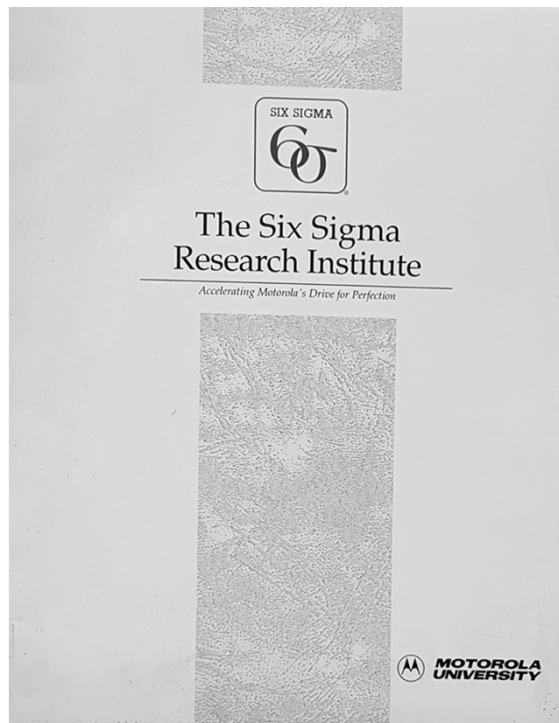# Six Sigma

MAE
2019

# What is Six Sigma?

- Customer satisfaction?

- Quality and reliability of products?

- Excellence in services?

- Continuous improvement?

- Application of statistical methods?

- Company-wide involvement?

- Improving financial bottom line?

… *and so on?*

# Simple Concept

## What are the three most common obstacles to excellence in products and processes?

# VARIATION

# VARIATION?

# VARIATION!

# How to Calibrate Quality?

- Quality as a concept applies to both manufacturing and service systems
- Idea of "defects per million parts" for physical products has a corresponding "defects per million opportunities" in transactions
- Hence *dpmo* as a performance index

# Meaning of "Sigma Level" in Six Sigma

- Define a measure that will reflect, *from the customer's point of view*, what is Critical to Quality  - **CTQ**

- Define the range of acceptable values of CTQ

- Understand target CTQ value and specification limit(s) for actual CTQ values

# 6 Sigma Process

*After 1.5 Sigma Shift:*  3.4 ppm
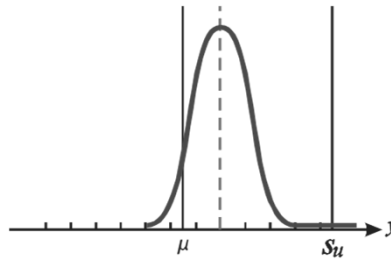


# Calibrating Quality with Sigma Levels

**(Distribution Shifted $\pm$ 1.5 sigma )**

*Sigma level*

Directly related to

*dpmo*

| σ | ppm |
|---|---|
| 2 | 308,537 |
| 3 | 66,807 |
| 4 | 6,210 |
| 5 | 233 |
| 6 | 3.4 |
| **Sigma Level** | **Defects per Million Opportunities** |

## Judging Performance by the "sigma" and "dpmo" Metric

- Six Sigma advocates defect elimination and error prevention

- Advantage: Common, comparable and exchangeable measures of performance across different systems
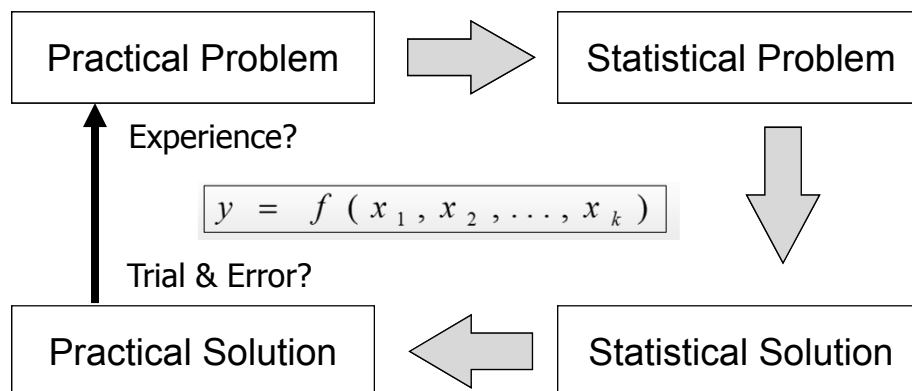
## Quality tools organized into a Six Sigma framework:

- **Define**
- **Measure**
- **Analyze**
- **Improve**
- **Control**

# Six Sigma Problem-Solving Framework

INPUT                    OUTPUT
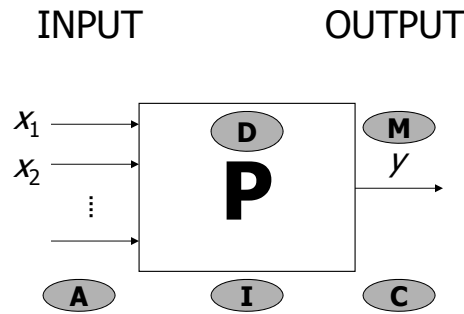


- $y$ represents a measure of CTQ ("Critical to Quality")
- A Six Sigma project improves the sigma level of $y$

# The Six Sigma Framework



| Practical Problem | ⟹ | Statistical Problem |

Experience?

$$y = f(x_1, x_2, \ldots, x_k)$$

Trial & Error?

| Practical Solution | ⟸ | Statistical Solution |

Statistical tools lead to data-based solutions *i.e.* backed by
factual information or "voice of the process",
with a view to satisfying the "voice of the customer"

# What is Six Sigma?

 *"Six Sigma… a disciplined method of using **extremely rigorous data gathering** and **statistical analysis** to pinpoint errors and ways of eliminating them*"

– Mikel Harry

# What is Six Sigma?

 *"Six Sigma is an **information-driven methodology** for reducing waste, **increasing customer satisfaction** and improving processes with a focus on **financially measurable** results*"

– MINITAB

# What is Six Sigma?

*" … Six Sigma has **changed the DNA of GE** – it is now the way we work – in everything we do and in every product we design."*

- Jack Welch, GE

# **10** Reasons Why Six Sigma Succeeds

1. Management top-down initiated (note 20/80!)
2. Structured deployment (DMAIC)
3. Customer focused (rather than inward-looking)
4. Clear performance metric (dpmo; sigma level)
5. Application of statistics (analytical, not will power)
6. Knowledge based (not judgment or procedure based)
7. Recognized time effect (short- and long-term)
8. Hierarchy of expertise (Champions, MBB, BB, etc)
9. Service as well as engineering applications
10. Results oriented (Project by project; 3-6 months; $)