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SIRIMLink

Driving innovation through technology and quality

FAIR MEASURE

Metrology as the foundation of domestic trade and the global economy

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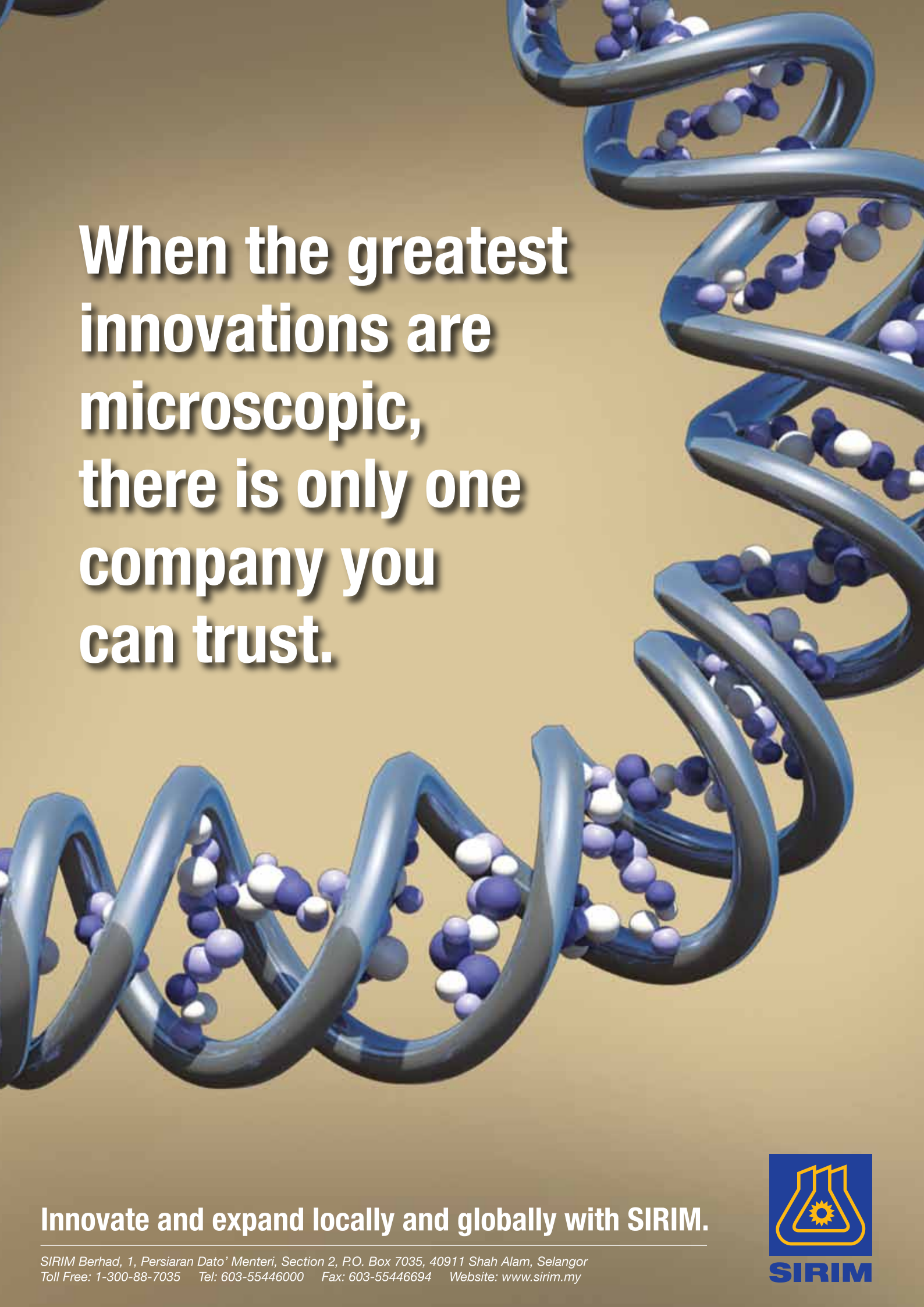

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MEASURING UP

GROWING UP AS I DID IN THE 1960s, I am no stranger to the older units of measurement we used to use back then: pounds and yards, *gantang* and *ela*. I was thus very relieved when SIRIM was founded in 1975 as the national standards keeper and immediately made it its business to implement the International System of Units (SI) as the national system. For at least ten years afterward, both the older and newer systems coexisted in a state of uncomfortable transition, and then slowly, the older system faded away all together. My own children have no idea what a *gantang* or *ela* looks like, and, I am sad to say, even my memory of those units of measurement is growing hazy.

Like many other countries, Malaysia's rapid advancement into the industrial economy would not have been possible without metrology. The foresight of the country's leaders in adopting the SI system allowed Malaysia to leapfrog many competing countries and to position itself as a leading developing economy.

Further, the national measurement system has been strengthened by the National Measurement System Act 2007 and the revised Weights and Measures Act 1972. The subsequent appointment of the National Metrology Laboratory (NML) as the National Measurement Standards Laboratory (NMSL) has empowered the NML to act in accordance with its statutory functions.

In this issue, we revisit the principles, frameworks and ideas that the science of measurement is based on. We also speak to metrologists at the NML to better understand their role in industry, society and research, and see how metrology intends to cope with the challenges of the future.

Enjoy the issue.

Nor Rashid Ismail
Vice President
Corporate Division

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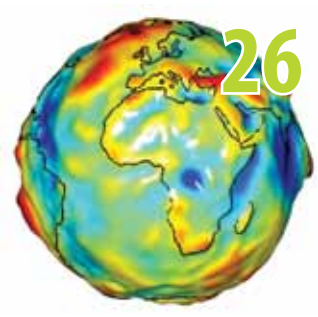
Certified Reference Materials are an indispensable part of trade but are also notoriously hard to produce. After years of research and training, however, the National Metrology Laboratory is finally beginning to see the fruits of its labour. See page 24.

GOLDEN TIMES

Why even the most accurate and precise clocks in the world will not prevent tardiness.



THE MYSTERY OF GRAVITY

The NML's three gravity spots have been measured to eight decimal points.

PISTON PERFECT

An NML researcher will soon be making pressure balances to rival the best in the world

WHAT'S NEW AT SIRIM

The news and highlights of the past quarter at SIRIM Berhad.

Innospace Sarawak to encourage innovation among community grassroots

More innovation centres to follow in Labuan, Sabah and Pahang.

INNOVATORS IN Sarawak now have a place to take their ideas to with the launch of the Innospace Centre at SIRIM's branch office in Kuching, the first of three such centres planned this year.

Datuk Seri Dr Maximus Johnity Ongkili taking a closer look at some of the products displayed at the Innospace Centre.

The Innospace centres are aimed at ensuring that aspiring grassroots innovators have a platform on which they can develop their ideas, thus encouraging a culture of innovation among the rakyat. Each centre will provide the space and facilities that innovators need to develop their inventions and make prototype models, while SIRIM officers will be on hand to answer any questions that users of the community innovation centres may have. Innospace centres will also offer training sessions on creativity and innovation as well as guidance and advice on commercialisation and entrepreneurship.

SIRIM Sarawak was selected as the first location for the Innospace Centre because it has knowledgeable officers and facilities that are ready to help innovators. SIRIM will also host innovation exhibitions and networking sessions to encourage investment in the ideas of local innovations as well as conduct patent searches for inventors to ensure they do not inadvertently violate any IP laws.

Training at Innospace centres will be conducted by the Malaysian Inventions Centre and National Productivity Corporation besides NGOs such as the Malaysian Innovation Foundation. Innospace Sarawak will include workshops on computer-aided designing, ceramics, packaging, prototyping, quality assurance and various handicrafts.

The opening of Innospace Sarawak was officiated by Datuk Seri Dr Maximus Johnity Ongkili, the Minister of Science, Technology and Innovation. Also present at the event were Dato' Ir Hj Yahaya Ahmad, President and Chief Executive of SIRIM as well as Mohamad Abdul Kadir Johari, General Manager of SIRIM Sarawak.

In launching Innospace Sarawak, Datuk Seri Dr Maximus said that the centre was modelled after the success of a similar project that was implemented in Holland. "We want to make the programme sustainable while developing creative minds among people in the country," said Datuk Seri Dr Maximus. "If these four centres prove to be successful, we will suggest that the federal government establish similar centres in all states or use an Innospace Mobile concept to reach a larger segment of the community."

SIRIM's biomedical wound management innovation to move into pilot production

MoA with Universiti Sains Malaysia and Universiti Pendidikan Sultan Idris expected to expand local product offerings

SIRIM'S EXPERTISE IN MEDICAL technology will soon be enhanced with its collaboration with two of the country's leading universities.

The collaboration with Universiti Sains Malaysia (USM) and Universiti Pendidikan Sultan Idris (UPSI) will involve the pilot production of biodegradable scaffolds for skin regenerating templates from natural polymers. The objective of the programme is to create chitosan bilayered scaffolds based on good manufacturing practices (GMP) as well as good laboratory practices (GLP). Chitosan has been identified as an ideal material for developing biodegradable tissue scaffolds for wound healing and dermal reconstruction.

SIRIM Berhad hosted the documents exchange ceremony at the Advanced Materials Research Centre (AMREC) in Kulim, Kedah. SIRIM was represented by Dr Hj Zainal Abidin Mohd Yusof, Vice President of the Research and Technology Development Division, while USM was represented by the then Vice Chancellor of its Industry and Community Network, Professor Lim Koon Ong. UPSI was represented by Professor Dr Mohd Mustaman Abd Karim, Deputy Vice Chancellor of Research and Innovation.

In his speech, Dr. Hj. Zainal Abidin explained how dressing and wound healing today usually involved the grafting of healthy skin to damaged skin, a less-than-ideal approach that often results in bad scarring. However, the chitosan bilayered scaffold - an award-winning innovation of SIRIM researchers at ITEX 2008 - will allow the skin to heal by acting as a template on which skin can regenerate naturally.

