Process Dominance

Data Science for Quality Management: Understanding Process Variation

with **Wendy Martin**

Learning objective:

Identify sources of variation with respect to process dominance

Process Control

- To control a process you must identify the sources of variation affecting the process.

- Identifying the sources of variation allows you to implement appropriate countermeasures.

Process Control

- Effective countermeasures are difficult to apply to unknown sources of variation.

Thinking About Process Variation

Given: $Y = f(X_1, X_2 \ldots X_n)$

- Where Y is some Product or Process Characteristic
  - ✓ Where n is a large number
  - ✓ Each X_a is a random variable
- The function (f) probably cannot be exactly defined

Thinking About Process Variation

Given: $Y = f(X_1, X_2 \ldots X_n)$

- The Variables could:
  - ✓ Be Continuous or Discrete
  - ✓ Vary in terms of how they change through time
  - ✓ Vary in terms of Importance or effect on Y
  - ✓ Combine Additively or Interactively
  - ✓ Influence Y directly or indirectly

Thinking About Process Variation

Given: $Y = f(X_1, X_2 \ldots X_n)$

- Control of Y will involve manipulation of the Xs

- Variation in the Xs generate variation in Y

Thinking About Process Variation

Given: $Y = f(X_1, X_2 \ldots X_n)$

- Most Xs vary within some natural bounds

  - ✓ The variation in the Xs may be slow, through-time changes or abrupt rapid changes

  - ✓ Many small-effect X variables generate small differences in each observation of Y

  - ✓ Enough small differences can sometimes add up to large amounts of variability in the Y distribution
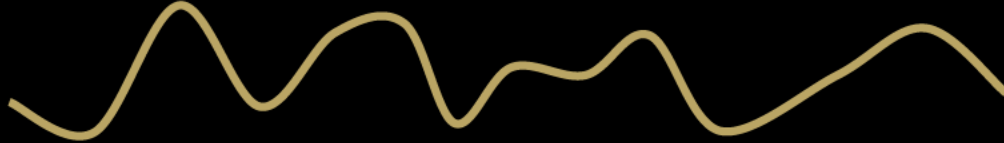
  - ✓ Large-effect X variables generate large shifts in Y

