# Introduction to Six Sigma

**Six Sigma Yellow Belt Course**

Dennis Behnke (熊德明), LSSMBB
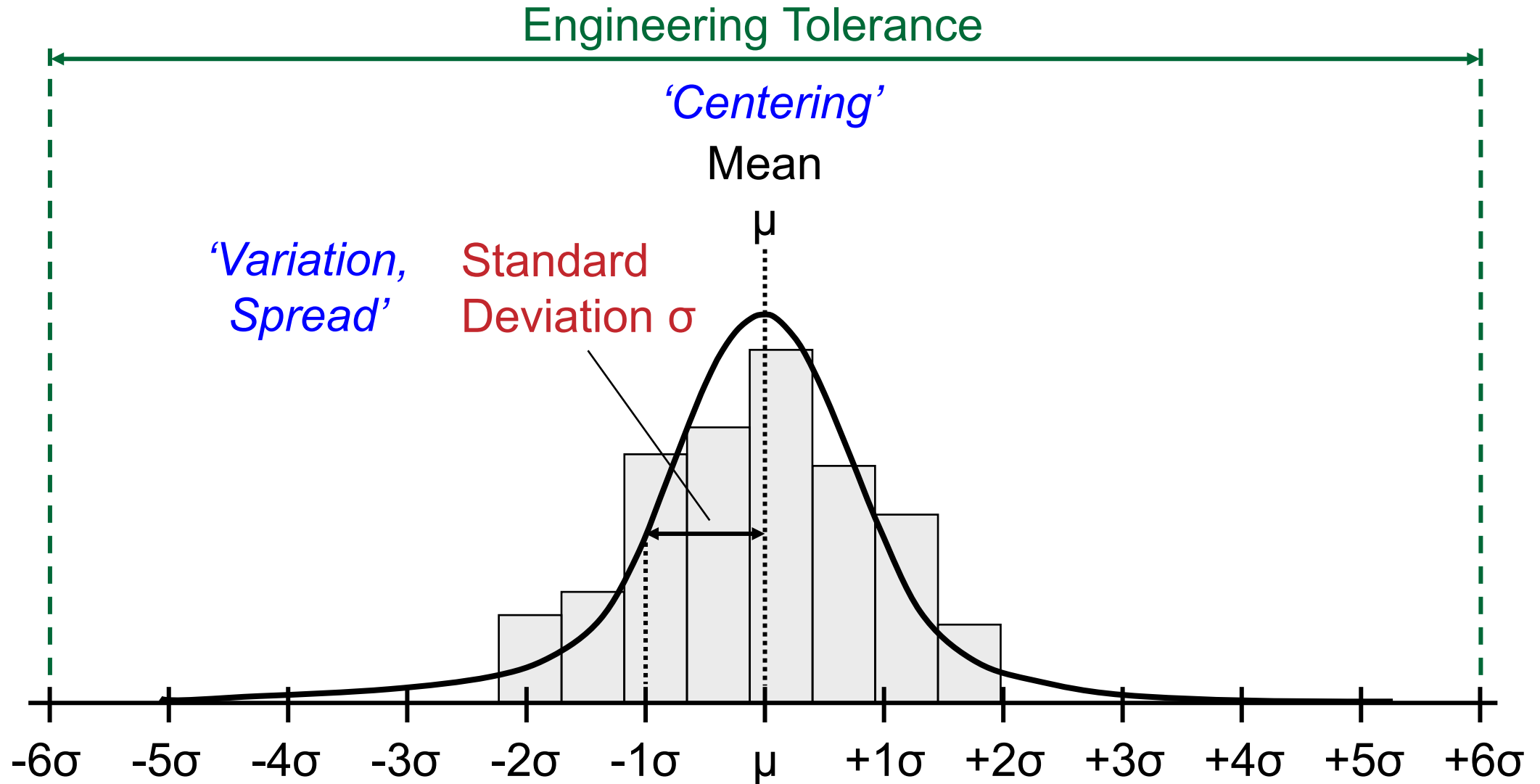
# Common Misconceptions

What Six Sigma is *not*:

1. A quality program

2. Just about statistics

3. Something for engineers only

4. Something for the manufacturing industry only

5. An outdated process improvement approach

6. The solution for all business problems

7. Useful even when the solution is known

8. Useful for firefighting

# What is Six Sigma?

1.  A virtually error-free process performance and quality standard.
    * Greek letter σ (Sigma) indicating process variation
    * Six Sigma quality / Six Sigma process performance