"Using a chitosan bilayered scaffold not only protects the patient from dehydration and infection but also accelerates fibroblastic synthesis for collagen as the wound heals," explained Dr Hj Zainal Abidin.

Dr Kartini Noorsal showing a sample of a chitosan bilayered scaffold to researchers from AMREC.

The RM2.94-million project will include limited GCP-certified (Good Clinical Practice) clinical trials. As Malaysia's leading industrial research institution, SIRIM will focus on ensuring the scaffold products are produced according to GMP-compliant procedures, while USM will focus on preclinical and limited clinical trials. UPSI will undertake the fabrication process for the project.

"The global market for wound management products is growing rapidly," said Dr Hj Zainal Abidin at the ceremony in Kulim. "It was worth USD5.2 billion in 2008, and this is expected to grow to USD16 billion by 2017."

According to Dr. Hj. Zainal Abidin, wound healing products have evolved from traditional bandages to advanced technologies based on moist would healing products made of biopolymers, hydrocloids, composites and even film. However, most of these products are imported at a cost of millions of ringgit to patients every year.

"This project will also thus reduce our reliance on foreign imports," said Dr. Hj. Zainal Abidin.

SIRIM innovations shine at ITEX 2010

Young researchers win a record of six gold and two silver medals at the annual exhibition, including "Best Green Invention"

THE COUNTRY'S FOREMOST industrial research institution SIRIM Berhad once again demonstrated its leadership in research and innovation when it bagged six gold and two silver medals at the 21st International Invention, Innovation and Technology Exhibition at the Kuala Lumpur Convention Centre earlier this year.

SIRIM's entourage of 42 researchers submitted eight competition entries this year in the categories of materials, electric and electronics, self-care products, learning and biotechnology, health and fitness. The winning entries included a biomedical wound management product made from water soluble chitosan derivatives, a proposal to use waste rubber as a binder in metal injection moulding as well as natural bioactives for topical applications.

SIRIM also walked away with the coveted "Best Green Invention" award in the research institution category. Titled "*Photopatternable Hybrid Organic-Inorganic Sol-gel Materials for Planar Optical Waveguide Applications*", the winning project successfully reduces the amount of photoresistant chemicals required in the fabrication of optical waveguides, making the products significantly less toxic to humans and the environment. Optical waveguides are widely used in broadband telecommunications systems.

The awards were presented by Dato' Dr. Sharifah Zarah Syed Ahmad, Deputy Secretary General (Policy) at the Ministry of Science, Technology and Innovation (MOSTI). ITEX 2010 brought together 650 innovations from researchers and scientists in local universities, research institutes

Dato' Ir Hj Yahaya Ahmad (third from left) with his winning teams of researchers after the awards were presented.

and the private sector. It also had several foreign entries from Russia, Iran, Korea, Taiwan, Hong Kong, India, Thailand and Vietnam.

Dato' Ir. Hj. Yahaya Ahmad, President and Chief Executive of SIRIM Berhad, said that all the credit for SIRIM's record haul at the competition should go to the innovators behind them.

"We are also encouraged by the emergence of several younger researchers at this year's competition, and hope that they will continue their winning ways in the years ahead," said Dato' Ir. Hj. Yahaya after the exhibition.

The gold-winning team led by Dr. Ahmad Hazri Abdul Rashid (second from right) with their invention *"Wound Management Product from Water Soluble Chitosan Derivatives"*.

GOLD MEDAL WINNERS

1. "*Photopatternable Hybrid Organic-Inorganic Sol-gel Materials for Planar Optical Waveguide Applications*" by Dr. Mohamad Zahid Abdul Malek, Mat Tamizi Zainuddin, Nik Mohd Azmi Nik Abdul Aziz, Hasrina Hashim, Samsul Azrolsani Abdul Aziz Nazri and Dr. Aishah Isnin. (Materials category)

2. "*Potential Application of Waste Rubber as a Binder in Metal Injection Moulding*" by Istikamah Subuki, Dr. Mohd Afian Omar, Dr. Hanafi Ismail, Muner Taha, Norsyakira Abdullah and Fauzi Ismail. (Materials category)

3. "*Wound Management Product From Water Soluble Chitosan Derivatives*" by Dr. Ahmad Hazri Abdul Rashid, Dr. Zanariah Ujang, Prof. Dr. Ahmad Sukari Halim, Mazita Mohd Diah, Siti Kasmarizawaty Suboh, Norrasyidah Sarmin, Farah Zuana Uzair, Harmayumi Wahid, Zulaina Ahmad, Mohd Helme Mohd Helan and Rozanida Abdul Rahman. (Materials category)

4. "*Improved HF Antenna Design for Wireless Authentication*" by Noraishah Shamsuddin, Nor Azlina Muslim, Rahimi Al Rozi, Dzurliza Ahmad and Borhanuddin Md. Yusof. (Electric and Electronics category)

5. "*Hybrid Network Resettable Circuit Breakers*" by Gooh Chye Seong, Mohd Rafedin Rakiman, Md. Yazid Miskom, Nurul-Amri Zakaria, Mohd Rizal Abdul Razak and Rosli Mohamad Noor. (Electric and Electronics category)

6. "*Green and Natural Bioactives for Topical Application*" by Dr. Zanariah Ujang, Dr. Ahmad Hazri Abdul Rashid, Mazita Mohd Diah, Thavamanithevi Subramaniam, Harmayumi Wahid, Mohd Helme Mohd Helan, Suzaini Badruddin, Siti Kasmarizawaty Suboh and Badariah Abdullah. (Self-care products category)

SILVER MEDAL WINNERS

1. "*Generic Microcontroller Training Kit*" by Al Malek Faisal Mohd Amin, Mohd Suhaimi Abd Wahab, Khairul Fatiah Mohd Yunos, Mohd Hazam Shah Abd Hamin and Borhi Boldi. (Learning items category)

2. "*Biosensor for Ammonia Detection*" by Dr. Jaafar Abdullah, Samsulida Abd. Rahman, Hamidah Sidek and Nur Ellina Azmi. (Biotechnology, health and fitness category)

Industrial collaboration paves the way forward for SIRIM in Middle East and North Africa

Developing economies in MENA region to benefit from SIRIM's products and services and training.

A COLLABORATION VENTURE with Perfect Way Sdn Bhd and Malaysia-Yemen Investment (InvestMy) has paved the way forward for SIRIM Berhad into the Middle East and North African Region (MENA) in areas relating to research and development, training and consultancy services.

The Memorandum of Understanding (MoU) was sealed at a signing ceremony at Impiana Hotel KLCC earlier this year in which SIRIM Berhad was represented by its President and Chief Executive, Dato' Ir. Hj. Yahaya Ahmad while Perfect Way Sdn Bhd was represented by its Chief Executive Officer, Mr Mohamed Ammar Omer Abdullah. Malaysia-Yemen Investment was represented by its President, Rozainah A. Wahab.

Signed on the sidelines of the 6th World Islamic Economic Forum (WIEF), the MoU provides the parties a platform for knowledge transfer and training consultancy while exploring business opportunities and technology networking in the Middle East region.

According to Dato' Ir. Hj. Yahaya Ahmad, "As a recognised industrial research and technology development institution with more than 30 years of experience, SIRIM is confident of contributing towards technology advancement at the international level in our areas of expertise such as Research and Technology Development, Technology Transfer as well as Quality and Conformity Assessment. The MoU comes at the perfect time for SIRIM as we seek opportunities to broaden our markets abroad, and we look forward to a successful long-term collaboration with both parties".

Under the MoU, SIRIM and Perfect Way will strengthen technical cooperation in the export of knowledge and expertise, research and development as well as training and consultancy services. Perfect Way will act as SIRIM's marketing arm and will promote its products and services in the Middle East and North Africa region (MENA) while facilitating, monitoring and servicing clients in the region.

Dato' Ir Hj Yahaya Ahmad (left) exchanging documents with Dr Hamid Ziad of Malaysia-Yemen Investment (centre). Looking on is Rozainah A. Wahab (right).

Meanwhile, SIRIM's collaboration with Malaysia-Yemen Investment will be on the development of technical training modules and providing consultancy on the setting up of a learning factory. It also entails technical information and personnel exchange programmes, technology transfer and the training of trainers.

Many countries in the Middle East have shared common positions with Malaysia on international economic and trade issues. With moves to liberalise the economies of these countries gaining momentum in recent years, economists predict that the markets of R&D and biotechnology in the region will grow very rapidly. With this collaboration, SIRIM aims to significantly contribute to Malaysia's economic growth and enhance its global footprint in research and innovation.

THE WONDERFUL WORLD OF METROLOGY

The international framework of metrology that we know today is largely the result of the Metre Convention: the 1875 treaty that created the International Bureau of Weights and Measures (BIPM), an intergovernmental organisation under the authority of the General Conference on Weights and Measures (CGPM) and the supervision of the International Committee for Weights and Measures (CIPM). The BIPM acts in matters of world metrology, particularly concerning the demand for measurement standards of ever increasing accuracy, range and diversity, and the need to demonstrate equivalence between national measurement standards. It has fifty-four Member States including Malaysia.

BIPM's Member States

GENERAL CONFERENCE ON WEIGHTS AND MEASURES (CGPM)

Consists of delegates from Member States and meets every four years

Associates of the CGPM

International Organisations

INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASURES (CIPM)

Consists of eighteen individuals elected by the CGPM. Charged with the supervision of the BIPM and its activities. The CIPM meets annually.

