give a clear visibility to the **Metrology Society of Australia** in Brazil we have quoted our Agreement of Cooperation in our home page www.sbmetrologia.org.br and also linked it to the MSA website. To make it accessible to our Australian colleagues, we are giving high priority to the implementation of the English version of our site.

To move further, let me propose to re-publish in our *Metrology & Instrumentation Journal*, directed to the Brazilian industry, the Portuguese version of the interesting article *A new perspective on assessing conformance to specification*, by Jeffrey Tapping, published in the last issue of TAM, kindly sent to us.

The Brazilian Metrology Society is developing and growing fast. Already affiliated to our organization we have about 1500 professionals as individual members and over 60 institutional affiliates, somehow interested in metrology and metrology related areas. We strongly believe that our organization must grow much more, amplifying our capillary action towards the development and dissemination of culture in metrology, also giving us an independent and powerful voice to be heard by the politicians and decision makers capable to interfere in the approval of important metrology projects and decisions for the country.

Complimenting the Australian metrology community, we offer our media as a communication channel to strengthen our cooperation.

Sincerely Yours.

Maurício Nogueira Frota

President of the Brazilian Metrology Society

Accuracy

A letter in a recent issue of New Scientist magazine [1] contains a cautionary tale on a lack of understanding of uncertainty in measurement. It describes an incident in which a dignitary visiting an archaeological site asked the age of a rock. The reply from a team member was "Four million and two years and three months". When asked how dating could be made so accurately, the team member said "No problem. When I started work at the site it was four million years old and I have been here two years and three months".

On a more serious note, an article in another issue [2] discusses accusations of tobacco companies manipulating the international standards system to their advantage. The official tar rating for cigarettes is measured using a standard smoking machine, which is specified in an ISO standard, and the committee that administers the standard is dominated by industry repre-

sentatives. In 1990 the European Union set the maximum tar rating for cigarettes to 15 mg. In 1988 when it was known that the new limit was to be set, the committee began work on a new specification for the standard smoking machine. The outcome was that on changing from the old standard to the new a major brand of cigarette changed from a rating of 15.5 mg to 14.5 mg without any change in the product!

The article states that smokers actually inhale far more nicotine and tar than is registered by the test, and quotes an industry representative as saying "Smoking standards have never been intended to measure either intake by the smoker or any health claim. Their purpose is purely comparison." The last sentence may come as a surprise to calibration metrologists who are accustomed to results being traceable to SI units, but many tests are carried out as measurements against the specification, because there is really no other way. These tests will still be required soon to be presented

with an uncertainty statement but the uncertainty will reflect the reproducibility of the test method and the accuracy in which it has been carried out.

The first sentence of the quotation is much more disturbing. The community, including consumers and legislators, will expect a test result to have a meaningful relationship to the application of the test. And they would also expect that the goalposts were not moved by changing a test, unless that made the test more meaningful in its application and use. Standards of this kind need something analogous to traceability, namely a requirement that they aim to represent realistically the application they are used for.

References

1. New Scientist 24 March 2001, page 59.
2. New Scientist 9 June 2001, page 4.

- Jeffrey Tapping

Conformance to Specification - Addendum

After the publication of my paper on conformance to specification in the last issue of this journal, my attention was drawn to an article which I certainly would have made a reference to if I had been aware of it [1].

The article is quite long, 50 pages in a book, and is directed towards people responsible for quality control in manufacturing. It discusses in some detail the effects of measurement and calibration of test equipment on a process. Of particular interest is a quantification of false acceptances and false rejection rates, taking into account calibration and measurement uncertainties. In this it implicitly acknowledges that the result of a measurement is a probability distribution.

The article was written just before the publication of the Guide to the Expression of Uncertainties in measurement, so some of it is not quite in conformance with current methods, but you will find quite a bit of good stuff in it if you have the perseverance to plough your way through. If you are interested in the blunt end of the calibration chain, then the article is well worth reading.

1. Hayes, J.L., "Calibration and Maintenance of Test and Measuring Equipment", Encyclopedia of Applied Physics, Vol 4 page 40, VCH Publishers, 1992.

- Jeffrey Tapping

MSA SA Group Meetings

We have had a number of talks this year on topics outside of the usual calibration areas, each one very interesting and well-received by the listeners. In July, to add to the talks on testing of breathalysers, speed cameras, and lung function, we received an address by Grant Mackey on testing of road surfaces.

Grant Mackey is Technical Support Manager for Transport SA, and he spoke to us mainly on his specialty of skid-testing, or more correctly, friction resistance testing of road surfaces. Grant told us that recent court decisions had changed the old belief that road authorities did not have a legal responsibility to maintain roads in a good and safe condition, so road surface testing now has a new importance. Since it is estimated that each fatal road accident costs the community about one million dollars the change is surely an appropriate one.

