Lecture #3

Prof. John W. Sutherland

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Engineering Design

Traditional View

- Customer needs
- System design
- Testing
- Product design

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Quality Engineering (MEEM 4650 / 5650)
Dept. of Mechanical Engineering - Engineering Mechanics
Michigan Technological University
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
Taguchi’s View of Engineering Design

1. Customer needs
2. System design
   - Definition of overall product structure
   - Product features
3. Parameter design
   - Selection of nominal values for design parameters. Robust design
4. Tolerance design
   - Selection of tolerances. Employ loss function idea
5. Robust product
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

![Diagram showing desired nominal performance and reduced performance variation](image-url)
Process Centering?

Upper Specification Limit

Nominal

Lower Specification Limit

Diameter
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)
Signal-to-Noise (S/N) Ratio

Taguchi advocates its use in robust design

How to increase??

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

\[
\frac{S/N}{\text{average standard deviation}} = \frac{\bar{x}}{s_{x}} = \frac{\mu_{x}}{\sigma_{x}}
\]

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

Inputs

Component

MTBF = $\frac{1}{\phi}$

where, $\phi$ is the failure rate

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

Output vs. Material Property

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