Consultative Committees and Joint Committees

National Metrological Institutes

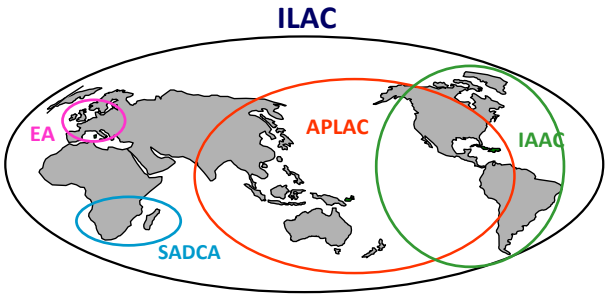
BIPM HEADQUARTERS

Direction, laboratories and permanent staff of the BIPM

CIPM MRA

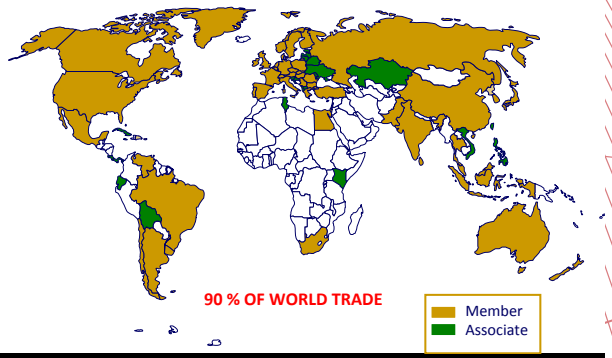
JCRB

INTERNATIONAL LABORATORY ACCREDITATION COOPERATION (ILAC-MRA)



The ILAC-MRA is a global network of accredited testing and calibration laboratories. It consists of 139 member bodies including 33,000 accredited laboratories and 6,000 inspection bodies. Malaysia is a signatory to the ILAC-MRA in the fields of testing and calibration through the Department of Standards Malaysia (STANDARDS MALAYSIA).

INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES (CIPM-MRA)



The CIPM-MRA consists of 48 Member States of the BIPM, 27 Associates of the CGPM, and 3 international organisations – the International Atomic Energy Agency (IAEA), the Institute for Reference Materials and Measurements (IRMM) and the World Meteorological Organisation (WMO). It also covers a further 134 institutes designated by the signatory bodies.

MONEY IN TRADE

Azim Ng Abdullah, Vice President of the Standards & Quality Division at SIRIM Berhad, talks about the National Metrology Laboratory's (NML) responsibilities in international trade and the global economy.

METROLOGY IS AN IMMENSELY important aspect of trade and industrial development.

In fact, it would not be an exaggeration to call metrology the foundation for global trade. Without a common metrological language, trade ties would crumble and economies would suffer. However, all units of measurement must link back to globally-accepted norms and definitions which the world and all its citizens understand and accept.

For Malaysia and most of the world, that link is BIPM: The International Bureau of Weights and Measures, an organisation based in France that is tasked with ensuring the worldwide uniformity of measurements and their traceability to the International System of Units (SI). The Bureau has 54 member states, one of which is Malaysia's National Metrology Laboratory (NML).

AZIM NG ABDULLAH: "The NML's calibration certificates are now acceptable worldwide."

"Every member state of the BIPM is supposed to ensure that its local definitions of kilos and metres are the same as everyone else's," explains Azim Ng Abdullah, Vice President of the Standards & Quality Division at SIRIM Berhad. "That's why the BIPM established the International Committee of Weights and Measures (CIPM): it oversees the mutual recognition of calibration and measurement certificates issued by National Metrological Institutes worldwide so that our countries can do all business with each other."

To achieve this goal, the CIPM coordinates the global Mutual Recognition Arrangement (MRA) among all its signatories. But becoming a signatory to the CIPM is no small deal: first, you undergo a series of key comparisons to establish your credibility as a metrological institute. Then, you are reviewed by peer NMIs in supplementary international comparisons of measurements. These comparisons involve items called 'artefacts': physical objects that are measured in each other's countries so that the results can be compared.

"If the NML says the artefact weighs 1.0001 grams in Malaysia, it should also weigh 1.0001 grams in another country," says Azim Ng. "And if the results are not the same (it happens), you have to agree upon the degree of tolerance within which trade would still be acceptable."

At the time of writing, the CIPM MRA had been signed by 48 Member States of the BIPM, 27 Associates of the CGPM, and three international organisations – the International Atomic Energy Agency (IAEA), the Institute for Reference Materials and Measurements (IRMM) and the World Meteorological Organization (WMO). It also covers a further 134 institutes designated by the signatory bodies.

"The final step to becoming a CIPM MRA signatory is to demonstrate your commitment to a quality management system by being accredited to the ISO/IEC 17025 standard for testing and calibration laboratories," says Azim Ng. "By We've already successfully completed all of that, which means that our calibration certificates are now acceptable worldwide."

THE DECIMAL RACE

Clearly, the NML's standing in the international community speaks for itself. That why the NML benchmarks itself and its capabilities against the best laboratories in the world – it is arguably among the best metrological laboratories in the region, and in some areas, it is comparable to NMIs in Europe. The real test for the NML is in building its capacity for more accurate and precise measurements, a challenge it shares with other metrological institutes the world over.

National metrological institutes have to constantly find ways to stay ahead of industries that are manufacturing products at an increasingly smaller sizes. They are also expected to be able to offer services at an accuracy and precision that is better than those of the manufacturers themselves. Ten years ago, global trade agreements were happy with definitions for micro measurements in the realm of 1×10^{-6}. Now, you need to have the capacity to measure things in terms of the nanoworld, or 1×10^{-9}. If you don't you won't be able to support the growing nano industries.

"Capacity building takes money," says Azim Ng. "We have to be able to measure everything at least one decimal point better than industry, otherwise we won't be able to fulfil our role as a standard reference point and metrology authority. But, in order to measure to that level of precision, we need to buy equipment which gets more expensive with every decimal point of accuracy."

There is also the challenge of finding and training metrologists to do all this work. After all, metrology is not exactly the first thing that comes to mind for science graduates fresh out of university.

"Metrology can be a very fulfilling career, and we can fill any knowledge or skills gaps through training and career development," says Azim.

MEASURING UP

Some might argue that given its capabilities and achievements, the NML ought to engage in more basic research and development, and it does. However, although the NML has had some modest successes that help keep things interesting at the lab (it has patented a new method for calibrating stopwatches that is faster and more accurate than other methods, for example), it is still some way off from making any breakthroughs in more sophisticated technologies.

"We're in the business of calibration and standardisation, not equipment, and so that is the focus of our innovation energies," explains Azim Ng. "We're not interested solely in inventing new equipment. We are interested in refining our calibration procedures and making them more efficient, more accurate, and more certain. Equipment is merely the means to achieve that."

To date, nearly USD50 million has been invested into the National Metrology Laboratory. Most of this has been spent on calibration standards and measurement equipment, including a nanoscale measurement machine that cost over RM2 million (USD600,000). Still, considering all that the NML has done and will continue to do for the country, it is money well spent.

"We're not here to make money for ourselves," says Azim Ng. "We serve a higher purpose: we're here to ensure that the whole country can make money."

PERFECT

We tend to take the modern infrastructure of our economies for granted, little realising how hard metrologists around the world have to work to enable that trade. Abdul Rashid Zainal Abidin, Senior General Manager of the National Metrology Laboratory, speaks to SIRIMLink about metrology's role in industry.

MEASURE

WHAT DO FISHMONGERS, taxi drivers and micro-engineers have in common?

Answer: they all need a metrologist.

The role of metrology in modern society and industry is so complete that one would be hard-pressed to find a branch of science that is more important or far-reaching in its influence. Almost everything has a metrologist somewhere behind it taking careful measurements and comparing them against global reference standards – electricity, pharmaceuticals, petrol and even our concept of time itself has metrology to thank for its existence and acceptance in our lives.

It is hard to imagine it now, but there was a time not so long ago when the infrastructure and systems between one country and the next were as different as the languages of their people. This presented some very interesting difficulties to the economies of that time. A ream of cotton could not be sold without being first divided up into units of measurement that the target market understood. And if you complained to a European that the price of rice was so high you could only afford three *gantang* a month, he would have to first convert that number into pounds or stones or maybe even something more exotic like a German *doppelzentner* before being able to appreciate your concern.

We've come a long way since then, thanks in no small part to the work of SIRIM and the National Metrology Laboratory (NML). >>

A NEW STANDARD FOR MALAYSIANS

Thirty years ago most Malaysians still bought and sold stuff in terms of *kati*, *chupak* and *ela*. Then, with the help of the Weights and Measures Act 1972, it became SIRIM's job to try and get everyone to start trading in terms of kilogrammes and metres, which is why most people today don't even recognise those old units of weight anymore.

Today, of course, the NML has much bigger fish to fry. As the National Custodian of Weights of Measures and keeper of Malaysia's Primary Physical Standards of measurement, the NML is the country's foremost authority on reference standards for the measurement units of mass, length, time, temperature, luminous intensity, resistance and voltage.

"Actually, our facility and expertise is regarded as being among the best in this region," says Abdul Rashid Zainal Abidin proudly. He is Senior General Manager of the NML and, if there were such an appellation, the country's Chief Metrologist. "Being primarily a government agency, our main duties to society and country are within industrial and legal metrology, although we do maintain some basic research and innovation activities in scientific metrology to develop physical standards and certified reference materials."

Industries are obsessed about improving inspection times, throughput and quickly analysing large amounts of measurement data. Why? Because doing so can significantly improve their abilities to lower production costs, and in today's competitive global economy, that means everything. The NML's understated duty in industrial metrology is to improve the competitiveness of businesses by improving their measurement capabilities. This not only improves the quality of the products these businesses make, but also their ability to improve their manufacturing efficiencies.

"If we support our industries in terms of their measurement capabilities, this will support their competitiveness globally," explains Abdul Rashid.

