Metrology
The Science of Measurement

164 Education Liaison & Outreach
Let’s take a trip back in time…
Prehistoric people didn’t have time to measure
But over time....
people started growing food
and developing permanent settlements
So, they needed a system of measurement...
or there would be mayhem!
History of Measurement
Egyptian Cubit

- Used to build pyramids
- Dependent on the pharaoh
- Missed calibration was punishable by death!
Fast-forward 5000 years to current measurement systems
Metric System (SI)

SEVEN BASE UNITS

- Mass: Kilogram (kg)
- Length: Meter (m)
- Time: Second (s)
- Temperature: Kelvin (K)
- Electric Current: Ampere (A)
- Amount of Substance: Mole (mol)
- Luminous Intensity: Candela (cd)
Metric System (SI)

- Simple to use
  - Bases of ten

- All other units derived from primary seven
  - For example: $V = \text{cm}^3 = 1 \text{ mL}$
Now, a couple of definitions...
Metrology

“the science that deals with measurement”

Measure

“to determine the dimension, quantity or capacity of something”
Metrology Concepts

**Uncertainty**

- Value assigned to a measurement result that characterizes how well it is known/unknown.

![Diagram showing measurement result and potential value ranges]
Metrology Concepts

Traceability

- Unbroken chain of comparisons to the SI units, all having stated uncertainties

You, the Consumer

Inaccurate Measurements

NMI
Metrology Concepts

Calibration

• Set of operations that establish the relationship between values of quantities indicated by a measuring instrument and a reference standard
Metrologist

- Designs and runs measurement calibrations & tests
- Analyzes the results
- Determines the final accuracy of the device under test
Metrology Careers

**Scientific Metrology**

- Organization and development of measurement standards and their maintenance (highest level)

NIST Atomic Clock

Accurate to 1 s in 20 million years
Metrology Careers

**Industrial Metrology**

- Adequate functioning of measurement instruments used in industry as well as production and testing processes
Metrology Careers

**Legal Metrology**

- Measurements that influence economic transactions, health and safety
Who Needs Accurate Measurements?
Pharmaceutical Industry

- Metrology laboratories test weights and volume standards for pharmaceutical companies
- Products include medicines like aspirin, antibiotics, vaccines, insulin, & vitamins
Defense Industry

- Metrology laboratories test standards for many military and defense companies.

- These companies make the guidance systems for the Patriot missiles and other things that are *top secret*.
Space Station, Satellites….

- Metrology laboratories test standards for many companies that provide parts of the space shuttle

- These parts include the metal, heat shield, electronics, fabrics, o-rings, optics, and tires
Retail Measurements

- State metrology laboratories test standards used to test retail scales and meters
- These include gas pumps, produce scales, milk, bread and other packaged items, and price scanning systems
Who Needs Accurate Measurements? Everybody!

Weights and Measures measurements affect more than $6.6 trillion of the $13.2 trillion U.S. GDP (1996)
### Interested in Metrology?

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“Metrology community is facing a shortage of qualified, trained metrology personnel across the U.S.”
For More Information

NCSL International (NCSLI)

www.ncsli.org
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Questions, Comments, Suggestions?