

Metrology Training at the Technical Education and Vocational Training Level

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What is Metrology ?

- ☀ Metrology is the science of measurements associated to the Evaluation to its uncertainty (VIM, 1993).
- ☀ Measurements are present in every aspect of our daily life.
- ☀ Who needs Metrology ? *(Question was addressed recently by Dr S. Bennett , Deputy Director of NPL at the M S Conference in January 2004)*



Science



Industry



Trade



Government



Health



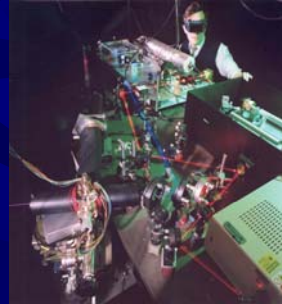
You and me

Why Science needs Metrology ?

"When you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge of it is of a meagre and unsatisfactory kind"

(Lord Kelvin)

- To test hypotheses and verify theories
- To establish consistency of results
- To determine fundamental constants
- To investigate susceptibility of phenomena to external influences



Why Industry needs metrology ?

- To make products that meet specifications
 - Customers' requirements
 - Standards (National and International)
- To comply with regulations
 - National laws
 - Requirements for exporting
- To ensure compatibility and interoperability
 - Manufacture and assembly
 - Spares and repairs
- To improve production processes
 - Reducing scrap
 - Cutting costs

ISO 9000 Certification



Metrology in Manufacturing Systems

The Airbus A380 is manufactured in four European countries and assembled in France.

Just imagine What would happen if there is an error (small difference) in the measurement of some parts.



Good Metrology = Safety

Bad Metrology = Disastrous Consequences

"Mission specifications called for using **metric units**, but the Lockheed group sent navigation information in **English units**.

The mix-up meant that Lockheed engineers modelled navigation with pounds force (the English unit for measuring thruster impulse) while JPL did its calculations in newtons (the metric measurement). *One pound force is equivalent to 4.45 newtons.*"



The spacecraft exploded and the \$US240 million was a complete waste

(Report on the loss of NASA's Mars Orbiter spacecraft on October 1999)

Is Mr Metrology needed in Industry ?

- In today's world (Globalization of trade and Investment) , there is no greater pressure on industrial companies than to become ISO certified.
- The ISO 9000 QMS require the use of competent personnel (section 6.2) and the establishment of an effective system for the control, inspection and measurement equipment (section 7.6).
- Through a DACUM curriculum analysis, *Bagley (2000)* showed that **adequate knowledge and training skills in metrology** is more than ever **necessary for industrial technicians, engineers and managers** in almost all engineering fields.
- The **need for metrologists** is continuing to rise in order to support the strong demand in both the private and the public industrial and commercial sectors.
- DeRuntz (2004) stated that **more than 90 percent of metrology degree holders** in USA and Europe **are employed** in the industry.



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Where is the place of Mr Metrology in Industry?

Mr Metrology is prepared and trained to operate in :

- Oil and Gas Industry,
- Manufacturing Industry,
- Electrical Power Industry,
- Food production,
- Water desalination Industry,
- Pharmaceutical industry,
- Defense (aerospace, naval, military) ,
- National and regional standardization organizations (SASO),
- Transportation, and
- Environmental Protection.



What are the Basic Skills Mr Metrology should Possess ?

- 'Mr Metrology' is asked to operate and maintain equipments used to measure dimensions, weight, time, temperature, density, pressure, and many other physical parameters present in the various industrial processes.
- He should be able to test and calibrate measurement equipment used in production to ensure that products are made perfectly according to design specifications. He is also involved in sampling and testing goods to ensure that they actually meet the required standards.
- He usually works in industrial Quality Control departments, Standardization Organizations (SASO) and specialized metrology companies.



WHO OFFERS METROLOGY TRAINING ?

Metrology training, which is required to support private industry as well as the public sector, is offered by :

- Educational Colleges and Technical Universities
(Rock Valley Technical College, Madison Area Technical College, Piedmonton Technical College, Ecole des Mines de Douai)
- International Organizations for Standards (NIST, API, ISO, OIML, BNM etc..),
- Professional Organizations (ASME, ASQ, etc...),
- Commercial test equipment manufacturers and industrial consultants..

Associate Degree

B.Sc.

Master

PhD

Training Certificate

A comprehensive list of metrology schools all over the world can be retrieved from the International Journal of Metrology site hosted at www.callabmag.com/schools.html.

WHAT SHOULD BE THE CONTENT OF A METROLOGY TRAINING PROGRAM ?

☀ In 1996, a group of experienced metrologists from the US government departments (trade, defense and industry) and technology educators worked out together within a DACUM-NSF program to identify the competencies required of metrologist needed by modern industry (Krause, 1996).

☀ They developed a list of knowledge in subjects that would constitute a metrology training program.

Academic	Mathematics
	Physics
	English
	Computer Technology
Metrology Core	General Metrology (Measurement principles, Uncertainty, Calibration)
	Administration - Accreditation
	Safety (Laboratory / Industry)
	Quality Assurance Systems
Metrology Specialty	Mechanical (Dimensional)
	Electrical / Electronics
	Optical
	Electro-Optics
	Chemical / Environment
	Nuclear

Proposal : Diploma in Mechanical Technology – Specialty in Metrology

- ☀ The proposal is based on the integration of Metrology specialty into existing mechanical technology (Production) syllabus
- ☀ Consistency with the GOTEVOT diploma degree (2 years training – Practical training based approach)
- ☀ The syllabus proposed has been checked with the ABET requirements to ensure quality outcomes.