It's a simple enough concept: Malaysia bars products from entering its marketplace if they

METROLOGISTS OF THE ROUND TABLE: Standing, from left: Dr Ahmad Makinudin Dahlan, Dr Osman Zakaria, Dr Wan Abd Malik Wan Mohamed and Dr Abd Rahman Mohamed. Seated, from left: Hafidzah Othman, Abdul Rashid Zainal Abidin and Dr Mohd Nasir Zainal Abidin.

don't meet the NML's stated requirements in terms of voltage, chemical content or environmental suitability. Similarly, national metrological and standards institutions in other countries around the world have requirements of their own, and if your product does not meet those standards, then you won't be able to enter those markets, either.

The most obvious example of this market mechanism at work is in the way some of Malaysia's neighbours have barred imports against certain Malaysian farmers and fishermen, claiming that the level of pesticide and preservatives in their goods are unacceptable.

"That's where we come in," says Abdul Rashid. "We have to help these farms and fisheries by developing certified reference materials that they can use to improve their systems and reduce the amount or type of pesticides they use in their processes. That's the only way they will be able to gain access to regional markets, which will in turn help other Malaysian agribusinesses, too."

SMALL IS BEAUTIFUL

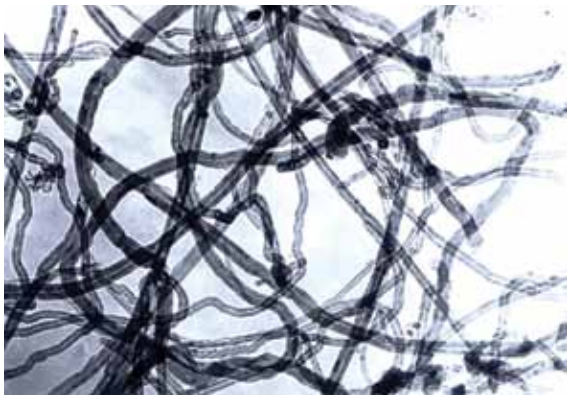
However, if there is one industry that needs metrologists more than any other, it is manufacturing.

In the not-too-distant past, mainstream manufacturing was largely concerned with scales in millimetres-to-micrometres – units that are at least visible to the naked eye (or under a microscope), and which posed few challenges as far as precision was concerned. In today's age of sub-micromachines and nanoscale processors, however, checking screws and joints is no longer a matter of visual inspection. At these scales, the usual rules of physics are not always useful. Because of the large surface area-to-volume ratio, surface effects such as electrostatics and wetting are far more significant than volume effects such as inertia or thermal mass. Only highly specialised machinery can do the quality assurance for you - machines that need to be regularly tuned and calibrated.

"As technology gets smaller and more precise, the capabilities of metrologists will get more

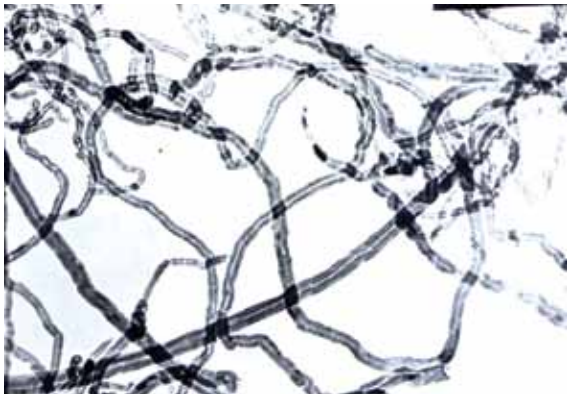
NANOTUBES FOR SALE

Carbon nanotubes are estimated to be at least 100 times stronger than carbon fibre and 1,000 times more conductive to electricity than copper. They are also expensive and can sell for up to USD2,000 per kilo, depending on their purity and diameter. Measuring and verifying that purity requires finely calibrated equipment that pushes the limits of metrology.



Industrial Grade Carbon Nanotubes: 90wt% 10-30nm outer diameter, about USD450 per kilo

Industrial Grade Carbon Nanotubes: 90wt% 20-40nm outer diameter, about USD700 per kilo



Multi-walled nanotubes: 95wt% 20-40nm outer diameter, up to USD2,000 per kilo.

precise too," says Abdul Rashid. "Metrological equipment must stay one step ahead of mainstream manufacturing equipment. Our job is to measure things at an accuracy that is at least a few decimal places more than them, and so we will always be able to provide them with valuable insights into their production processes."

At this point, you might be tempted to ask: why must things get smaller, anyway? The answer is simply that smaller is really better.

Imagine a blacksmith hammering a steel blade into shape. With every stroke of his hammer, the steel molecules are mashed closer and closer together until at last the blade cannot be flattened or shaped any further. Now, imagine another swordsmith who, through some genius of technology, is able to systematically place and stack all those steel atoms one at a time the way one might build a Lego® model – who do you think will have the better sword at the end of the day?

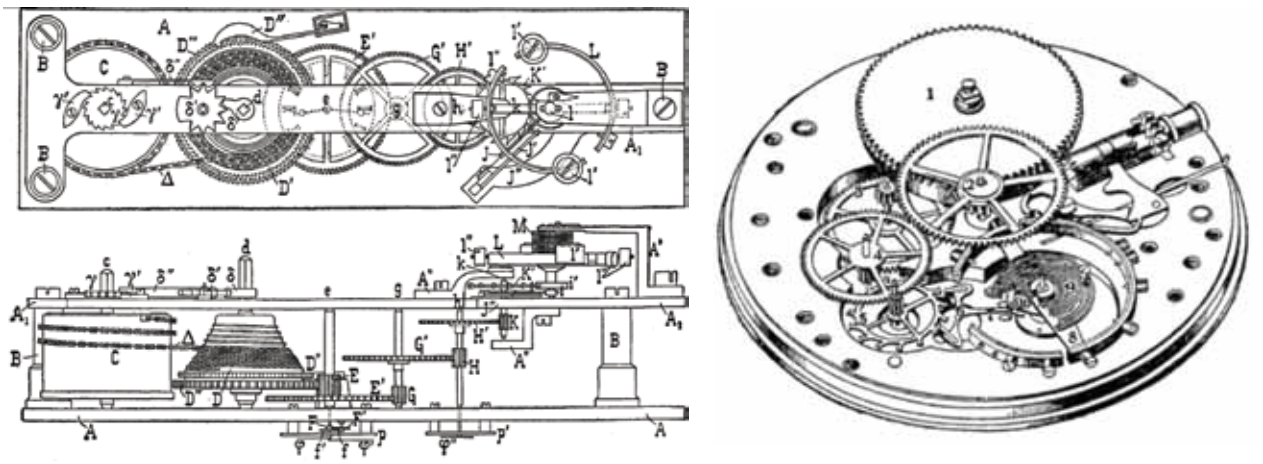
Let's take another example: the marvel of Swiss watchmaking, an industry worth USD 10 billion per year and Switzerland's third largest export. The beauty of a Swiss watchmaking has always been in its extraordinary precision – the parts fit together so perfectly that wristwatches are turned into beautiful works of art. These engineering masterpieces also have fewer engineering faults and last much longer.

Without a doubt, the more precise your manufacturing abilities are, the higher the quality of your products will be. That's why businesses want the ability to put their products together at a smaller scale.

"Being able to manufacture items to a precision of one micron is great, but if a competitor can manufacture the same things to a precision of 0.1 micron, then that makes his product at least 10 times "tighter" than yours," says Abdul Rashid.

That difference might not be apparent in the factory itself or even when the product first rolls off the production line. Eventually, however, consumers will be able to feel the difference - ask anyone who owns a finely-tuned German sportscar or a Rolex that once belonged to his grandfather.

Photo credits, from left: Malenkov, Leo Reynolds and Misteraitch; all on Flikr.



SMALL WONDERS: The average swiss-made wristwatch has over 200 tiny parts all tightly packed into a casing small enough to fit on a child's wrist. Such fine craftsmanship has earned swiss watches a reputation for lasting a lifetime.

SPEAKING THE SAME LANGUAGE

And yet it is not enough to just be small and precise anymore. With today's modern manufacturing chains, companies also need to ensure that their facilities operate within the same units of measurement.

To illustrate this point, Abdul Rashid points to the manufacturing miracle of the Airbus A380. Although the superjumbo jet's final assembly location is in Toulouse, France, its parts are manufactured all over the world. The major sections of the plane are built in France, Germany, Spain, and the United Kingdom, and are transported to Toulouse by ground and sea (they're too big for air travel). But other sections of the plane come from over 1500 suppliers scattered across 30 countries around the world – the wings alone are made of some 32,000 individual parts in Wales.

The wonder, of course, is in how the company manages to bring together over four million different parts from around the world and have them all fit together so perfectly to make one of the largest flying machines the world has ever seen.

"The secret is metrology," says Abdul Rashid with a wink. "Airbus ensures that even if all these manufacturers don't speak the same language, they at least speak in the same units of measurement. By making sure each of them builds their respective parts according to the same precise specifications and that their measurements are all kept in sync with each other, Airbus engineers are able to guarantee that the components will fit together quite snugly."

The same kind of thing happens in the automotive and marine building industries, both of which rely on extensive manufacturing chains that source components from different parts manufacturers from around the world.

"Metrology is everywhere," says Abdul Rashid. "It's in the way businesses quantify and measure their raw materials to the precision and accuracy of their quality assurance programs, leading ultimately to the way their products meet the requirements of other markets around the world.

