Total Quality Management-basics

Ing.J.Skorkovský,CSc.
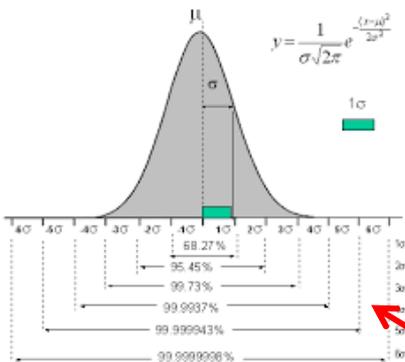
and various listed resources

Department of Corporate Economy

MASARYK UNIVERZISY Brno
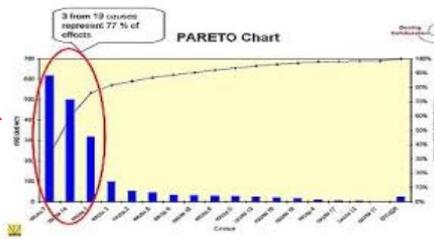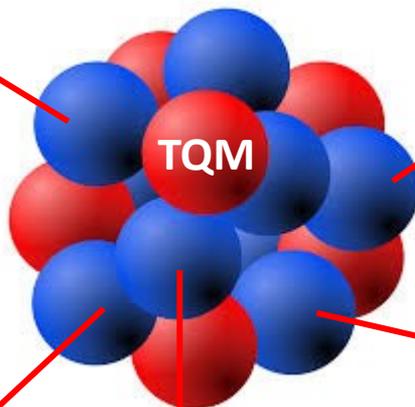
Czech Republic

Basic methods

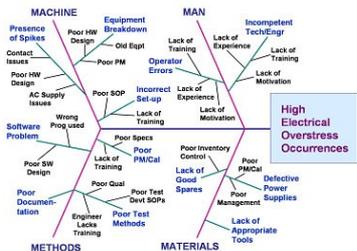$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

μ

σ

1σ

68.27 %
95.45%
99.73%
99.9937%
99.999943%
99.9999998%

Six sigma

ACT | PLAN | CHECK | DO

Inspiration of 6σ method

Define | Measure | Analyze | Improve | Control
D M A I C

One of the 6σ method

TQM

PARETO Chart

3 from 18 causes represent 77 % of effects

Pareto
(extra session)

Ishikawa FBD

MACHINE | MAN
Presence of Spikes | Equipment Breakdown | Poor HW Design | Old Eqpt | Lack of Training | Incompetent Tech/Engr | Lack of Experience
Contact Issues | Poor PM | Operator Errors | Lack of Training
Poor HW Design | Poor SOP | Incorrect Set-up | Lack of Experience | Lack of Motivation
AC Supply Issues | Wrong Prog used | Lack of Training | Lack of Motivation
Software Problem | Poor Specs | High Electrical Overstress Occurrences
Poor SW Design | Lack of PM/Cal | Poor Inventory Control
Poor Documen-tation | Poor Qual | Lack of Good Spares | Poor PM/Cal | Defective Power Supplies
Engineer Lacks Training | Poor Test Devt SOPs | Poor Management
Poor Test Methods | Lack of Appropriate Tools
METHODS | MATERIALS

(extra session)

6σ →

Kaizen

- Customer orientation
- Total Quality Control/Six Sigma
- Robotics
- Quality Circles
- Suggestion system
- Automation
- Discipline in the workplace
- Total Productive Maintenance (TPM)

- Kanban
- Quality Improvement
- Just –in-Time (JIT)
- Zero defects
- Small-group activities
- Cooperative labor-management relations
- Productivity improvement
- New-product development

Kanban & JIT
(extra session)

Dimensions of Quality

- **Performance -** How well a car handles, gas mileage and so on

- **Features -** Extra item added (stereo CD, GPS, tire checking,..)

- **Reliability -** It should operates without error (DPMO) within expected time frame (done by customer voice)

- **Conformance** - The degree to witch a product meets pre-established standards

- **Durability -** How long the product last(life span or see PLC see later in Boston show)

- **Serviceability -** The ease of getting repairs, the sped of repairs

- **Esthetics -** How a product looks, feels, sounds ,smells or tastes

- **Safety -** Assurance that customer will not suffer injury or harm from the product (automobiles, brakes, accelerators strings,…)

