

Manufacturing Philosophies

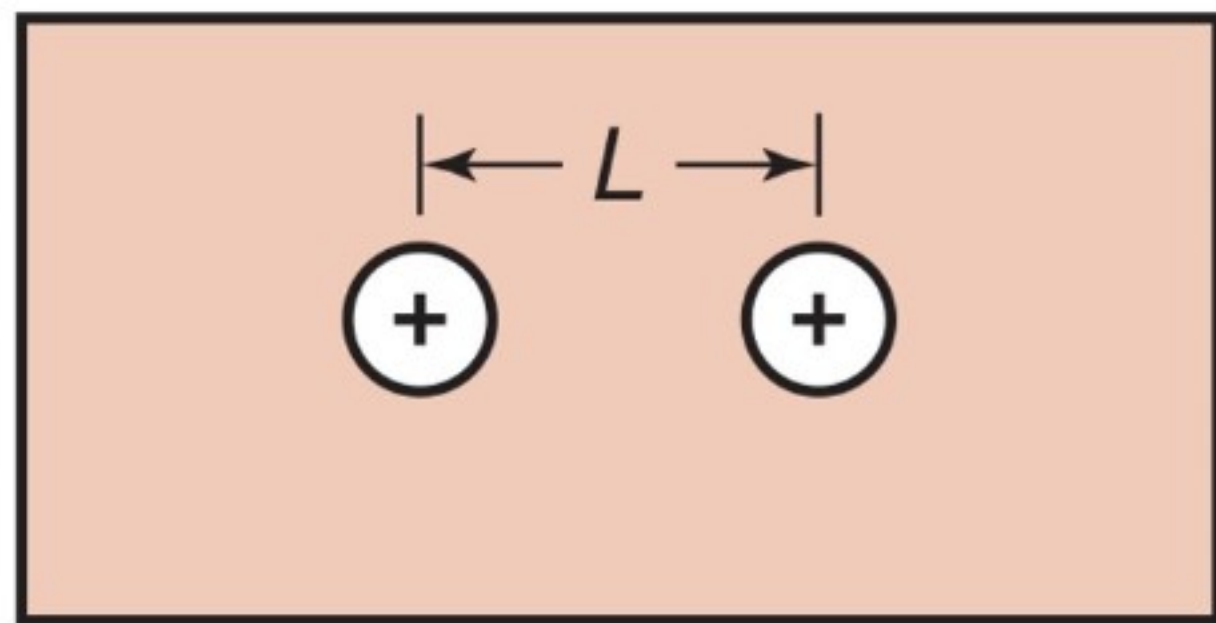
Genichi Taguchi 1924 - 2012

Robust Design

Robust Manufacturing

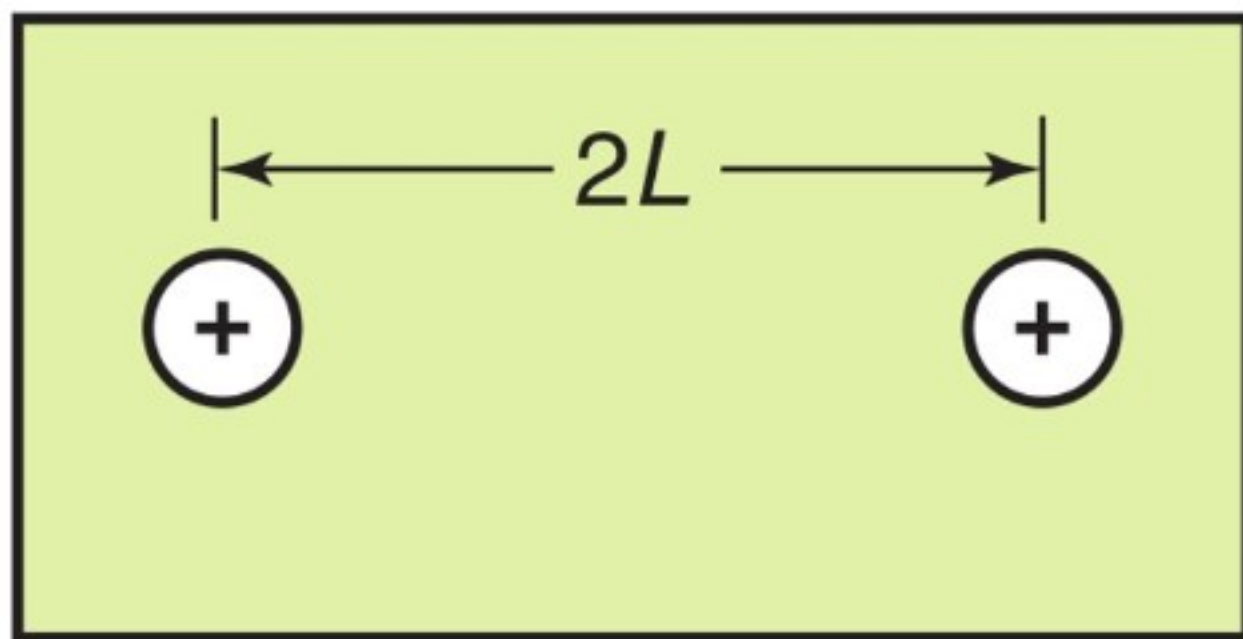
DOE
Design
of
Experiments

Taguchi: Methods



(a)

A hand-drawn callout bubble containing the expression $\pm \alpha$.



(b)

A hand-drawn callout bubble containing the expression $\pm \frac{\alpha}{2}$.

Assertions

1. Cost is most important
2. Cost cannot be reduced without reducing quality.
3. Quality can be improved without affecting cost
4. Cost can be reduced through quality improvement

Taguchi Loss function

replacement cost

total cost of part replacement

cost part

shipping cost

installation cost

etc

$$K = \frac{\text{replacement cost}}{(LSL - T)^2}$$

$$\text{loss cost} = K((Y - T)^2 + \sigma^2)$$

LSL

lower specification limit

USL

upper specification limit

T

target dimension

\bar{y}

average part dimension

σ

std deviation

Example

Tubes

Wall thickness

$$2.6 \pm 0.6 \text{ mm}$$

$$\sigma = 0.2$$

$$T = 2.6 \text{ mm}$$

$$USL = 3.2 \text{ mm}$$

$$LSL = 2.0 \text{ mm}$$

replacement cost \$10

10,000 per month

assume $y = T$

$$K = \frac{10}{(2 - 2.6)^2} = 27.28$$

$$\text{loss} = k \left(\frac{(y - T)^2}{\sigma^2} + \sigma^2 \right)$$

$$= 27.28 (0.2)^2 = \$1.11 \text{ per part}$$

$$10000 \cdot 1.11 = \$11,100 \text{ per month}$$

Improvement

Cost \$50000

$$\sigma = 0.1$$

$$\text{loss} = K \sigma^2 = 27.28 (0.1)^2 = \$0.28 \text{ per unit}$$

$$10,000 \cdot 0.28 = \$2800 \text{ per month}$$

$$\text{Savings} \quad 11100 - 2800 = \$8300 \text{ per month}$$

$$\frac{\$50000}{\$8300/m} = 6.02 \text{ months} \quad \text{payoff period}$$

Kaizen


"Change for the better"