A number of devices are used to test surfaces. The oldest is called the British Pendulum. It has an arm that rotates around a horizontal axis, and on the end of the arm is a shoe-like weight faced with a rubber sheet. The arm is positioned so that it can swing down from a horizontal position such that the rubber sheet is dragged across the surface to be tested. The angle travelled by the arm after impact is a measure of the frictional characteristic of the surface. Obviously a number of characteristics of the apparatus will affect the readings, and the test method is laid out in a British Standard. One of the specifications is that the surface is tested wet, and in fact all of the various test methods require a wet surface, mostly because this represents the worst-case condition for a road or similar surface. Another requirement is that the rubber is smooth, not treaded, because this gives a more consistent result, and again this is specified in other test methods.

But can you imagine testing the length of the Eyre Highway or Main North Road with a British Pendulum? For this task mobile devices are used, either fitted to a trailer or in a dedicated truck. The other device used in South Australia is called the Griptest, which is a small trailer. The Griptest has three wheels, and one is set so that it rotates at a speed equivalent to less than the speed of the trailer and so it is continuously skidding. Various forces on the skid-wheel are measured, fed into a computer and a grading calculated. The rotational difference for the skid wheel is varied repeatedly from zero to 5 km/h, and we were told that the forces generated by this effectively destroyed one vehicle which towed the machine across the Nullarbor Plain.

There was a host of detail given about roads, such as the effects of gravel-size, the composition of the stone, the surface characteristics of the gravel, the camber of

the road, the recovery problems resulting from B-Double trailers, methods of surface rejuvenation, the results on cars and motorcycles of differential skid characteristics between paint and bitumen or across the carriageway, and much more. All in all a fascinating talk presented by a knowledgeable enthusiast. And since the meeting was held at the Police Club we were all careful to behave ourselves.

Further meetings

Two more meetings are scheduled for this year. One on 17th September, and an early Christmas celebration on 27th November.

We will be moving to communicating about meetings *via e-mail rather than by letter*. **Any SA members who have acquired or changed their e-mail address in the last year are asked to notify the new address to tapping@ozemail.com.au as soon as possible.**

- Jeffrey Tapping

Measurement Matters

When is an inch not an inch?

The importance of having standards of measurement is highlighted by this story from early last century. In World War 1 Australia agreed to contribute to the war effort by manufacturing small arms (.303 rifles) at Lithgow in NSW. The American Civil war had decisively demonstrated the value of interchangeable parts and ammunition. At the time Britain had two major manufacturers - Birmingham Small Arms and Enfield. Blue prints were sent to Australia and the factory was built at Lithgow. The two British factories had just standardised their inch. Previously there had been two inches used in British arms - the Birmingham inch and the Enfield inch. The blueprint sent to Australia contained the wrong inch. The result of this error meant that Australian arms and ammunition were not interchangeable with the British built ones. This was not a good result for allies fighting side by side and defeated the whole purpose of the exercise.

Units

Force: Pounds or Newtons... Does it really matter? Well yes it does, even a small mistake involving units can have drastic consequences. When NASA lost a \$125

million Mars Climate Orbiter spacecraft the error was tracked back to the failure to convert some calculations from the Imperial measurement system into the metric system. One team of flight controllers had programmed the spacecraft in pounds and feet while the other had entered Newtons and metres.

A more humorous example of mistaken units was reported in the New England Journal of Medicine where researchers at the Mayo Clinic were trying to measure the number of calories expended when subjects chewed gum. They decided to use hertz to measure the number of chews. They then reported their subjects were asked to chew at precisely 100 Hz. Since hertz is defined as the number of cycles per second this meant their subject would really have those jaws moving. In fact what was meant was 100 times per minute, a much more achievable and leisurely pace.

Finally a challenge for those of you who are unit minded. Spot the errors in this press release issued by the Kennedy Space Centre on 11 September 1998.

"At lift-off, the space craft will weigh 1418 pounds (3210 kilograms). It is 7.6 feet (925 meters) high, 6.4 feet (21 metres) deep, and 5.4 feet (18 meters) wide. Power is provided by a single large solar array, which is 18.6 feet (61 meters) long and 6.8 feet (22 meters) across. After cruising in space for 286 days, the spacecraft will be captured in an elliptical orbit around Mars."

If you have any other interesting examples of measurement mistakes I would be interested in hearing from you. Please contact me on 02 9856 0353 or by e-mail mhaire@nsc.gov.au

- Marian Haire

National Standards Commission

Measurement Trivia

1 **barn** = 10^{-28} square metre

It is an extremely small unit of area, used for expressing the effective cross-sectional area of an atom. The unit was devised in 1942 by the American nuclear physicists Baker and Holloway, and so named - apocryphally - because, compared with a subatomic particle, an atomic nucleus is 'as big as a barn door': an unmissable target.

And, would you believe it, someone came up with the following...

1 **shed** = 10^{-52} square metre

= 10^{-24} barn

The unit was given this name as a 'smaller version' of the barn.

The following article is reprinted with permission from Philip Stein and the American Society for Quality. It appeared in the ASQ Measurement Quality Division publication *The Standard*, Autumn 1996.