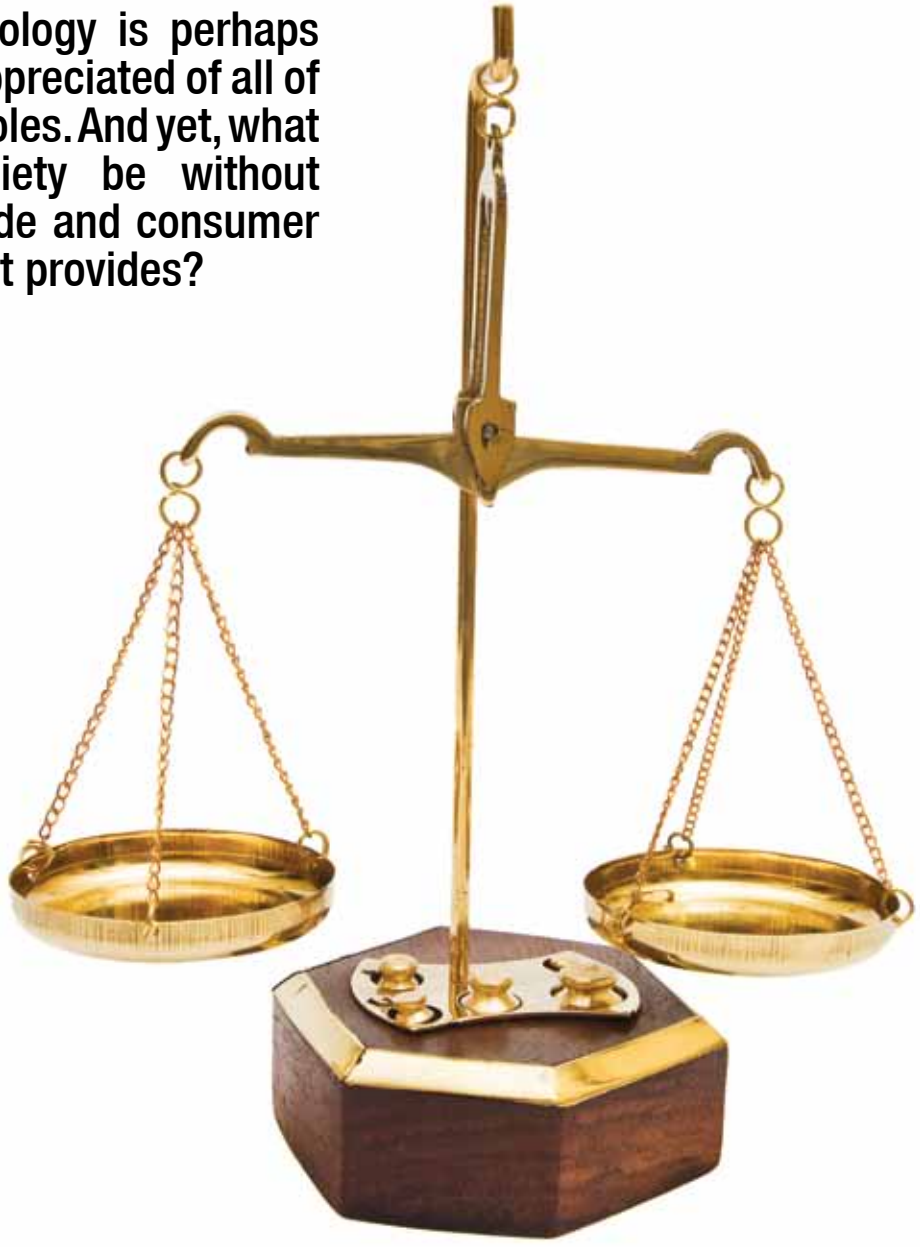
MIRACLE OF METROLOGY

HUGE WONDER: The A380 is the largest jumbo jet in the world with an approved capacity of 853 passengers. Each plane has about 4 million parts (including 800km worth of wiring), of which 2.5 million parts are produced by 1,500 companies in 30 other countries around the world including:

- **Wings - Broughton, Wales**
- **Fuselage parts - Hamburg, Germany**
- **Tailfin - Stade, Germany**
- **Rudder - Puerto Real, Spain**
- **Nose - Saint Nazaire, France**
- **Fuselage and cockpit sub-assemblies - Méaulte, France**
- **Horizontal tailplane - Getafe, Spain**
- **Final assembly - Toulouse, France**
- **Cabin installation and painting - Hamburg, Germany**

LAWS OF MEASURE

Legal metrology is perhaps the least appreciated of all of the NML's roles. And yet, what would society be without the fair trade and consumer protection it provides?



FAIR TRADE ASSURANCE

THERE IS SOMETHING TO BE said about the role of law and order in modern civilisation. However, what is infinitely more interesting is the role of metrology in law.

Modern regulatory systems rely upon evidence to prove that someone has (or has not) been behaving badly. In order to gather this evidence, it uses certain instruments to objectively and conclusively decide whether or not a law has been broken. So, if your car is spewing out more than its fair share of toxic hydrocarbons, a gas analyser will say so. And if a lorry is carrying more weight than it should, the highway weigh station will say so.

All these instruments are prescribed by law to be tools for enforcing certain laws and regulations, the assumption being that machines do not lie.

Except that they can.

LYING MACHINES

Machines that lie are commonly found in trade, where they are used to collect money from the public. Think of all the fuel dispensers at petrol stations, the weighing scales at markets, the rulers at fabric wholesalers, the electricity watt-hour meters outside your home and the meters used in parking lots and taxis. All these devices are used to collect money from us.

Luckily, before any of these instruments can be used in public, they have to be pattern approved by the NML. The prototypes undergo a rigorous examination and measurement inspection at the NML, and if they comply with the NML's exacting standards (which follow the recommendations of the International Organization of Legal Metrology), then the prototypes are "passed" and the manufacturer can proceed to market the products.

"Without the NML's nod, a manufacturer would be hard-pressed to find someone willing to buy these kinds of products," says Abdul Rashid

NO CHEATING: Any vending machine intended to be used to collect money from the public must first be pattern approved by the NML.

Zainal Abidin, Senior General Manager at the NML. "Furthermore, all instruments that are used in consumer trade must also be inspected by an authorised agency at least once a year."

These inspections are carried out to ensure that the machines are not 'lying' to users, and that business owners are not inadvertently short-changing consumers. Here, metrologists at the NML once again step to the fore, since the NML is in charge of calibrating the tools that these government agencies use for inspections. This includes hand-held measures for the standard litre or metre, as well as more sophisticated instruments like those used in road safety – in this field alone, the NML calibrates breathalysers (drunk driving), smoke density meters (smoke emissions), sound level meters (noise pollution), radar guns (highway speeding) and luxmeters (tinted glass).

"The NML functions as the country's master calibrating authority for all the legal instruments used to enforce the law and fair trade," says Abdul Rashid. As the custodian of weights and measures related to trade, the NML works very closely with the Ministry of Domestic Trade and Consumer Affairs, which acts as the enforcement agency. "Government agencies send their instruments to NML's labs to be tuned to perfection once a year, and then those instruments are used to verify the dispensers, meters and measures all over the country." >>

ABDUL RASHID: "Wear and tear can degrade the accuracy of instrumentation after a while, the same way a wristwatch can start to tell the wrong time after a couple of years."

CONSUMER POWER

Of course, the average consumer might think that they don't really need the NML's protection from scoundrels. After all, we all know what a metre or kilo looks and feels like, and so we can spot a fraud, can't we?

Well that may be true when you are buying curtains or onions, but what about a cab ride? Taxis in the Klang Valley are supposed to charge RM3.00 for the first two kilometres, and RM0.10 for every 100 metres thereafter (see sidebar: "How Does a Taxi Meter Work?"). In addition, they are supposed to charge RM0.10 for every 30-seconds in standstill traffic situations. Now tell me: short of having a human metrological speed-and-distance sensor for a brain, how can you be sure that the taxi meter is accurate and that you are not being overcharged?

The fact is, you can't.

"We go to a petrol station, fill up our tanks and assume that just because the digital display says we have pumped 10.92 litres of petrol we think we get what we paid for," Abdul Rashid explains. "That is not always true. Machines can lie. Wear and tear can degrade the accuracy of their instrumentation after a while, the same way a wristwatch can start to tell the wrong time after a couple of years."

All machines need to be taken care of, no matter how big or small they are. Just think of your car: nuts and bolts get jigged out of place, environmental conditions cause parts to rust, sensors accumulate dust - these things can render all machines less accurate, which is why they need to be calibrated. Now, this might not seem like such a big deal, until you consider how much the health business relies on modern machinery, too.

"Go to ten different clinics within a mile from this lab, and you'll get maybe ten different blood pressure readings – why?" demands Abdul Rashid. "That kind of inconsistency is unacceptable. Someone has to set a reference standard for all these blood pressure machines to be calibrated against, so that people know what is what and are not confused by conflicting results."

Everything from medical imaging equipment to surgery lasers to the oxygen supply units they use in hospital wards require close calibration and monitoring to ensure they are both accurate and safe to operate.

"When a company claims that the oxygen it sells in its tanks is of 95% purity, the hospital cannot just take their word for it," Abdul Rashid says. "You cannot just smell the gas that comes out of their tanks to verify the claim. To be certain, you have to use a gas analyser, and that gas analyser must be properly calibrated in order to be accurate."

ENABLING INTERNATIONAL TRADE

Another area in which metrology plays a hugely important but largely unnoticed role is in international trade, specifically when it comes to the export and import of goods and other natural resources. Because it earns tax on the goods, the

government needs to know the precise weight and volume of the natural resources it exports.

Again, this might not seem like such a challenge when you think about measuring the volume of petrol or palm oil, because you can see it and hold it in a glass. But what about gas?

"That's why ships that transport Liquefied Natural Gas (LNG) or Compressed Natural Gas (CNG) out of the country need to have their storage tanks measured by qualified quantity surveyors," says Abdul Rashid. "Our job at the NML is to verify the measurement data of all these surveyors and to certify the tanks so that the customs department can levy an appropriate tax on their content."

And if you are asking yourself what kind of government splits hairs over losing a few tax dollars on a couple of kilos of gas, then you are forgetting that when it comes to global trade in natural resources, the transactions typically involve billions of ringgit.