2.  A management system bringing scientific reasoning into business.
    * Cadres (YB, GB, BB, MBB)
    * Set of tools and methods
    * Project management approach
    * Working style

# Sigma as Process Variation

Engineering Tolerance

*'Centering'*

Mean

μ

*'Variation, Spread'*  Standard Deviation σ

-6σ  -5σ  -4σ  -3σ  -2σ  -1σ  μ  +1σ  +2σ  +3σ  +4σ  +5σ  +6σ

# Six Sigma as a Quality/Performance Level

**Sigma Level**                                    **e.g. spelling errors in books**

1. One Sigma  ⟶  170 misspelled words per page in a book

2. Two Sigma  ⟶  25 misspelled words per page in a book

3. Three Sigma  ⟶  1.5 misspelled words per page in a book

4. Four Sigma  ⟶  1 misspelled word in 30 pages

5. Five Sigma  ⟶  1 misspelled word in a set of encyclopedias

6. Six Sigma  ⟶  1 misspelled word in all books of a small library

# Sigma Level and Related Parts per Million

Sigma Level, PPM, and '% Defective' are related:

| Sigma Level | PPM | % Defective |
|:---:|:---:|:---:|
| **2** | 308'537 | 30.8% |
| **3** | 66'807 | 6.7% |
| **4** | 6'210 | 0.6% |
| **5** | 233 | 0.02% |
| **6** | 3.4 | 0.0003% |

# Exercise

You own an apartment with 120 sqm of carpet.

If you have it cleaned, how much carpet would be dirty with a …

| Sigma Level | % Defective | sqm | L × W |
|:---:|:---:|:---:|:---:|
| 2 | 30.8% | 36.96 | 6 m × 6 m |
| 3 | 6.7% | 8.04 | 2.8 m × 2.8 m |
| 4 | 0.6% | 0.72 | 85 cm × 85 cm |
| 5 | 0.02% | 0.024 | 15 cm × 15 cm |
| 6 | 0.0003% | 0.00036 | 1.9 cm × 1.9 cm |

# Six Sigma Belt System

| **Six Sigma Yellow Belt** | **Six Sigma Green Belt** | **Six Sigma Black Belt** | **6σ Master Black Belt** |
|---|---|---|---|
| • Basic Understanding and awareness of Six Sigma ideas and tools | • Can act as PM for smaller scale 6σ projects<br>• Often part-time process improvement experts | • Can act as PM for larger scale 6σ projects<br>• Often full-time process improvement experts | • 6σ trainer, coach, mentor<br>• Supports company-wide implementation<br>• Assists in supervising 6σ projects |

# Six Sigma Tools and Methods

| Six Sigma Yellow Belt | Six Sigma Green Belt | Six Sigma Black Belt | 6σ Master Black Belt |
|---|---|---|---|
| • Kano Model | • Flow Charts | • Failure Mode and Effects Analysis (FMEA) | • Conjoint Analyses |
| • Six Sigma Metrics | • Histograms | • Measurement System Analysis (MSA) | • Cluster Analyses |
| • Process Capabilities | • Check/Tally Sheets | • Hypothesis Testing | • Discrete Event Simulations (DES) |
| • Quality Function Deployments | • Ishikawa Diagrams | • Analysis of Variance (ANOVA) | • Machine Learning/Artificial Intelligence |
| • Balanced Scorecard | • Pareto Chart | • Design of Experiments (DOE) | • Data Warehousing |
| • Non-Parametric Statistics | • Scatter Diagram s | • Multiple Regression | • … |
| • … | • Control/Shewhart Charts | • … | |
| | • … | | |