Continuous improvement

Six Sigma

Developed by Toyota

DMAIC



Define
Measure
Analyze
Improve
Control

Lean Manufacturing

Eliminate Waste

Overproduction

Waiting Time

Unnecessary Transportation

Unnecessary Processing

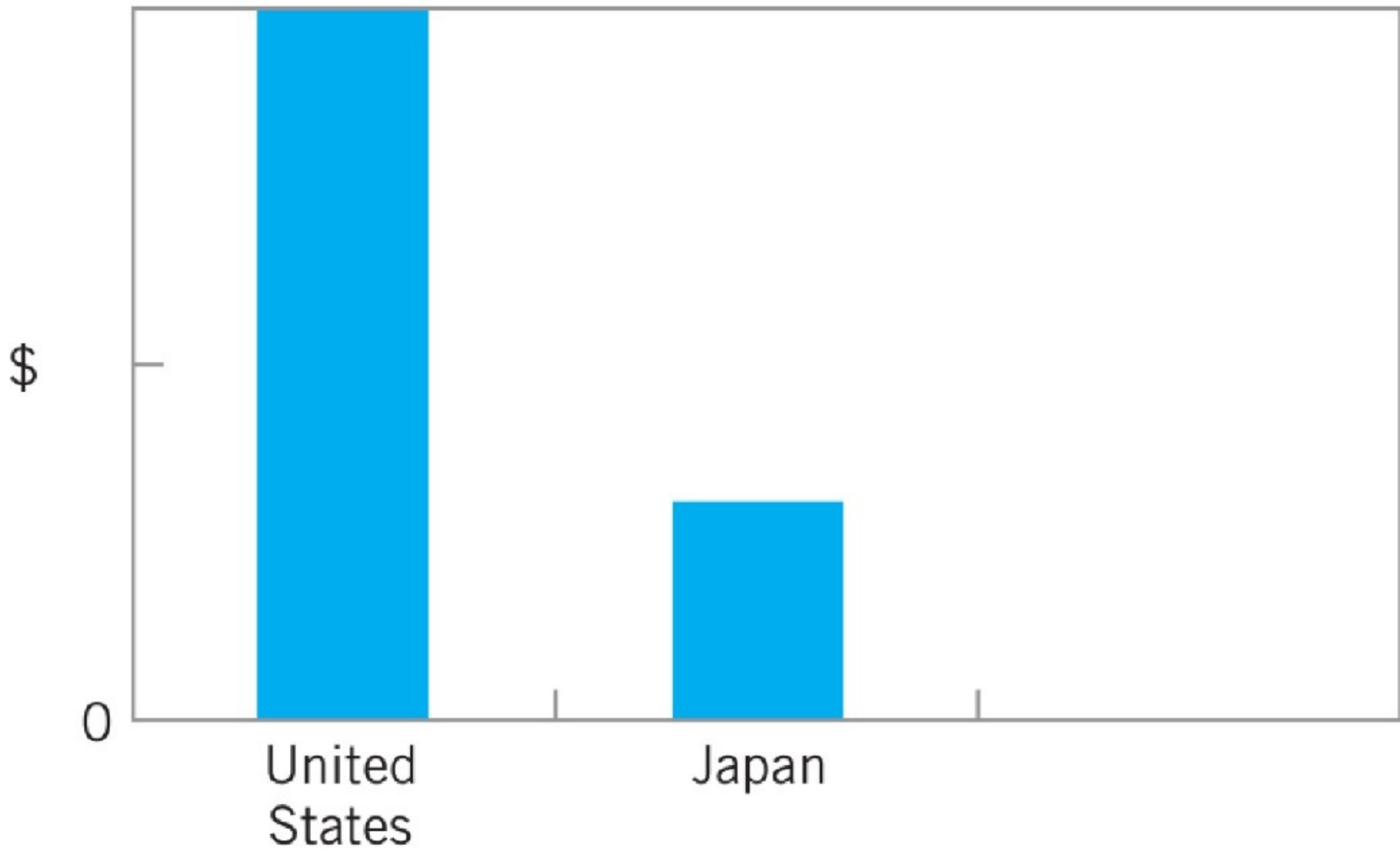
Inventory

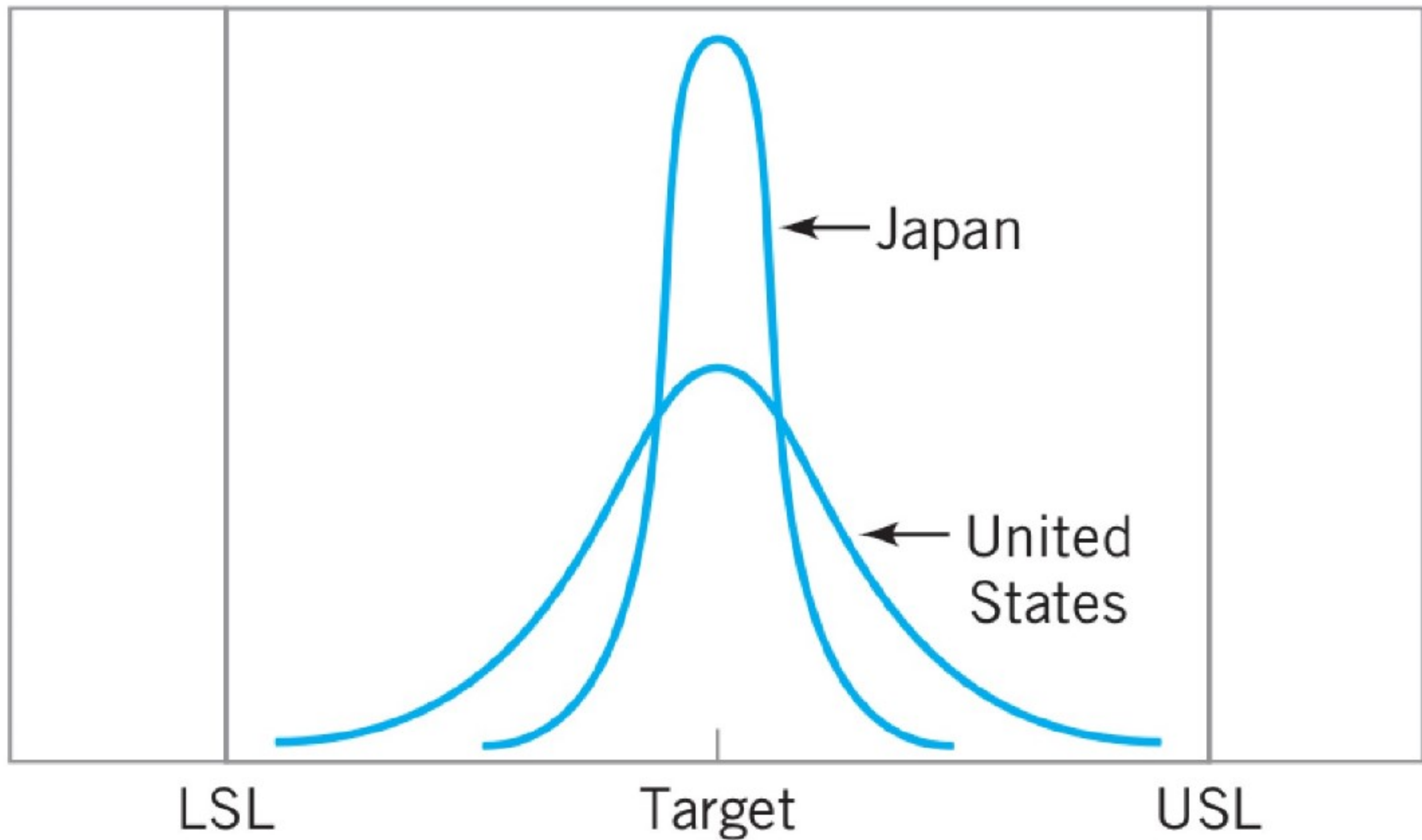
Unnecessary Motion

Production Defects

Just in Time

Lean Six Sigma





- ▶ Ford Transmission Quality Study (<https://youtu.be/uAfUOfSY-S0>)