"Even if our measurements are off by a mere one or even half a percent, that could mean tens of millions of ringgit in lost taxes," says Abdul Rashid. "Also, countries which import these goods like Taiwan and Japan have very precise instruments at their ports to verify the volume of goods they receive, as they cannot afford to pay for these errors, either. That's why it is so important for everyone to have clearly defined metrological standards. They are the foundation of global trade."

HOW DOES A TAXI METER WORK?

IT MEASURES TRIP DISTANCE

The meter uses electricity to determine how far you've travelled. This is done with the help of the car's transducer -- a sensor attached to the transmission, the same sensor that provides data to the speedometer and odometer. It sends a pulse to the meter at specified distance intervals, such as 200 metres. When the taxi meter is installed, an engineer drives the car a perfectly measured kilometre to teach it how to record distance correctly.

IT MEASURES TRIP TIME

The meter measures time in precisely the same manner, receiving pulses at specific intervals, such as every two seconds. This is how you get charged for time spent waiting in traffic or for quick stops where the driver sits idle.

IT DISCERNS BETWEEN RATES

If distance pulses outnumber the time pulses, such as when you're moving at a decent speed, the meter counts these as dominant and charges the rate per kilometre or 200 metres. If the time pulses outnumber the distance pulses, the meter knows to calculate this part of your travel at the "waiting" rate, if applicable.

IT DETERMINES THE PRICE

The meter tabulates the price and displays it in real time. You can watch it steadily increase during the course of your ride. The final price will be the total after all tabulations are made

and the taxi stops. This is the amount the driver will ask you to pay.

IT USES PRESET COST INFORMATION

The prices are programmed into the meter. Drivers have their meter tested and calibrated to ensure they charge the amount set by the taxi company or local regulations. Totals can include taxes and any preset minimum trip charges.

SOME EVEN PROTECT THE CONSUMER

Some new taxi meters use GPS to make sure drivers are taking the most direct routes. These are not used in Malaysia yet, but may appear soon.

By Kate Evelyn, courtesy of eHow.com - Clear Instructions on How to Do (just about) Everything. Used with permission.

APPLES AND ORANGES

The Metrology in Chemistry Group at the NML have been hard at work over the past couple of years developing CRMs for alcohol in water, pH buffers and more. Now, that hard work is starting to pay off.

IN LIFE AND BUSINESS, WE ARE often told to make sure we always compare apples to apples. Unfortunately, not all apples are created equal – they can vary in their content of citric acid, water, fructose and fibre. But what if you had a single apple that you could create over and over again? One which you could use as a benchmark to compare all other apples against? What if you could comparatively measure an apple's sweetness, sourness, crunchiness and, ultimately, tastiness?

That is what developing Certified Reference Materials (CRMs) is about (also called Standard Reference Materials in the U.S. and European Reference Materials in Europe). The idea is that these reference materials can be used as 'controls' to check the quality and traceability of products objectively. Thus, if the lead content in a glass of water is five times above the lead content of the CRM for Lead in Water, then you know you have a problem. Similarly, if the ethanol-in-water content of a man's breathalyser test is two times above the ethanol-in-water content of the CRM for Ethanol in Water, then you know he is intoxicated. Other examples include CRMs for lead in blood (to be used as a reference for lead poisoning), lead in water (water system contamination) and pesticides.

ETHANOL FOR ENFORCEMENT: The NML's standard ethanol solution will be used to calibrate breathalysers to help enforce laws against drunk driving.

CRM EXPLOSION

The demand for reference materials is growing rapidly on the international stage, with one estimate valuing the market as being worth over USD3 billion worldwide. Virtually every industry from food to pharmaceuticals to aerospace is required to test what it produces against a reference material in order to comply with industry quality standards.

However, CRMs are also exceedingly hard to make.

"Let's say I want to develop a CRM for the percentage of oxygen in air so that oxygen suppliers in the health and marine industries can have a suitable point of reference to develop their products," explains Abdul Rashid Zainal Abidin. "This involves detecting and measuring oxygen content in parts per million within a certain controlled environment. That's not easy to do."

In the fields of physical measurements, SIRIM has already given us the national kilogramme, volt, frequency, temperature and pressure standards. But, in the fields of chemistry and biological analysis, Malaysia still has a long way to go. The NML has been put in charge of developing these CRMs for the country.

Unlike normal physical standards, CRMs are about chemistry in nature. They are difficult to develop because the homogeneity and stability of these materials changes with the environment – the chemical balance and concentration of a CRM that is developed today can change over time due to evaporation, humidity and temperature fluctuations. CRMs have a limited shelf life.

"Once you reproduce the CRM, you then have to watch out for other environmental factors that can affect the purity of the material such as temperature and humidity, all of which can render your CRM no longer suitable for its intended application," says Abdul Rashid. "You have to be able to declare your material to be of such-and-such a concentration and to what measure of uncertainty are you confident about it."

What is important for the NML right now is to learn the science and techniques behind making CRMs. Currently, Malaysia buys most of the CRMs it needs from overseas. By learning how to make their own CRMs, the NML will be able to reproduce CRMs whenever they need to and save the country a bundle of money in the process.

"The NML comes in right at the top," says Abdul Rashid, holding his hands up to form a pyramid on the table. "We develop the standard reference materials and use them to support different government agencies in their testing and enforcement activities."

LOOK MA, I'VE GOT MY OWN pH BUFFER: Khirul Anuar Mohd Amin, a Metrologist at the NML, showing off his samples of the pH buffering agent "Potassium Dihydrogen Phosphate" which he intends to be able to produce by the end of the year. Buffering agents are used to drive solutions to a certain pH state and then prevent that pH from changing. They have applications in any business that uses chemicals extensively such as agriculture, cosmetics and medicine.

The NML can also use reference materials to compare their results against international figures published by the FAO and World Meteorological Organisation (WMO), thus allowing them to see where Malaysia stands in terms of food safety, pollution and other areas of concern.

"The idea is to mirror the activities of these international bodies in order to compare our measurement results to those of our overseas counterparts, be it chemical or biological," says Abdul Rashid. "In this way, we can create a system of reference that starts off with these international bodies, then goes down to national bodies like the NML before being passed on to all these respective enforcement agencies."

TIME AFTER TIME

If someone's watch is running 15-minutes later than yours, can you blame him for running late?

TIME IS GOLD, SO THEY SAY. BUT few of us realise the amount of work that goes into keeping everyone's clocks ticking to the same beat. And yet when you think of the thousands of watch and clock manufacturers around the world and the different tools and equipment they use to make their products, is it any wonder why so many people are sometimes late for appointments?

In the ancient world, time was measured in terms of passing days and moons. However, this form of measuring time was rarely accurate. A promise to meet "when the moon was full" often meant several days of waiting, as people tended to have their own vague interpretations of what a full moon really meant. Also, because daytime in summer is longer than daytime in winter, the duration of "one day" often varied from one season to the next, and from one part of the world to another. The result, as one might imagine, was many missed appointments and a lot of frustration.

ON SCHEDULE: Dr Mohd Nasir Zainal Abidin checking to see that the GPS calibration is taking place on time. The NML's Caesium atomic clock only loses track of one second every 120,000 years.

This problem of measuring time was partially solved by the ancient sundial. Invented around 3,500 BC, the sundial was man's first attempt to break down a day into distinct phases such as dawn, noon and dusk. Then, as a way of keeping track of the solat, Muslim scholars built upon the concept of the sundial and divided "daytime" into 12 hours of equal length. Since the day had 12 hours, it was decided that night should be allocated 12 hours, too. And thus, the modern 24-hour day was born.

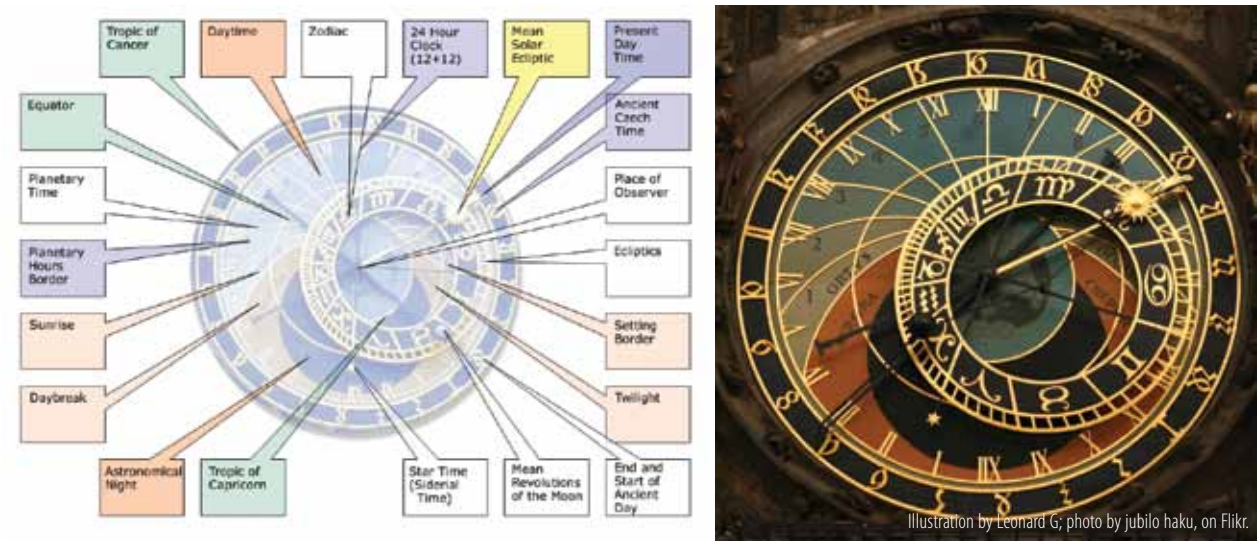
As civilisation progressed, however, international trade and travel made it necessary to establish more accurate units of time. The Muslim scholars' principle of dividing time into equivalent parts was expanded upon, and the hour was eventually broken into minutes, and later, into seconds.

