START PROJECTING NOW

SIX SIGMA INTRODUCTION

LEAN SIX SIGMA WHITE BELT

Agenda

- What is Six Sigma?
- Lean Six Sigma
- Data Driven Decisions
- 6σ Definition
- Real World Examples
- How to Calculate σ Level
- Other Indicators
- Six Sigma Principles
- Six Sigma Challenges

What is Six Sigma?

A **structured** methodology,

based on **statistical** analysis

to identify process **variation**,

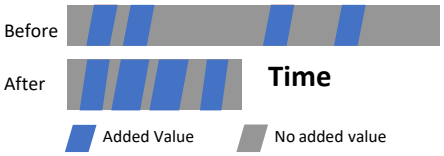
therefore **reduce defects**

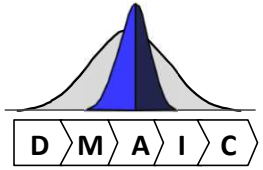
and increase **customer satisfaction**.

Lean Six Sigma

Complementary Scopes

	VALUE STREAM	PROCESSES VARIATION
OBJECTIVE	• Reduction of waste • Continuous improvement • Productivity	• Reduction of variability sources • Deployed according to need • Optimization and quality
SCOPE	• Short term • Lean tools • Simple	• Medium and long term • Statistical tools • Complex
REFERENCE	Toyota	Motorola

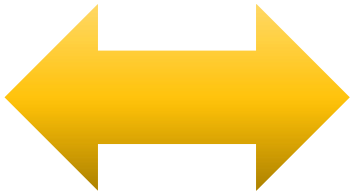




Data Driven Decisions

Decisions based on intuition or experience

- Process doesn't work
- Results can be improved
- Never worked well



Six Sigma is based on measurement and metrics

- Statistical prove
- Validation of assumptions
- Historical data

Data Driven Decisions

Decision Making Without Six Sigma

- Ideas implemented based on someone's influence
- Past experiences may lead to believe the idea will be successful or unsuccessful
- Success is weighted after implementation – Problems are addressed after impacts
- Ideas implemented in beta mode to reduce risks and expenses

Beta Testing

- Controlled and reduced environment test before deployment to the entire population
- Trial-and-error can impact customer negatively
- Improvements may be superficial and unsustainable
- Without a Six Sigma approach, it can cause extra expenses and not reach aimed results

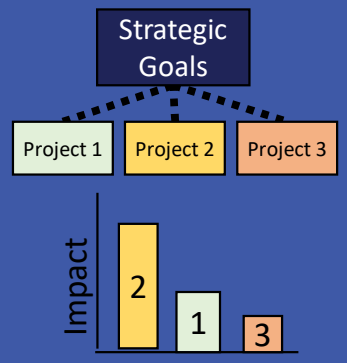
Data Driven Decisions

Decision Making With Six Sigma

- Map the process
- Identify problem(s) and its root cause(s)
- Apply statistical analysis
- Identify possible solution(s) and outcome(s)
- Risk assessment
- Plan implementation
- High-level accuracy
- Sustainable changes through control methods

6σ Definition

Methodology to improve process and business performance…

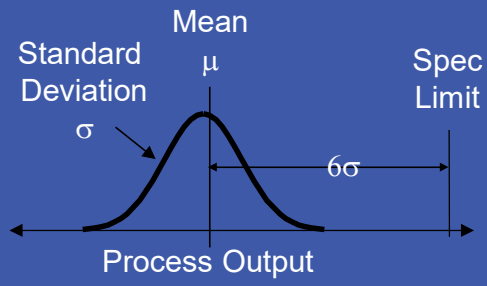


* Work the right projects

by using the right tool…

* Toolbox: variety of tools

to reduce defects.



* Defects per million oportunities

A **6σ** process, so called "perfect" process, has only
3.4 defects per million opportunities, or **99.99966%** of products without defects.

A 5σ process has 233 defects per million opportunities, or 99.97% accuracy.

Real World Examples

Estimated Quantity of Defects

Event	4σ	5σ	6σ
	99.379%	99.977%	99.99966%
Wrong drug prescriptions in USA per year	26,206,200	970,600	14,348
Surgeries errors in USA per week	6,138	227	3
Flights incidents in USA per year	64,683	2,396	35
Lost mails in Canada per week	477,692	17,692	262
Unsafe water in Quebec per year (liters per person)	1,813	67	1
Customers with power outage in Quebec	27,324	1,012	15

* Based on total volume in a given year

Real World Examples

Amazon processed **36.8 millions** orders on 2013 Cyber Monday*.

Considering a conservative cost estimation per error of **35.00 USD**, we can see below the financial impact for Amazon based on different levels of sigma.

