Metrology

- Comes from Greek “metron” (measure) and -logy.
- It refers to science of measurement, including all theoretical and practical aspects of measurement.

Measurement

- It is the procedure of comparing an unknown quantity to a known standard by means of consistent system of units.
- Provides a numerical value of quantity within certain limits of accuracy and precision.

Inspection

- It is the procedure in which part characteristics (e.g. dimension) are examined whether they conform to design specification.
- Many inspection procedures rely on measurement techniques while others use ga(u)ging methods (simply determine whether the part passes or fails inspection).
**Product Quality**

- It refers to a product’s **fitness for use**.
- It is the totality of features that bear on a product’s ability **to satisfy a given need**.

**Need for Quality**

- Quality is a very important aspect of manufacturing.
- It is a **big issue** (wide range of topics like TQM, Six Sigma, Taguchi, ISO Standards, etc.)
- Needed for **interchangeable manufacturing**.
- Basic **concept of standardization** and mass production.
- Components of a product must **fit together, assemble properly and be replaceable**.
- Quality should be **built into a product**.
- **Prevention of defects** is a major goal.
**Measure of Quality**

**High Quality Product**
- 😊 performs its functions **reliably**
- 😊 performs its functions **for a long time**
- 😊 performs its functions **conveniently**

**Low Quality Product**
- 😂 does not perform its function reliably
- 😂 fails or breaks after short time of use
- 😂 difficult to use

**GOAL**

Continuous Quality Improvement

(functionality, reliability, durability, …)

**Inspection & Measurement**

What?  When?  How?
**What to Inspect?**

**Inspection specific to PRODUCTS**
- Electronic parts (circuits, chips, etc.)
- Machine elements (engines, brakes, gears, etc.)
- Heat and thermodynamic components (engines, fuel injectors, etc.)
- Medical and Bio-related products (implants, dental devices, surgical parts, etc.)
- Aerospace components (turbine blades and discs, airplane body, etc.)
- ...

**Inspection specific to PROCESSES**
- Chip removal processes (turning, milling, drilling, etc.)
- Chipless manufacturing (casting, molding, forging, etc.)
- Non-traditional methods (EDM, ECM, laser ablation/cutting, etc.)
- ...

When to Inspect?

**Inspection AFTER production**
- costly production steps already complete
- high cost of rejection or rework
- difficult to test for all possible defects
- difficult to identify responsibility for defect

**Inspection DURING production**
- defects found early, at each production step
- reduced cost of rejection or rework
- facilitates continuous process improvement
Measurement of DIMENSIONS

- Linear measurements (length, thickness, etc.)
- Angular measurements (taper, angle, etc.)
- Measurement of surface texture (roughness, waviness, etc.)
- Measurement of geometric shape (roundness, flatness, squareness, etc.)
- Measurement of screw threads and gears
- ...

Inspection for DIMENSIONAL ACCURACY

- post-process (traditional)
- in-process (modern trend)

DIMENSIONAL TOLERANCES

- permissible variation in dimensions
- directly affects product quality and cost
Scale of Measurement

**Large scale (low frequency) measurements**
- Measurements at macro levels
  - Dimension (length, angle, etc.)
  - Tolerance
  - Form error (contour measurement)

**Medium scale (medium frequency) measurements**
- Measurements at meso levels
  - Surface texture/topography (waviness)
  - Geometric shape (flatness, roundness, etc.)

**Small scale (high frequency) measurements**
- Measurements at micro levels
  - Surface texture/topography (surface roughness)