Engineering Design

Traditional View

Customer needs

System design

Testing

Product design
Taguchi’s View of Engineering Design

Customer needs

System design
Definition of overall product structure
Product features

Parameter design
Selection of nominal values for design parameters. Robust design

Tolerance design
Selection of tolerances. Employ loss function idea

Robust product
Strengths of Taguchi’s Approach

- Center of Gravity: Engineering Design process
- Definition of the roles of factors that influence product/process performance
- Robust Design -- Parameter Design Concept
- Use of the Loss Function -- link between variation and economic performance
Robust Design

Control factors → Product functioning in the field → Performance response

Noise factors

Adjust Control Factors → Product functioning in the field → Reduced performance response variation

Noise factors
Performance

- Source of variation - a fundamental measure of product/process performance
Process Centering?

Upper Specification Limit

Nominal

Lower Specification Limit
Why Emphasis on Variation?

- Traditionally, quality & productivity are conflicting goals

  True under product control model.

  Enter the *New Philosophy* --- the subject of this course

- What motivates us to reduce the variation?

  Deming: "sources of variation are sources of waste and inefficiency"
More on Variation

- Of course, as sources of variation are identified and eliminated -- quality improves.

- Also, as sources of variation are identified and eliminated -- productivity improves.

We can have our cake and eat it too!!

Summary: with process control we will look for process faults, and then take actions to eliminate them. In doing this we will improve quality & productivity.
DOE & Variation

(DOE: Design of Experiments)

Low     Variable 1     High

22.5 oz.     26.5 oz.

Low     Variable 2     High

22.0 oz.     26.5 oz.
Signal-to-Noise (S/N) Ratio

Taguchi advocates its use in robust design

How to increase??

- Increase signal - Western approach
- Reduce noise - Eastern approach

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S/N = \frac{\text{average}}{\text{standard deviation}} = \frac{\bar{x}}{s_x} = \frac{\mu}{\sigma_x}
\]

Does it make any difference how we increase it?
S/N Example

Mean = 8
S.D. = 4
S/N = 2
Increasing S/N - Machine Output

Inputs

Machine

Output
100 parts out
80% efficiency
80 good parts
Increasing S/N - Product Reliability

**MTBF** = \( \frac{1}{\phi} \)

where, \( \phi \) is the failure rate

\[
MTBF = \left( \frac{1}{2} + \frac{1}{3} + \ldots + \frac{1}{n} \right) \frac{1}{\phi}
\]
Increasing S/N - Material Properties

Output

Material Property
Deming’s 14 Points

- More precisely, Deming’s 14 Obligations of Top Management
- Developed during his interactions with industry
- His "take" on what management should be doing to adopt the new philosophy
- Not a menu - can’t just pick the points you want