Sigma Level	Defects per Million Opportunities	Estimated Quantity of Defects	Estimated Total Cost (USD)
1σ	691,462	25,447,200	$890,652,000.00
2σ	308,538	11,354,272	$397,399,520.00
3σ	66,807	2,458,608	$86,051,280.00
4σ	6,210	228,528	$7,998,480.00
5σ	233	8,464	$296,240.00
6σ	3.4	125	$4,379.20

* https://bgr.com/2013/12/26/amazon-holiday-season-sales-2013/

How to Calculate σ Level

$$\text{YIELD} = \left(\frac{\text{\# Opportunities - \# Defects}}{\text{\# Opportunities}} \right) \times 100$$

PPM	Yield %	Sigma	PPM	Yield %	Sigma	PPM	Yield %	Sigma
3.4	99.9997	6.00	6210	99.3790	4.00	308000	69.2000	2.00
5	99.9995	5.92	8190	99.1810	3.90	344000	65.6000	1.90
8	99.9992	5.81	10700	98.9300	3.80	382000	61.8000	1.80
10	99.9990	5.76	13900	98.6100	3.70	420000	58.0000	1.70
20	99.9980	5.61	17800	98.2200	3.60	460000	54.0000	1.60
30	99.9970	5.51	22700	97.7300	3.50	500000	50.0000	1.50
40	99.9960	5.44	28700	97.1300	3.40	540000	46.0000	1.40
70	99.9930	5.31	35900	96.4100	3.30	570000	43.0000	1.32
100	99.9900	5.22	44600	95.5400	3.20	610000	39.0000	1.22
150	99.9850	5.12	54800	94.5200	3.10	650000	35.0000	1.11
230	99.9770	5.00	66800	93.3200	3.00	690000	31.0000	1.00
330	99.9670	4.91	80800	91.9200	2.90	720000	28.0000	0.92
480	99.9520	4.80	96800	90.3200	2.80	750000	25.0000	0.83
680	99.9320	4.70	115000	88.5000	2.70	780000	22.0000	0.73
960	99.9040	4.60	135000	86.5000	2.60	810000	19.0000	0.62
1350	99.8650	4.50	158000	84.2000	2.50	840000	16.0000	0.51
1860	99.8140	4.40	184000	81.6000	2.40	860000	14.0000	0.42
2550	99.7450	4.30	212000	78.8000	2.30	880000	12.0000	0.33
3460	99.6540	4.20	242000	75.8000	2.20	900000	10.0000	0.22
4660	99.5340	4.10	274000	72.6000	2.10	920000	8.0000	0.09

How to Calculate σ Level

Example

Let's consider a company issues 150 invoices per day, or 750 per week.
Customers are complaining that invoices have wrong prices in it.
Financial department randomly selects 250 invoices from previous week for analysis and finds out that 30 were issued with the wrong price.

What is the sigma level of the invoicing process?

Opportunities: 750 invoices per week
Defects: 30 invoices per week

$$\textbf{YIELD} = \left(\frac{750 - 30}{750} \right) \times 100 = \textbf{96\%}$$

Checking the Sigma table, we can say the invoicing process is between 3.20 and 3.30 sigma.

PPM	Yield %	Sigma
28700	97.1300	3.40
35900	96.4100	3.30
44600	95.5400	3.20
54800	94.5200	3.10

Other Indicators

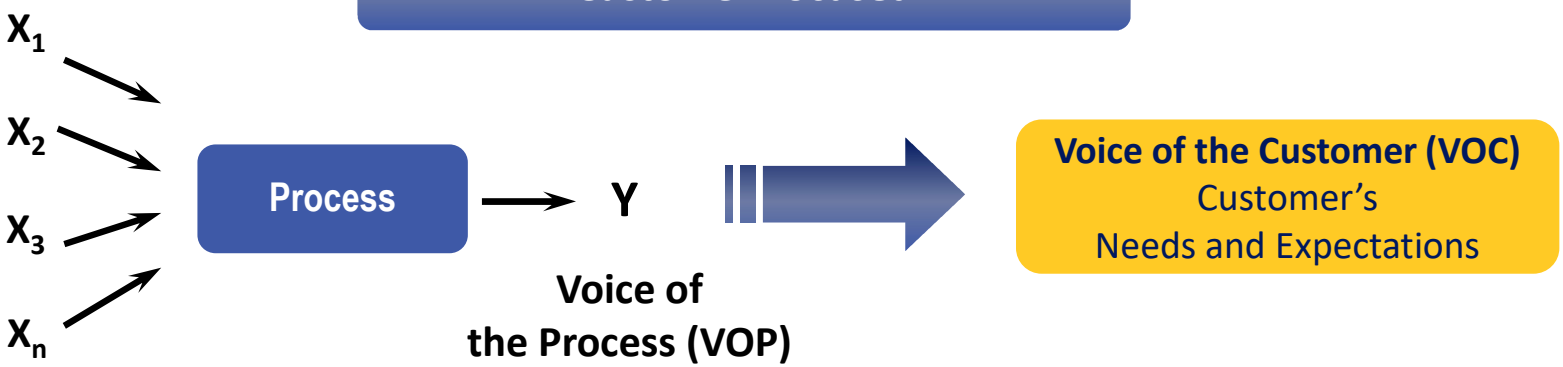
Example

Process:	**Labelling** →	**Packing** →	**Shipping**
Performance:	Legible printing	Sealed	2 days
Sigma Level:	2.1σ	3.2σ	4.4σ
Weekly Cost:	$1,000	$2,000	$500
Improvement Cost:	$3,000	$3,000	$1,000

Continuous Improvement

Six Sigma Principles

Customer-Focused



Process Input Variables (PIV)

Process Output Variables (POV)

Critical To Satisfaction (CTS)

Cost Quality Delivery

Control the **INPUTS** to achieve the desired **OUTPUTS** and satisfy our customers' expectations.