The Contrarian Metrologist

by Philip Stein

Uncertain Times Three

In the Winter issue of *The Standard*, I began a discussion of uncertainty and its separation into types A and B. In that article, I said incorrectly that Random errors are now called Type A and are defined as 'those which are evaluated by statistical methods' and that Systematic errors are now called Type B, and are defined as 'those which are evaluated by other means'. This error was kindly pointed out to me by Dr. G.M.S. de Silva of Dhahran, Saudi Arabia and I stand corrected. I do understand uncertainty and its definition better than I expressed there. I guess I was trying to make it easier to understand and wound up oversimplifying it instead.

What this means, then, is that I have to come clean and discuss the whole topic with all of its complexity. I'm going to do that here, and I hope I can keep it understandable anyway.

Dr. de Silva wrote, in part,

"According to the definitions of the guide (Guide to the Expression of Uncertainty in Measurement, International Organization for Standardization, 1995), uncertainties arising from "random effects" and "systematic effects" are fundamentally the same. Both types of uncertainty can be evaluated by either Type A methods or Type B methods"

So Type A uncertainties are those which are evaluated by statistical methods, and Type B are those which are evaluated by other means. There are two interesting things to note about this picture. The first is that Type B errors are estimated by the metrologist, (we hope) by applying good scientific methodology and sense, but not necessarily according to any required method or procedure. The second is that certain errors can, unlike a leopard, change their 'spots' and switch from one type to another. This can, as we will see, be very useful.

Let me give you an example. First, imagine weighing a one-kilogram box of steel nails on a two-pan balance, using a set of brass weights. I repeat the measurement several times in order to statistically determine the repeatability of the measurement process. The Type A uncertainty may be calculated (as the standard deviation) from the variation among the many replicates (repeats) of the same measurement. The Type

B uncertainty comes from the difference between the weight set and national standard weights, from the difference in buoyancy between brass and steel, and from any consistent asymmetry in the balance. Note that inconsistent problems with the balance, changes in the buoyancy correction due to changes in weather, etc. may show up as Type A uncertainty because they are different for different replicates.

Now imagine a sort of expanded gauge R&R study, a measurement capability study. Using the same type of balance I weigh four separate boxes of nails, using two different balances and two different weight sets, and I replicate each possible combination twice (a total of 32 measurements). Using the Analysis of Variance statistical procedure, I separate the total uncertainty into contributions from scale, weight set, and random error. Of course, the boxes of nails have different weights, but that's not part of the uncertainty, those weights are the reported results themselves. Now, if we wish, we can assign (statistically) estimated uncertainties in the weights, the balances, and the buoyancies to Type A because we have separately quantified them and can include them in the mathematical model of the measurement system, where before they simply added to the overall uncertainty and we couldn't identify their sources. This is entirely consistent with the Guide.

The real reason we're interested in separating and allocating uncertainty to Types A and B is that the way to reduce or eliminate these uncertainties is different depending on which type they are. Many Type B uncertainties, for example, can be eliminated by calibration (just correct for the known, calibrated difference from the national standard), or by correction (calculate and apply the buoyancy correction). Type A uncertainties are not repeatable - their variation is random - and can be reduced by averaging repeated measurements or by engineering improvements in the measurement process.

Well, I've gotten a bit wordy here and I've barely scratched the surface. I'll put off for another column the questions of how to combine Types A and B for a total statement of uncertainty. I'll also postpone some of the contrarian stuff - like the complaint from one well-known metrologist that the trouble with Type B errors is that you can estimate them any way you like.

Phil Stein can be reached at:

Philip G. Stein Consultants, 400 Oak Street
Pennington, NJ 08534

You can also reach him via the Internet at
pstein@measurement.com

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Instrument Society of America: 2001 Conference and Exhibition
Houston, Texas, USA
Website: www.isamarketplace.org

September 17-19, 2001

IMEKO Conference: Virtual and real tools for Education in Measurement
Enschede, The Netherlands
Website: www.mi.el.utwente.nl/imeko/tc1/

October 2-4, 2001

MSA '01: Everyday Metrology: 4th Biennial Conference of the Metrology Society of Australia
Broadbeach, Gold Coast, Queensland, Australia
Website: www.metrology.asn.au

October 8-10, 2001

18th Metrology Symposium of the Croatian Metrology Society
Cavtat, Dubrovnik, Croatia
Website: www.hmd.hr

July 7-12, 2002

15th Biennial Conference of the Aust Institute of Physics
University of NSW, Sydney, NSW, Australia

July 21-25, 2002

INTERACT 2002: analytical chemistry, chemical metrology, chemometrics, ecotoxicology, environmental chemistry, pharmaceutical chemistry
Sydney, New South Wales, Australia
Website: www.pco.com.au/interact2002

June 22-26, 2003

XVII IMEKO World Congress
Dubrovnik, Croatia
Website: www.hmd.hr/imeko

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