# Six Sigma as a Project Management Approach

**Scientific Method**

1. Ask a question

2. Do some background research

3. Construct a hypothesis

4. Test the hypothesis with an experiment

5. Analyze the data and draw conclusions

6. Communicate results

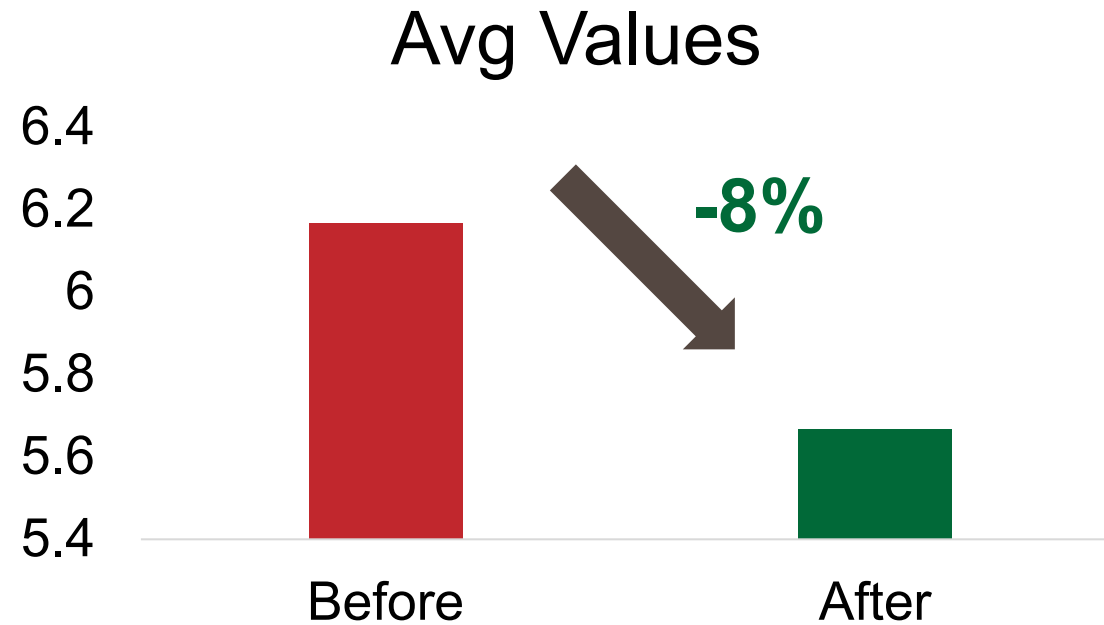**Six Sigma Method**



Define

Measure

Analyze

Improve

Control

# Frequently Observed Working Style

A project manager presents the following status:

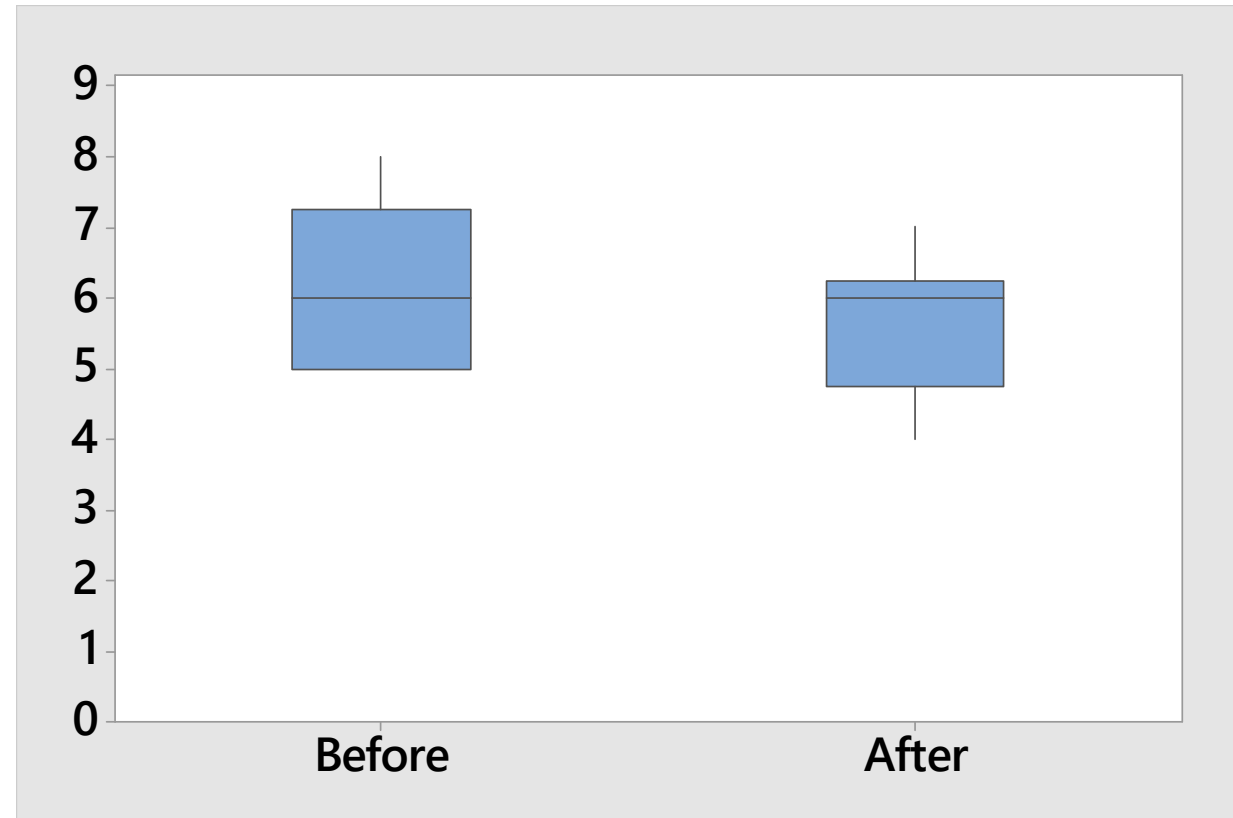| Before | After |
|:------:|:-----:|
| 6 | 5 |
| 5 | 6 |
| 7 | 4 |
| 6 | 7 |
| 5 | 6 |
| 8 | 6 |