Six Sigma Principles

Customer-Focused

By understanding the voice of the customer it is possible to:

- Customize products and services
- Offer additional products and services
- Prioritize developments
- Understand the market and trends
- Identify problems
- Identify opportunities and test ideas

Six Sigma Principles

Customer-Focused

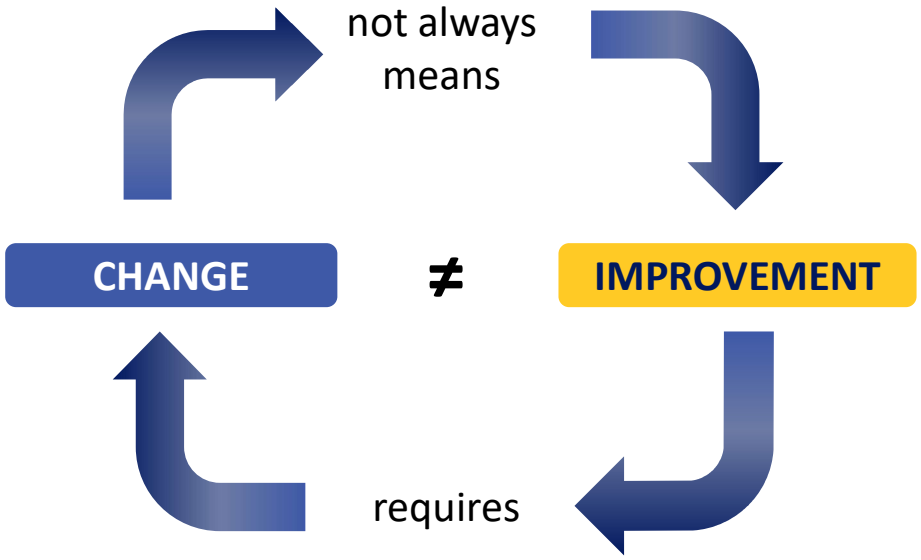
Value Stream

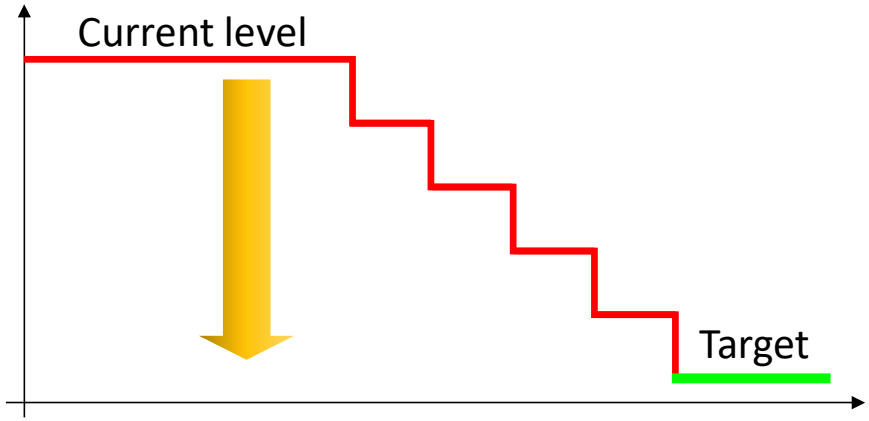
- It is a sequence of actions / events and resources required to produce an end service or product, adding value to the customer.
- Identify wastes, issues and opportunities

Supplier	Raw Material	Process	Delivery
Supermarket	Tomato	Person 1: Slice	
Bakery	Lettuce	Person 1: Wash	
Butcher	Bun	Person 1: Toast	Person 3: Serve
	Hamburger	Person 2: Grill	
		Person 2: Assemble	

Six Sigma Principles

Continuous Improvement





Six Sigma Principles

Variation

Variation:

- Cheese

Solution:

- Measuring cup

Variation:

- Scoop
- Pour
- Above rim
- Remove excess

Six Sigma Principles

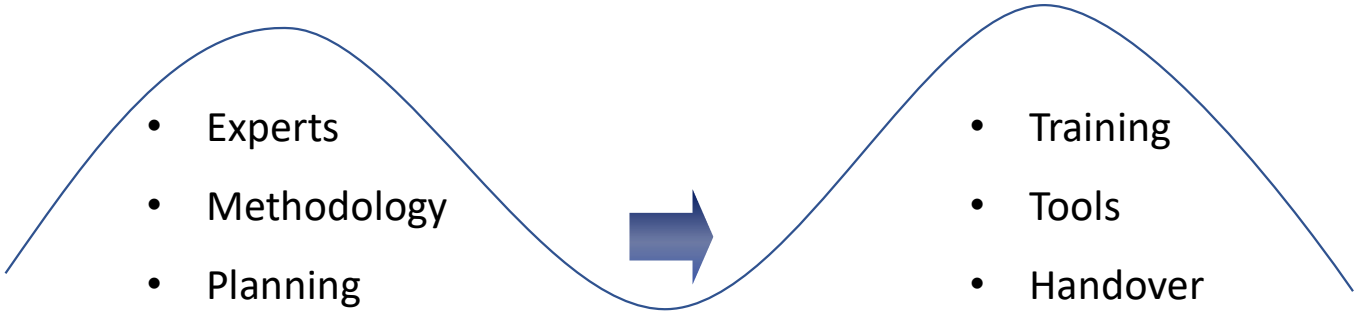
Waste

Process

Person 1	Slice tomato
	Wash the lettuce
	Toast the buns
Person 2	Grill the burger
	Assemble
Person 3	Serve