Process Variation Through Time

Variable A — Slow through time

Variable B — Many small-effect X variables

Variable C — Abrupt, rapid change

Identifying Sources of Variation With Respect to Process Dominance

- Setup-dominant process

- Machine-dominant process

- Fixture- or pallet-dominant process

- Tooling-dominant process

- Operator-dominant process

Identifying Sources of Variation With Respect to Process Dominance

- Material- or component-dominant process

- Preventive maintenance-dominant process

- Climate-dominant process

- Stability, Control or Time-based dominant process

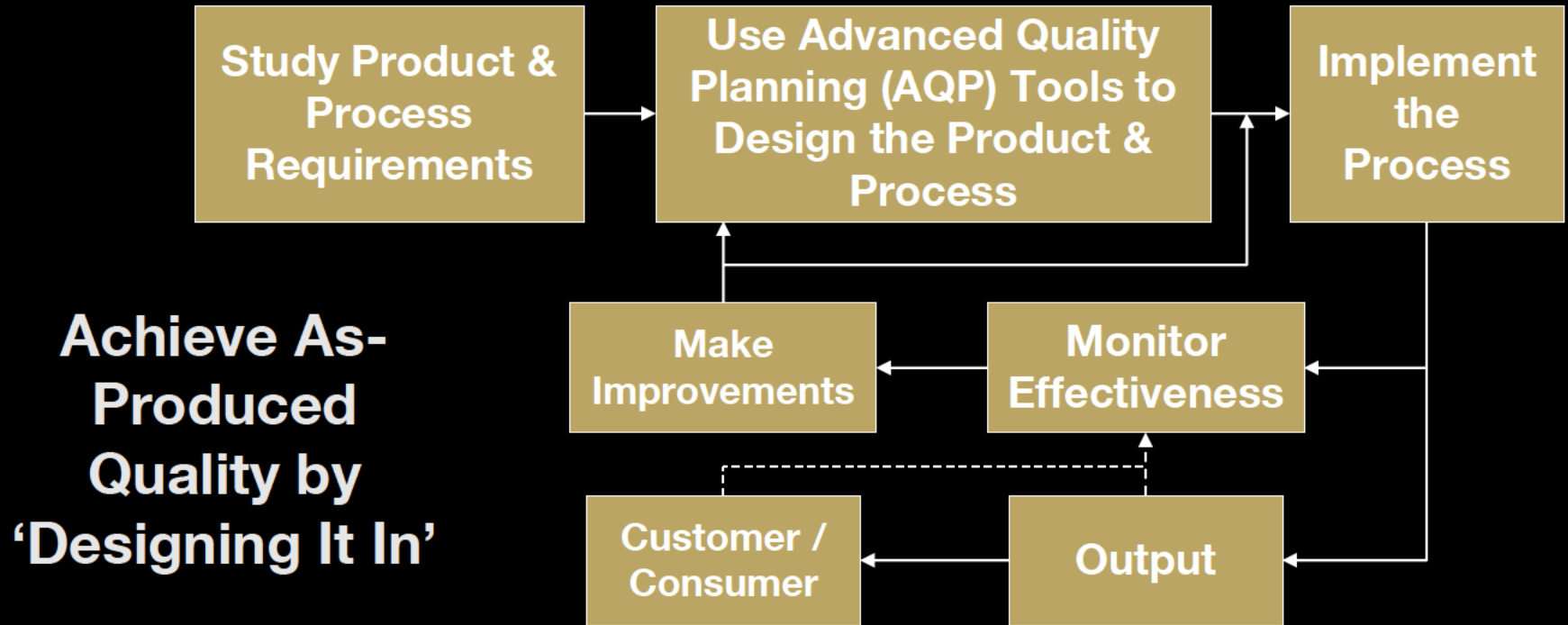# Identifying Sources of Variation With Respect to Process Dominance

- Example:

Type of Dominance	Primary Cause of Output Variability	Primary Controls	Measurement Recommendations
Setup	Set-up to Set-up Differences	Set-up limits (+/- 10% of tolerance from target) SOP, data verification and error/mistake proofing	Statistical verification with consideration for α, β, σ, and Δ, relative to target deviation

Process Control Technologies

- Various technologies can be applied to achieve your quality goals.

- Control charts are only one of many tools that can be employed.

The Process Control Cycle – Phase 3

Achieve As-Produced Quality by 'Designing It In'

Study Product & Process Requirements

Use Advanced Quality Planning (AQP) Tools to Design the Product & Process

Implement the Process

Make Improvements

Monitor Effectiveness

Customer / Consumer

Output

AQP Tools / Control Methods

- Robust Product and Process Design Achieved Through the Use of Experimental Design Methods

- Mistake-Proofing

- Automatic Control Systems

AQP Tools / Control Methods

- Adjustment Charts

- Standardized Operations and Procedures

- Reliability Methods

Sources

The material used in the PowerPoint presentations associated with this course was drawn from a number of sources. Specifically, much of the content included was adopted or adapted from the following previously-published material:

- Luftig, J. An Introduction to Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1982
- Luftig, J. Advanced Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1984.
- Luftig, J. A Quality Improvement Strategy for Critical Product and Process Characteristics. Luftig & Associates, Inc. Farmington Hills, MI, 1991
- Luftig, J. Guidelines for Reporting the Capability of Critical Product Characteristics. Anheuser-Busch Companies, St. Louis, MO. 1994
- Spooner-Jordan, V. Understanding Variation. Luftig & Warren International, Southfield, MI 1996
- Luftig, J. and Petrovich, M. Quality with Confidence in Manufacturing. SPSS, Inc. Chicago, IL 1997
- Littlejohn, R., Ouellette, S., & Petrovich, M. Black Belt Business Improvement Specialist Training, Luftig & Warren International, 2000
- Ouellette, S. Six Sigma Champion Training, ROI Alliance, LLC & Luftig & Warren, International, Southfield, MI 2005