## Avg Values



*'We have achieved an 8 percent improvement.'*

# Six Sigma Working Style

A Six Sigma project manager may present the status as follows:

| # | Before | After |
|---|--------|-------|
| 1 | 6 | 5 |
| 2 | 5 | 6 |
| 3 | 7 | 4 |
| 4 | 6 | 7 |
| 5 | 5 | 6 |
| 6 | 8 | 6 |
| Avg | 6.2 | 5.7 |
| Med | 6 | 6 |

Wilcoxon one-sided SRT:
V = 13.5, p-value = 0.2949



*'We can't see any statistically valid improvement at this point in time.'*

# Six Sigma Attitude

1. Show me the data

2. How do you know?

3. Has it been verified? (=does it conform to specifications?)

4. Has it been validated? (=does it meet the needs?)

5. I can't see any test statistics

6. What measurement scale did you use?

…

# What is Six Sigma?

1. A virtually error-free process performance and quality standard.
   - Greek letter σ (Sigma) indicating process variation
   - Six Sigma quality / Six Sigma process performance
2. A management system bringing scientific reasoning into business.
   - Cadres (YB, GB, BB, MBB)
   - Set of tools and methods
   - Project management approach
   - Working style

# References I

- [PyzdekKeller18] Thomas Pyzdek, Paul Keller: The Six Sigma Handbook, 5th ed. 2018

- [Ishikawa88] Kaoru Ishikawa: What Is Total Quality Control? The Japanese Way, 1988

- [Ishikawa86] Kaoru Ishikawa: Guide to Quality Control, 1986

- [Cano12] Emilio L. Cano, Javier M. Moguerza, Andrés Redchuk: Six Sigma with R: Statistical Engineering for Process Improvement (Use R! Book 36), 2012

- [George19] Michael L. George, Dan Blackwell, Dinesh Rajan: Lean Six Sigma in the Age of Artificial Intelligence: Harnessing the Power of the Fourth Industrial Revolution, 2019

- [George02] Michael L. George: Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed, 2002

# References II

- [George03] Michael L. George: Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions, 2002

- [Pande12] Peter Pande, Robert Neuman, Roland Cavanagh: The Six Sigma Way: How to Maximize the Impact of Your Change and Improvement Efforts, 2nd ed. 2014

- [Wheat03] Barbara Wheat, Chuck Mills, Mike Carnell: Leaning Into Six Sigma: A Parable of the Journey to Six Sigma and a Lean Enterprise, 2003

- [Eckes07] Goerge Eckes: The Six Sigma Revolution. How General Electric and Others Turned Process into Profits, 2007

- [Bass07] Issa Bass: Six Sigma Statistics with EXCEL and MINITAB, 2007

- [Khan13] Rehman M. Khan: Problem Solving and Data Analysis Using Minitab: A Clear and Easy Guide to Six Sigma Methodology, 2013