Six Sigma Principles

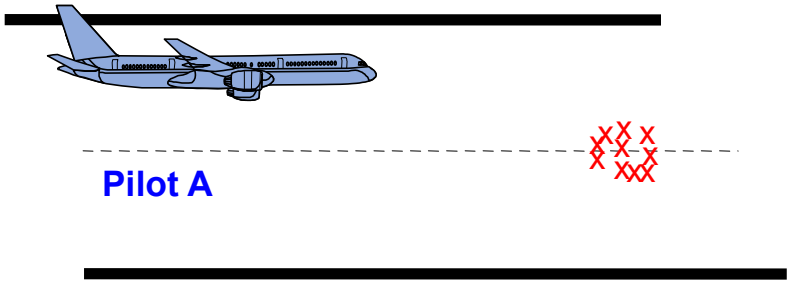
Equipping People

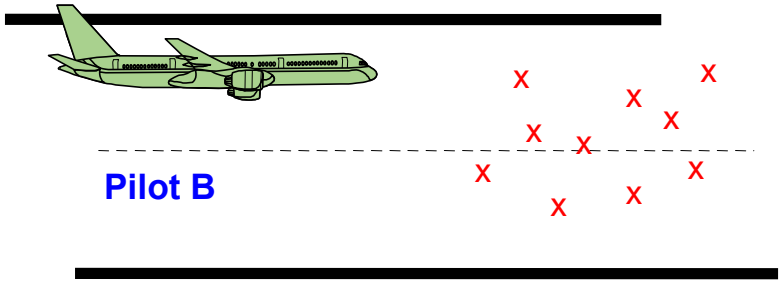


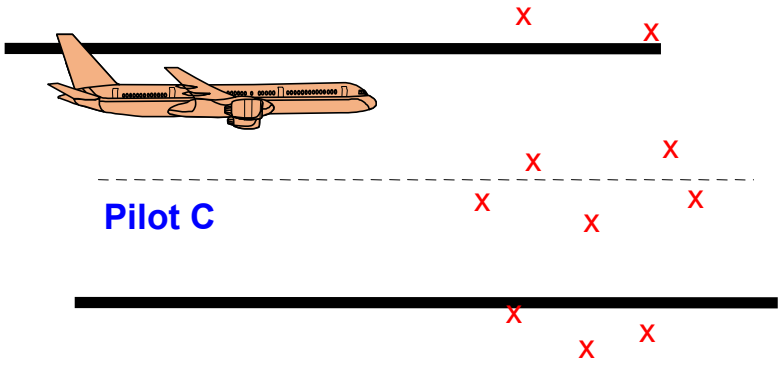
Sustainable Improvements

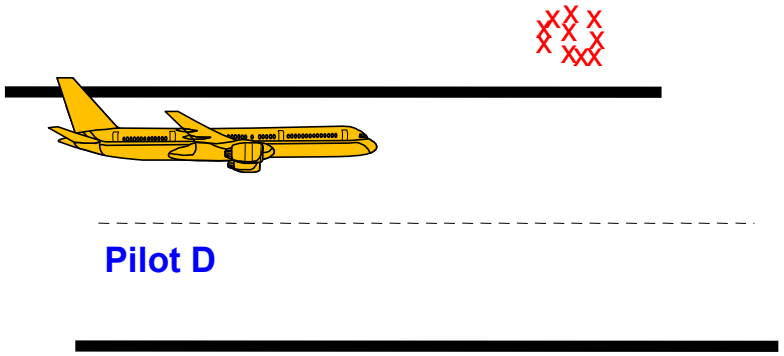
Six Sigma Principles

Controllig the Process









Six Sigma Challenges

- Assumption that it is **expensive**
- Believe that it is **complicated**
- **Arrogance** based on past success
- Dependence on **inspection and rework**
- Reliance on **trial and error**
- **Resistance** to change
- Not linked to company's **culture**

Six Sigma Challenges

Lack of Support

Commo barriers:

- Lack of strategic alignment
- Lack of Six Sigma knowledge or basic understanding
- Lost of interest
- Fear of the unknow
- Unwilling to change

Six Sigma Challenges

Lack of Resources or Knowledge

- Mass training cost can be an issue
- Dedicated experts may not be affordable

…are challenges, but not barriers!

- Make resources partially available
- Train staff gradually

…can make it possible to profit from the use of tools and progressively deploy the methodology.

Six Sigma Challenges

Poor Project Execution

- Not follow the methodology
- Project scope too big
- Wrong priority definition
- Lack of commitment
- Lack of time

Six Sigma Challenges

Data Access Issue

Inacurate data is a common issue:

- Lack of a plan to collect data
- Measurement system is inadequate
- Lack of metrics
- Human interference
- Significant period of time
- Lenghty time between data collection and analysis
- Compliance rules

Six Sigma Challenges

Concerns about Using Six Sigma in a Specificy Industry

- Concepts and tools are commonly related to industrial environment
- Companies mistakenly believe it is not possible or it is too hard to adapt

Six Sigma can be implemented in any industry

Thank You!

Questions?