And the rest, as they say, is history.

MODERN TIMEKEEPERS

Time as we understand it today is a much maligned and frequently misunderstood thing. We assume that everyone's idea of 11:45 is the same as ours, but that assumption can only be true if everyone's clock is ticking to the exact same rhythm as our own. Even if we set our watches according to the eight o'clock news countdown on TV, how do we know that the station has got it right? What do *they* refer to when they set their clocks?

PRAGUE'S ASTRONOMICAL CLOCK



ASTRONOMICAL WONDER: The Prague *Orloj* is a medieval astronomical clock in Prague, Czech Republic, that measures the passing of time in over twenty different ways.

The answer lies at the National Metrology Laboratory in Salak Tinggi, Selangor. Here, SIRIM metrologists use a Caesium atomic clock to ensure that the Malaysian Standard Time is kept precisely in sync with the International Atomic Time (TAI). This is compiled from over 200 atomic clocks in about 60 national laboratories worldwide by the International Bureau of Weights and Measures (BIPM) in Sèvres, France, and is calibrated by comparing it to primary atomic clocks maintained by only a few national laboratories worldwide.

"Our atomic clock only loses track of one second every 120,000 years, but it is not intelligent enough to tell the time of day by itself," explains Dr Mohd Nasir Zainal Abidin, Head of the Electrical Section at the National Metrology Laboratory. "To do that, we compare our atomic clock second pulses with clock signals from GPS satellites and then submit the data to the BIPM who will in turn compute the International Atomic Time (TAI)."

By setting our clocks according to the Malaysian Standard Time, we are not only keeping ourselves in sync with each other locally, but also with other countries around the world. As one might imagine, this global synchronisation is of paramount importance when it comes to scheduling international events – if the World Cup Final kicks-off at 8pm in Johannesburg (+0200 UTC/GMT), then we expect to watch it in Malaysia at precisely 2am (+0800 UTC/GMT). A timekeeping error in that circumstance would be unforgiveable.

Additionally, while the average person might consider five minutes "give-or-take" accurate enough for things like lunch dates, one need only think of the Olympics to realise how important smaller units of time are to the world at large – speed records are no longer spoken of in terms of seconds, but in milliseconds and microseconds. Time precision is also important in international trade, where billions of ringgit exchange hands every second of every day. A single slip up could theoretically result in global chaos.

"Without a common understanding of time, we'd be in serious trouble," sums up Dr Mohd Nasir. "That is why SIRIM's role as custodian of Malaysian Standard Time is so important."

By broadcasting Malaysian Standard Time at news countdowns, TV stations try to ensure that everyone in the country is on the same time. If we all set our watches to tick in sync with these countdowns, then we'd all have the exact same time. Unfortunately, I doubt that would cure tardiness any time soon.

THE MYSTERY OF GRAVITY

If you think that apples tumble off trees just as quickly no matter where you are in the world, think again.

GRAVITY IS ONE OF THOSE forces of nature that we don't think much about but which influences our lives in ways one might never imagine. In physics, however, it's importance is much more appreciated. In fact, the value of gravity – denoted as *g* – is considered one of the most important parameters in science.

Gravity is used in dozens of different applications in force, pressure and volume measurements – essentially, any law of physics that requires *g* to work, including Newton's three laws of motion. However, the value of *g* is very much influenced by differences in geological formations and topology such as latitude and altitude. In other words, the *g* that I experience where I sit writing this article will be different from the *g* that you experience where you sit reading this article. In theory, this means that we will also experience different measures of force, pressure and volume.

WHERE IS THE SPOT? KRISS scientists setting up the absolute gravimeter at the NML's Pressure Laboratory.

From a metrological point of view, this kind of inconsistency is simply unacceptable. That's why the NML recently invited scientists over from the Korea Research Institute of Science and Standards (KRISS) to help them determine the absolute measurement of acceleration due to gravity (*g*) at three different laboratories in the NML's complex.

The measurement was carried out by Dr In-Mook Choi and Dr Min-Seok Kim from KRISS at NML's Force Laboratory, Pressure Laboratory and Volume Laboratory. The team used an absolute gravimeter to conduct the measurements, which is based on the free fall of a body subjected only to gravitational force. The table on the next page summarises the results of the measurements.

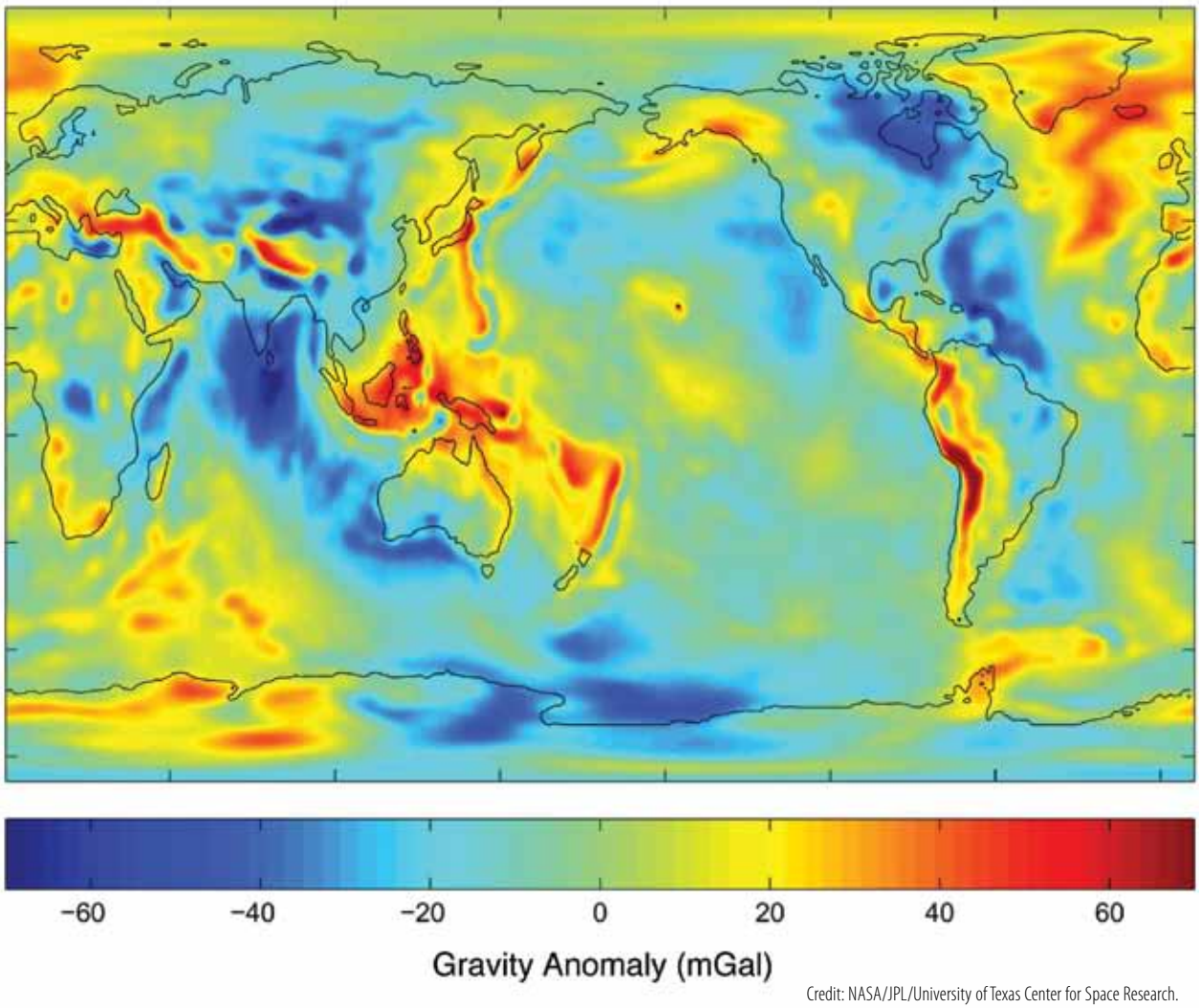
As you can see, the *g* values on the NML's grounds may differ by as much as 0.00000229 ms^{-2} between locations less than 500 metres apart. Despite this unusual imperfection of nature, however, the results also prove that the NML can today provide measurements in mass and related quantities with significantly improved uncertainty than before.

SUMMARY OF GRAVITY MEASUREMENT RESULTS AT THE NATIONAL METROLOGY LABORATORY

Laboratory	Section	$g/10^{-8}$ m•s^{-2} @ Z_{ref}	Uncertainty (k=2)/ 10^{-8} m•s^{-2}
Force	Mechanical Metrology	9.78 059 360 @ 0.809 m	10
Pressure	Mechanical Metrology	9.78 059 338 @ 0.809 m	10
Volume	Flow Metrology	9.78 059 567 @ 0.809 m	10

Note: Z_{ref} is the instrumental reference height at corresponding site.

WHAT NEWTON DID *NOT* KNOW



Credit: NASA/JPL/University of Texas Center for Space Research.

Genius as he was, Isaac Newton could never have known that some places on Earth have higher gravity than others - he simply did not have the sophisticated equipment necessary to make the discovery.

Why the disparity? Sometimes the reason is unknown. To help better understand the Earth's surface, the Gravity Recovery and Climate Experiment (GRACE) was launched as a joint partnership between NASA and German Aerospace Center.

GRACE uses a pair of identically orbiting satellites to create a map of Earth's gravitational field. It does this by measuring changes in the separation of the two identical spacecraft to an accuracy of one-hundredth the width of a human hair, or about 1 micron. Red points on this map (above) indicate areas where gravity is slightly stronger than usual, while in blue areas gravity is slightly weaker. Many bumps and valleys on the map can be attributed to surface features, but others cannot and so might relate to unusually high or low sub-surface densities.

