Fundamentals of Mechanical Measurement

Measurement Conceptual
The Process of Measurement
The Generalized Measuring System
Types of Input Quantities
What is doing?
Is it need? Is it useful?
The significance of data processing?

- Level of exactness of statistical model
- Level of improvement on decision making

Data → Information → Facts → Knowledge
The Process of Measurement

- Fundamental measuring process

[Diagram]

- Measurand
- Input
- Process of comparison (Measurement)
- Standard
- Result
- Readout
Fundamental Measurement Methods

• Direct Comparison
  – with either a primary or a second standard

• Using a Calibrated System
  – through the use of a calibrated system
  – indirect comparison
The Generalized Measuring System

Calibration input

Measurand

Sensor-transducer

Auxiliary power (not always required)

Transduced Signal (analogous to input)

Auxiliary power (usually required)

Signal conditional

Analogous Driving signal

indicat or

Recorder

Computer

Processor

Controller
The Generalized Measuring System

- A detection-transduction, or sensor-transducer, stage
- An intermediate stage, which we shall call the signal-conditioning stage
- A terminating, or readout-recording, stage
Measure exa

- Gage for measuring pressure in automobile tires
Measure example

• Measuring System

<table>
<thead>
<tr>
<th>Sensor-transducer</th>
<th>Input pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston/cylinder</td>
<td>(Pressure to Force)</td>
</tr>
<tr>
<td>Spring</td>
<td>(Force to displacement)</td>
</tr>
</tbody>
</table>

Signal Condition (None)
A relatively complex measuring system

Stage 1: Sensor-transducer
- Accelerometer
  - Voltage output from accelerometer with unwanted "noise"

Stage 2: Signal-conditioning system
- Filter
  - Signal with noise removed
- Integrating circuit
  - Time-integrated voltage analogous to velocity
- Amplifier
  - Increased voltage for computer recording

Stage 3: Recording-readout system
- Data-acquisition computer
- Printer

Computer graph
- Velocity vs. Time
- Graph showing velocity over time
Types of Input Quantities

• Time Dependence
  – Static (constant in time)
  – Dynamic (varying in time)
    • Steady-state periodic
    • Nonrepetitive or transient
      – Single pulse or aperiodic
      – Continuing or random

• Analog and Digital Signals
Analog signal concepts

- Analog describes a signal that is continuous in time.
Discrete time signal concepts

• For which information about the magnitude of the signal is available only at discrete point in time.
Analog and discrete signal concepts

- The analog signal has been replaced by \( \{y(r\delta t)\} \), which represents \( N \) values of a discrete time signal for \( y(t) \).
Digital signal concepts

- A digital signal exists at discrete values in time.
- The magnitude of a digital signal is discrete.