START PROJECTING NOW

SIX SIGMA DEVELOPMENT

LEAN SIX SIGMA WHITE BELT

Agenda

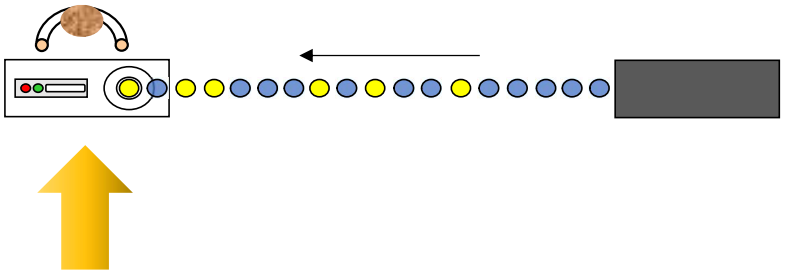
- Six Sigma Application
- Statistical Process Control
- Toyota and Lean
- Motorola - Focus on Defects
- ABB, Allied Signal and GE
- Six Sigma Growth
- Applying Six Sigma

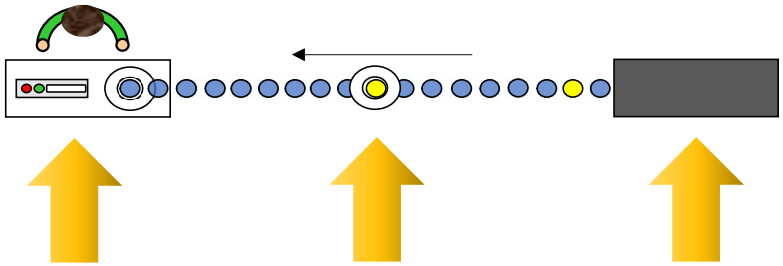
Six Sigma Application

Quality Programs → **Reduce Defects** ← **Six Sigma**

- Specific goal
- Focus on results only
- Skips processes and root causes
- High non-quality cost
- High process variation

- Continuous improvement
- Focus on processes
- Find and solve root causes
- Reduce costs
- Increase performance
- Reduce process variation