PISTON PERFECT

One NML researcher's quest for perfection may give leading dead-weight pressure balance manufacturers a run for their money.

PRESSURE MEASUREMENT applications are commonly found in industries such as power, gas, optics, aerospace, defence, meteorology, medical health and safety. Additionally, most pressure-related instruments are designed to be part of the research and development activities behind these products, and are used to ensure product quality, reliability and safety.

One metrology instrument that is indispensable as far as pressure measurement is concerned is the dead-weight pressure balance (DWPB). At the heart of the system is a piston-cylinder assembly (PCA), which consists of a mirror-polished piston that is fitted into an equally finely-made cylinder. The assembly has extremely demanding dimensional tolerances such as straightness, parallelism and roundness of sub-micron accuracies. It also has a radial clearance between the piston and cylinder of around one micron or less.

DR WAN ABD MALIK: "My pressure balance will be able to offer the same uncertainty of measurement."

If you think that the expertise and talent for making machines of such precise measurements is hard to come by, you guessed right. In fact, in the wonderful world of DWPBs, there are really only two countries worth taking any notice of: France and the United States. The DWPBs manufactured in these countries have dominated the marketplace for years and are commonly used as primary pressure standards in National Metrology Institutes (NMIs) all over the world.

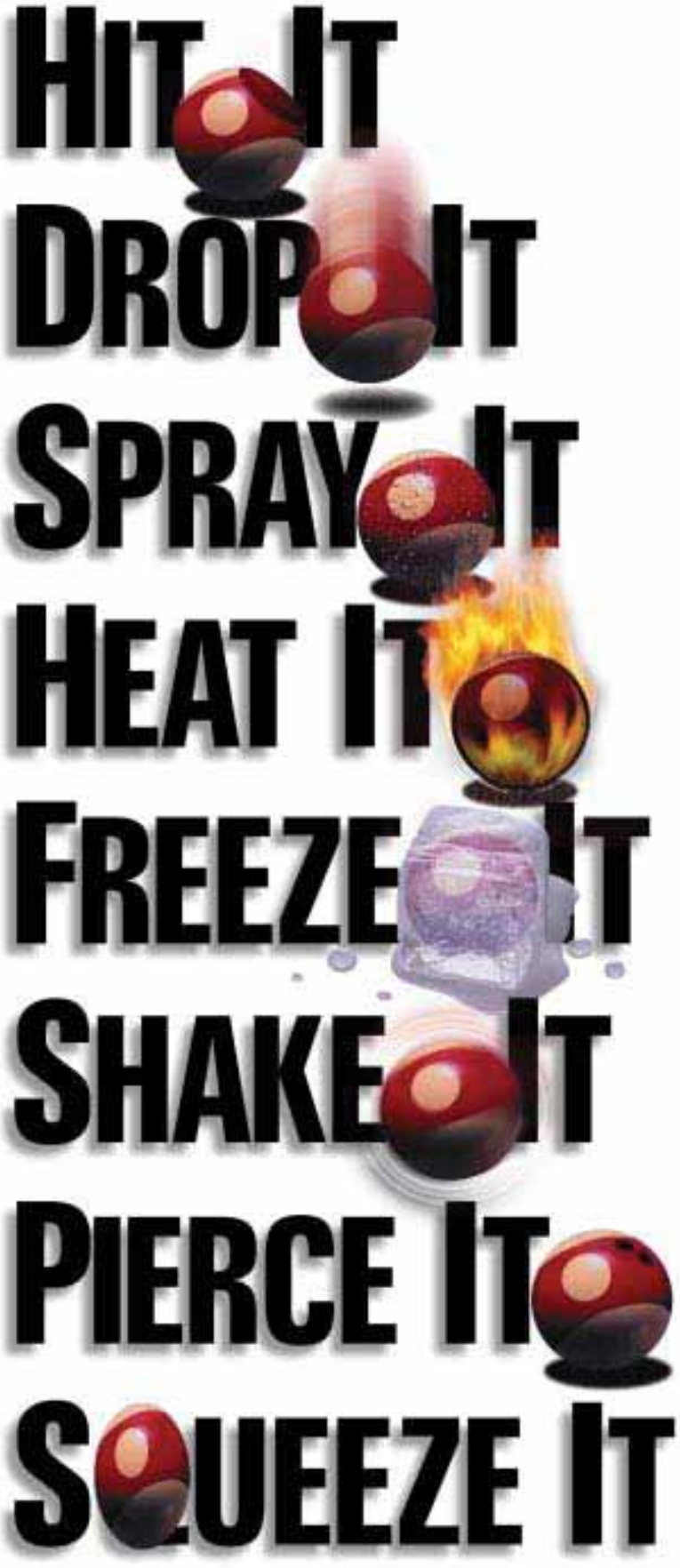
Now, Dr Wan Abd Malik Wan Mohamed, Head of the Technical Services and Metrology Advisory Section at the NML, has turned the U.S.-French twosome into an elite threesome. He has succeeded in doing what only two other countries in the world have been able to do: making a PCA with the uncertainty of pressure measurement achieving 10 parts per million (ppm) at 95% level of confidence.

"I handmade it out of tungsten carbide, one of the hardest materials known to man," says Dr Wan as he sets the piston spinning inside the cylinder in his hand. "Even the most precise CNC machining technology available today can only achieve dimensional tolerances of five microns."

Dr Wan's near-perfect PCA can spin for nearly an hour, even under the weight of a full grown man. He intends to use it to make a DWPB system similar to the one used in his lab – a system which costs USD450,000, all told.

"My dead-weight pressure balance will have a slightly different design and mounting post to house my own PCA, but it will be able to offer scientists and metrologists the same level of uncertainty of measurement," Dr Wan enthuses, the piston still spinning in his hand. "At approximately USD15,000 per assembly in the marketplace, my DWPB will also be significantly more cost-effective than others."

WE HIT IT DROP IT SPRAY IT HEAT IT FREEZE IT SHAKE IT PIERCE IT SQUEEZE IT



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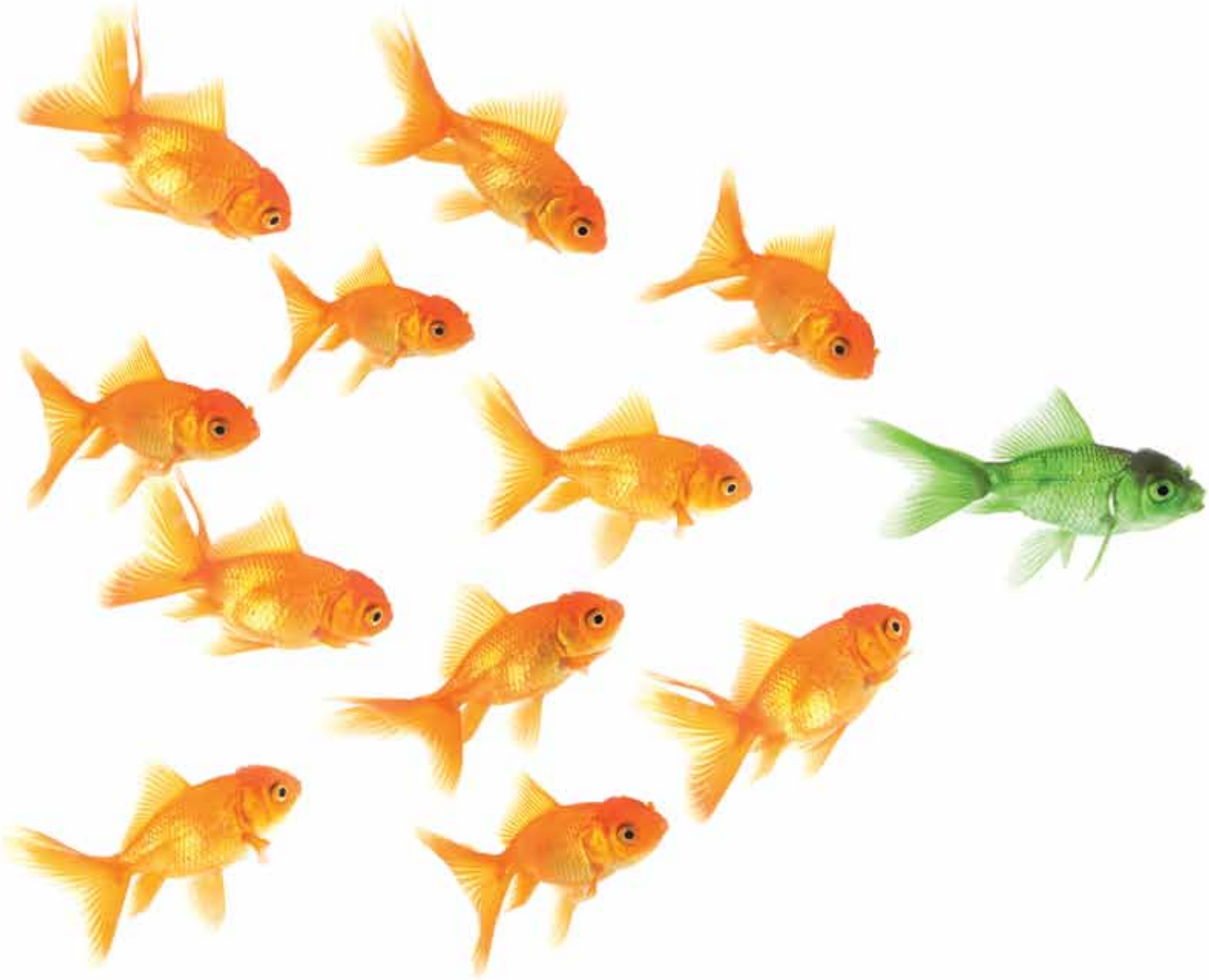

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