Statistical Process Control

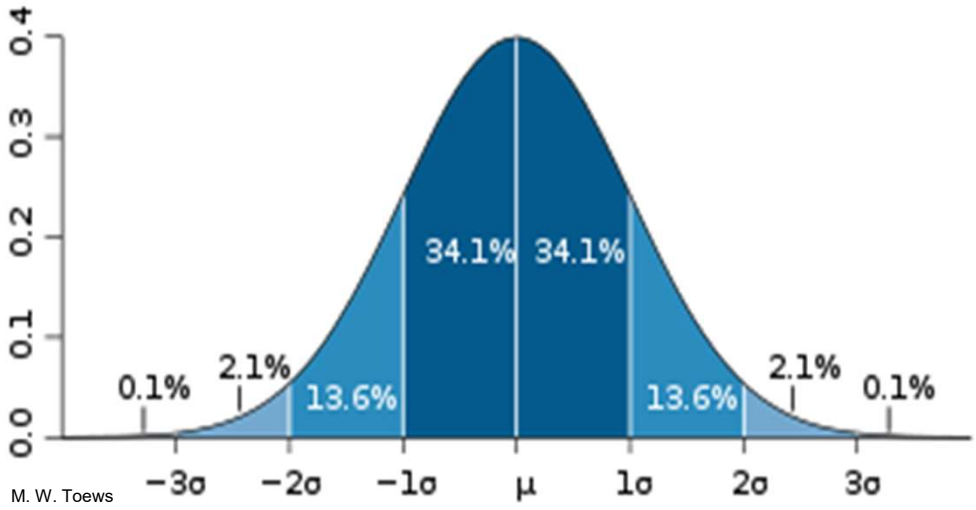
DMAIC and DMADV methodologies

D	Define
M	Measure
A	Analyze
I	Improve
C	Control

D	Define
M	Measure
A	Analyze
D	Design
V	Verify

Statistical Process Control

Normal Distribution, Normal Curve or Bell Curve



± 1 σ 68.26 %

± 2 σ 95.44%

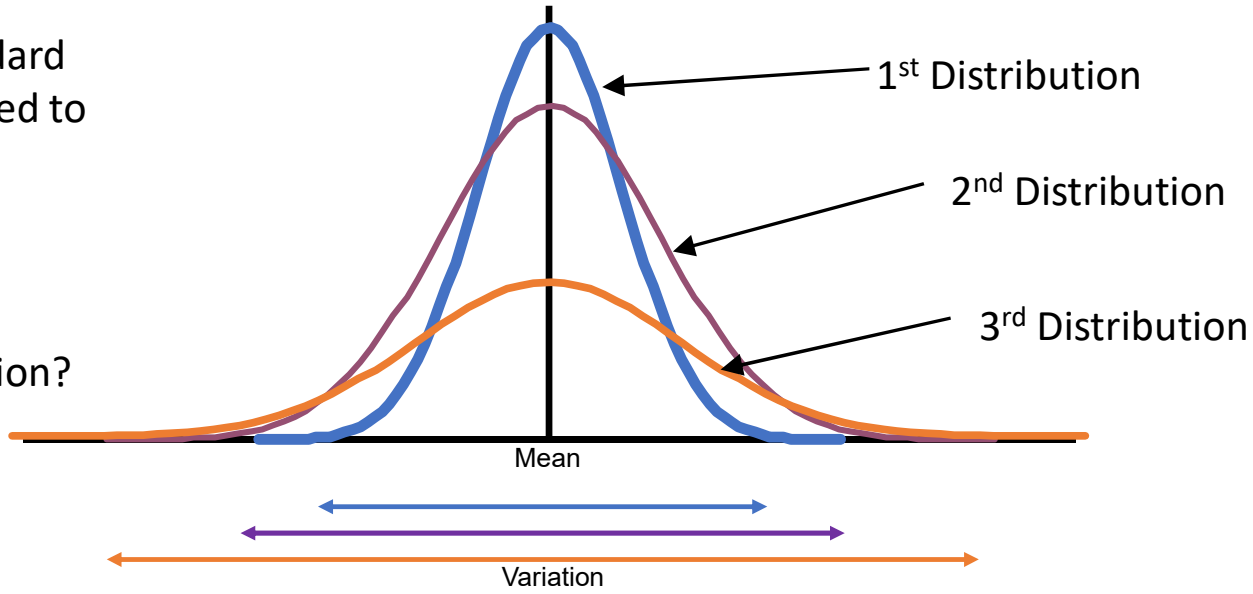
± 3 σ 99.73%

Carl Friedrich Gauss, in 1809

Statistical Process Control

Distribution Examples

- The Mean and Standard Deviation are required to fully describe the distribution.
- Which distribution displays more variation?



The Means are the same, but the Standard Deviations differ.

Statistical Process Control

Statistical Quality Control

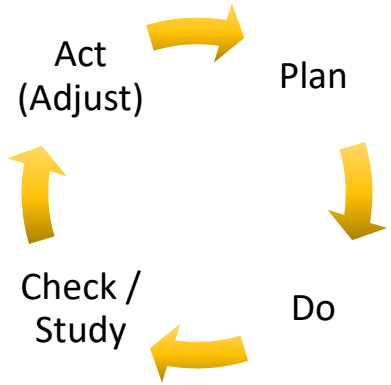
- Sigma level related to quality
- Process performing at 3σ needs improvement
- Application in the manufacturing and industrial process
- Control Chart (1924)
- Common and special causes
- Detection and prevention of problems

Walter A. Shewhart, in the early 1900's

Statistical Process Control

PDCA or PDSA

- Championed the work of Walter Shewhart
- Applied Shewhart concepts outside industrial environment
- Developed the PDCA cycle, also known as the Deming Cycle
- Later modified to PDSA, as check emphasizes inspection over analysis
- Brought the concepts to Japan



William Edwards Deming, around 1925

Toyota and Lean

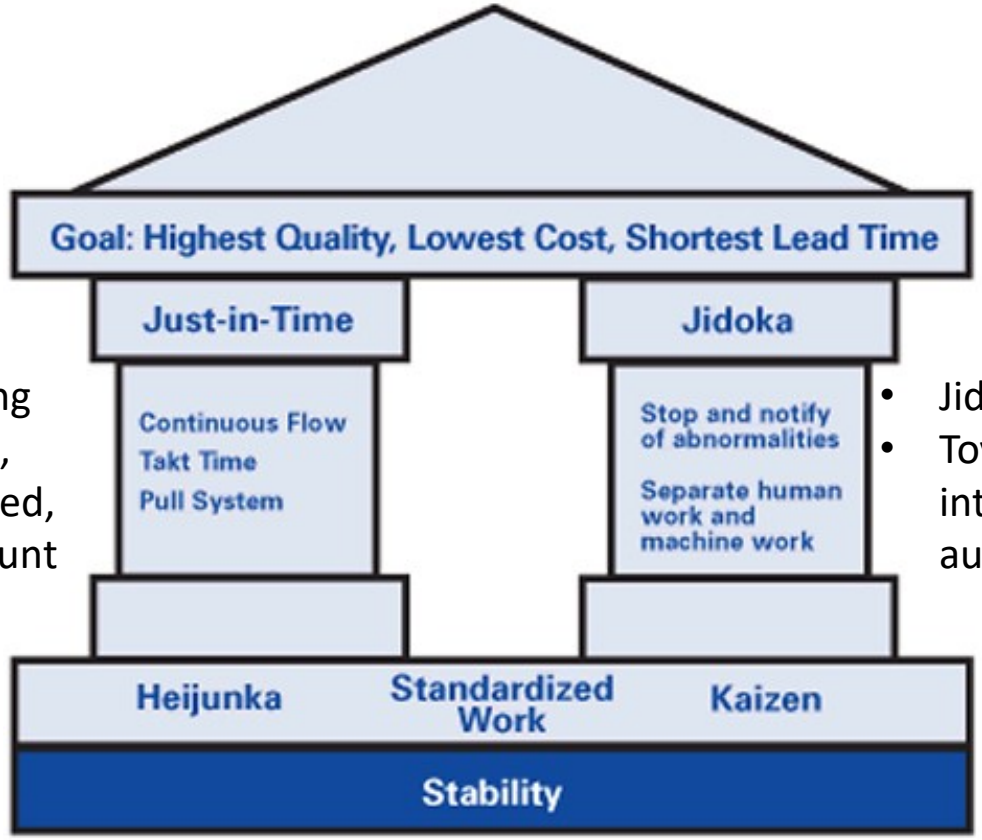
Toyota Production System

- Urgent need to be increase performance after WWII
- Combination of Henry Ford manufacturing ideas and statistics applied to quality
- Use of automation
- Better use of efficiency tools

Kiichiro Toyoda: process efficiency and automation
Eiji Toyoda and Taiichi Ohno: concepts of Just-in-Time and Jidoka

Toyota and Lean

- Just-in-Time: "Making only what is needed, only when it is needed, and only in the amount that is needed“*



Toyota Production System “House.”

- Jidoka: automation
- Toyota Jidoka: auto**no**mation, intelligent automation, automation with a human touch

* Toyota Motor Corporation: The Toyota Production System – Leaner manufacturing for a greener planet; TMC, Public Affairs Division, Tokyo, 1998

Toyota and Lean

Toyota System Principles

- Customer values
- Value stream
- Waste
- Continuous process flow
- Continuous improvement

Foundation of Lean Six Sigma

Motorola - Focus on Defects

- A Japanese company takes over a Motorola plant
- Lean concepts are applied
- Television defects are 1/20th the amount of previous production by Motorola
- In the middle 1980's, Motorola starts questioning effectiveness of their quality system
- Motorola's CEO, Bob Galvin, demands an improvement of 10 times in 5 years
- Engineer Bill Smith and Dr. Mikel Harry lead the changes:
    - Improvement of measurement, from a thousand opportunities to a million opportunities as per Shewhart
    - Deployment of statistical process control
    - Said to have saved over $16 billion within 12 years *

Motorola deployed Six Sigma methodology around the world

* https://www.isixsigma.com/new-to-six-sigma/history/history-six-sigma/

ABB, Allied Signal and GE

- Dr. Harry joins Asea Brown Boveri
- Richard Schroeder becomes champion for Six Sigma
- Financial goal is incorporated to the strategy: Profit focus along with Quality focus
- Around $2 billion in savings in 2 years, 68% reduction in defects and 30% reduction on production costs (WERKEMA, 2004)

- In 1993 Schroeder and Harry join Allied Signal
- CEO Larry Bossidy wants to have well-versed leaders to properly support projects
- Harry creates a system for educating executives and deploy Six Sigma internally
- $2 billion in cost reduction by 1998 and 12% growth in that year (ROTONDARO, 2002)

ABB, Allied Signal and GE

- CEO Jack Welch invites Larry Bossidy to speak at a GE corporate meeting in 1995
- Welch was not a proponent of quality measures, criticizing its programs for not delivering results
- $12 billion in savings over five years *
- Welch is known as Six Sigma champion due to his leadership and approach of the methodology
- He redesign employee reward structure by adding Six Sigma performance to evaluation goals

* https://www.isixsigma.com/implementation/financial-analysis/six-sigma-costs-and-savings/

Six Sigma Growth

The Rush

The success of GE and Motorola, among others, led many companies to rush to implement Six Sigma.

In the rush, companies ignored important concepts of the methodology and poorly executed improvements. The results achieved were not as expected at all, resulting in misconceptions of Six Sigma.

Six Sigma Growth

Myths	Truth
• Six Sigma ignores common sense	• Six Sigma normally starts with common ideas
• Six Sigma is expensive	• Six Sigma can be slowly implemented and recover investment
• Six Sigma fix anything	• Six Sigma can be applied to any process, however not if the root cause is culture or morale

Applying Six Sigma

- Project selection
- Analysis and quantification of process issue
    - Sigma level, downtime, cost of non-quality, etc.
- Investment cost to address the problem
- Project and process management

Applying Six Sigma

Levels of Certification

White Belt — **Understand basic concepts of Six Sigma**

- Introduction to Six Sigma methodology
- Understanding of the basic principles
- Better understanding of how project teams work
- Prepare to participate on project selection
- Prepare to understand project information and milestones presented in project meetings

Applying Six Sigma

Levels of Certification

Yellow Belt

Understand basic concepts of Six Sigma and be able to assist

Includes White Belt knowledge level with additional basic information about the DMAIC method used in Six Sigma. Below concepts are also included:

- Team roles
- Team management
- Basic statistic / quality tools and charts
- Data collection
- Measurement system and metrics
- Root cause analysis

Applying Six Sigma

Levels of Certification

Green Belt

Understand statistical analysis and be able to apply Six Sigma

Consist of intermediate knowledge of statistical tools and analysis, as well as small projects leadership. In addition to Yellow Belt training, it includes:

- Project management and team leadership
- Probability and statistical distributions
- Failure mode and effects analysis (FMEA)
- Hypothesis testing
- Control charts
- Waste elimination and Kaizen

Applying Six Sigma

Levels of Certification

Black Belt — **Manage improvement projects and teams**

In addition to Green Belt hard skills, includes also more statistical knowledge and soft skills, such as:

- Manage Green Belts
- Advanced project and team management skills
- Expansive knowledge on brainstorming and project tools
- Understanding of Lean and Total Quality Management
- Capabilities for mapping processes (flow charts, VSM)
- Use of Excel or Minitab for data analysis and advanced statistics

Applying Six Sigma

Levels of Certification

Master Black Belt

Manage Black Belts and Green Belts

- High level strategy
- Consultant for complex projects
- Advanced knowledge of statistical concepts
- Six Sigma expert – deep knowledge of methodology, tools and analysis

Thank You!

Questions?

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IMPROVEMENT AND QUALITY METHODS

LEAN SIX SIGMA WHITE BELT

Agenda

- Improvement and Quality Methods
  - Lean Process Management
  - Total Quality Management (TQM)
  - Business Process Reengineering
  - Rummler-Brache
  - Scrum
  - The Customer Experience Management Method (CEM)
  - JumpStart
- When to Use Six Sigma

Improvement and Quality Methods

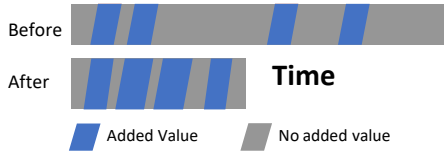
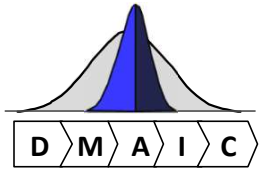
Lean Process Management

Lean and Six Sigma principles complement each other.

- Can be applied to any process
- Focus on continuous improvement
- Waste reduction or elimination
- Culture of quality
- Kaizen : change for better
- Lean is often considered part of Six Sigma

Improvement and Quality Methods

Lean Six Sigma

	VALUE STREAM	PROCESSES VARIATION
OBJECTIVE	• Reduction of waste • Continuous improvement • Productivity 	• Reduction of variability sources • Deployed according to need • Optimization and quality 
SCOPE	• Short term • Lean tools • Simple	• Medium and long term • Statistical tools • Complex
REFERENCE	Toyota	Motorola

Complementary Scopes

Improvement and Quality Methods

Total Quality Management (TQM)

The program is a long-term approach aiming customer satisfaction.

As any other methodology, results depend on the its success of implementation:

- Commitment at all levels of the organization, especially leaders
- Empowered employees
- Reward and recognition program
- Strategic planning aligned with quality goals

"An organization is only as strong as the weakest element."

Improvement and Quality Methods

Total Quality Management (TQM)

Key elements for TQM success:

- Ethics
- Integrity
- Trust
- Training
- Teamwork
- Leadership
- Recognition
- Communication

Benefits:

- Employee engagement and morale
- Savings in production costs
- Savings in product costs
- Reduction of cycle times
- Increase of customer satisfaction

Improvement and Quality Methods

Business Process Reengineering (BPR)

Also known as business process redesign or business transformation, it focus on recreating business process.

It is more concerned with a radical change across an entire organization instead of small and continuous quality increments.

- Planning: identify and communicate
- Design: have a team of experts and redesign
- Implementation: rigorous change management and testing procedure

"Reengineering Work: Don't Automate, Obliterate“
Michael Hammer

Improvement and Quality Methods

Rummler-Brache

Developed in the 80s by Geary Rummler and Alan Brache.

- Nine boxes Model: three levels of performance and three dimensions

	Design	Goals	Management
Performer	Tools and training needed to do the job and achieve goals	Individual performance metrics linked to process goals	Right people, training, feedback and rewards to achieve goals
Process	Process design to allow goals achievement	Manageable processes linked to business goals and the customer requirements	Infrastructure and process ownership for monitoring and improvement
Organization	Organization structure that allows goals achievement	Clear strategy and well deployed goals	Resources, planning and monitoring of performance evaluation of the integrated processes

Improvement and Quality Methods

Rummler-Brache

The 6 phases of Rummler-Brache approach:

- **Improvement Planning**: identify opportunities for change and draft the improvement plan
- **Definition**: define project scope, stablish goals and form teams with specific roles
- **Analysis and Design**: understand and analyze current situation ("IS" process) and design solutions ("SHOULD" process) to be implemented
- **Implementation**: implement redesigned process
- **Process Management**: monitor optimized process and take corrective action when necessary
- **Organization Management – "Organization as an Adaptive System":** integrate processes, having metrics at all levels connect to one another, with a control plan in place to ensure continued success.

Improvement and Quality Methods

Scrum

- Scrum is an Agile project management method with initial emphasis on software development, but more and more being used in different fields.
- Projects are broken down to fit timebox interactions called Sprints, normally between two and four weeks work by a small team of 10 or fewer members.
- Scrum relates to improvement initiatives as its concept provides recurrent results analysis in a short period of time allowing changes to meet customer needs.
- Used to create new technical products or integrate new developments on existing products within a short time frame.

Improvement and Quality Methods

Scrum

Three main phases:

- **Pregame**: data and business requirements analysis, involves translating business concepts into technical concepts.
- **Game**: development in sprints with a review and validation of the deliverables before moving on to the next sprint.
- **Postgame**: quality assurance, testing and change management procedures before final release.

Improvement and Quality Methods

The Customer Experience Management Method (CEM)

- Combines process improvement with customer relations management
- Outside-in approach focusing on what the customer wants or needs
- Based on data analysis collected through customer feedback
- Downside: for some departments it is hard to relate to customer satisfaction

Improvement and Quality Methods

JumpStart

- Fast-paced method
- Problem and solution identification in a single session
- Can be used within different improvement or quality tools / methods
- Not recommended for critical or high impact processes
- Focus on brainstorming root causes for the problem and possible solutions
- Quick solutions and incremental improvement
- Downside: sometimes solutions are trial and error / wait and see

When to Use Six Sigma

- **Unknown cause**: seek the root cause(s), prioritize and solve
- **Widespread problem**: scope definition and manageable projects
- **Complex problem**: narrow down variables and define approach
- **Costs tied to processes**: assumptions validation with small margin of error

Thank You!

Questions?