DPMO=Defect per million opportunities

Flow times – lead times (some used units)-

- **Flow Time (FT) is know as a Cycle Time (CT)**

- **Lead Time =LT** (length of the process) – time only, supposed to be constant used for planning
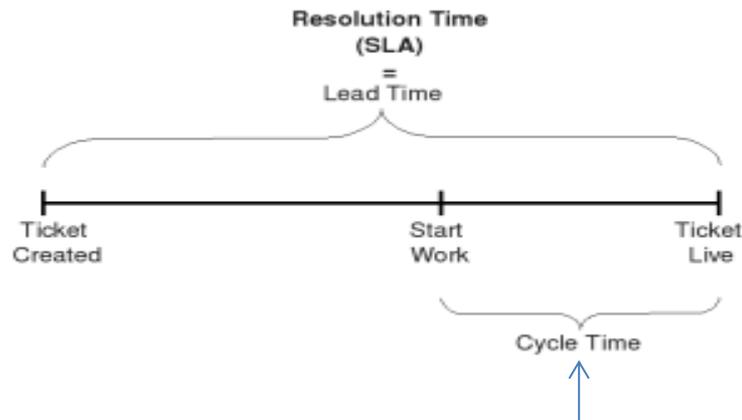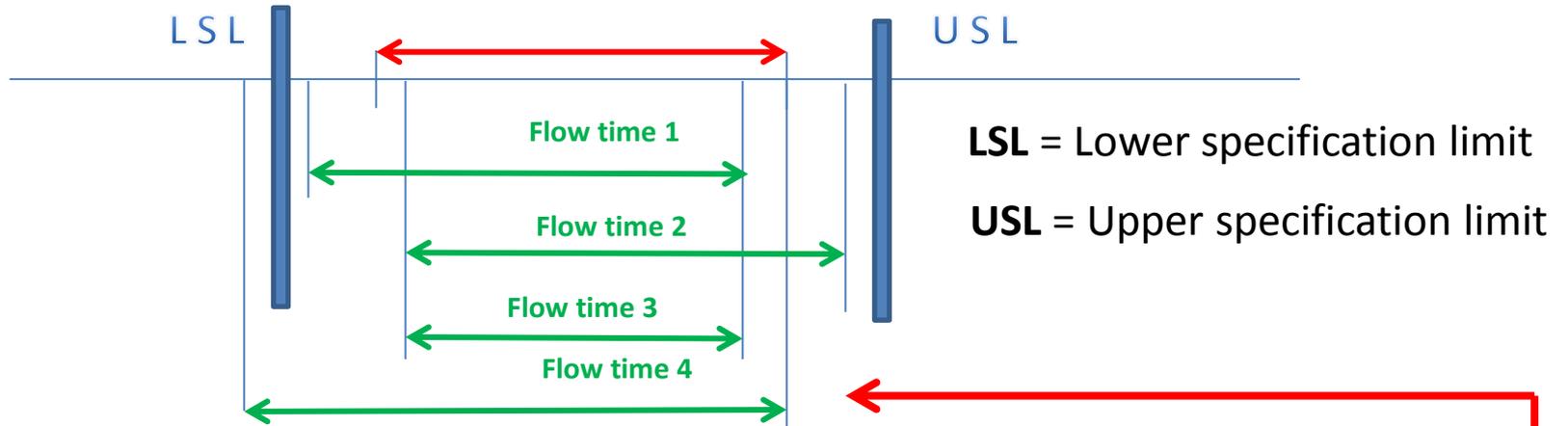

Aaverage time from release of the job of the beginning of the routing
until it reaches an inventory point at the end of the routing
or time that part spends as a WIP.

Six sigma

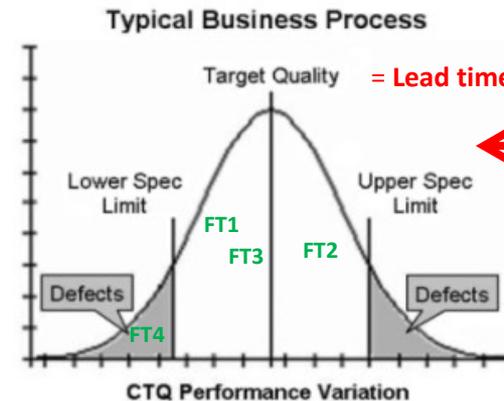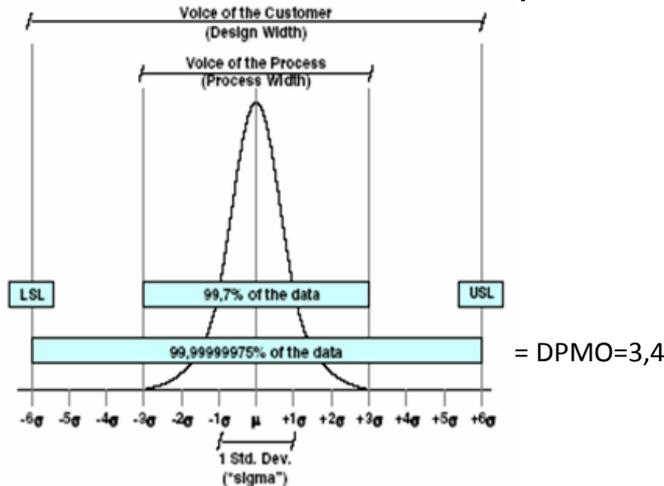**Lead time** (expected=voice of customer) = Target Quality (expected value)
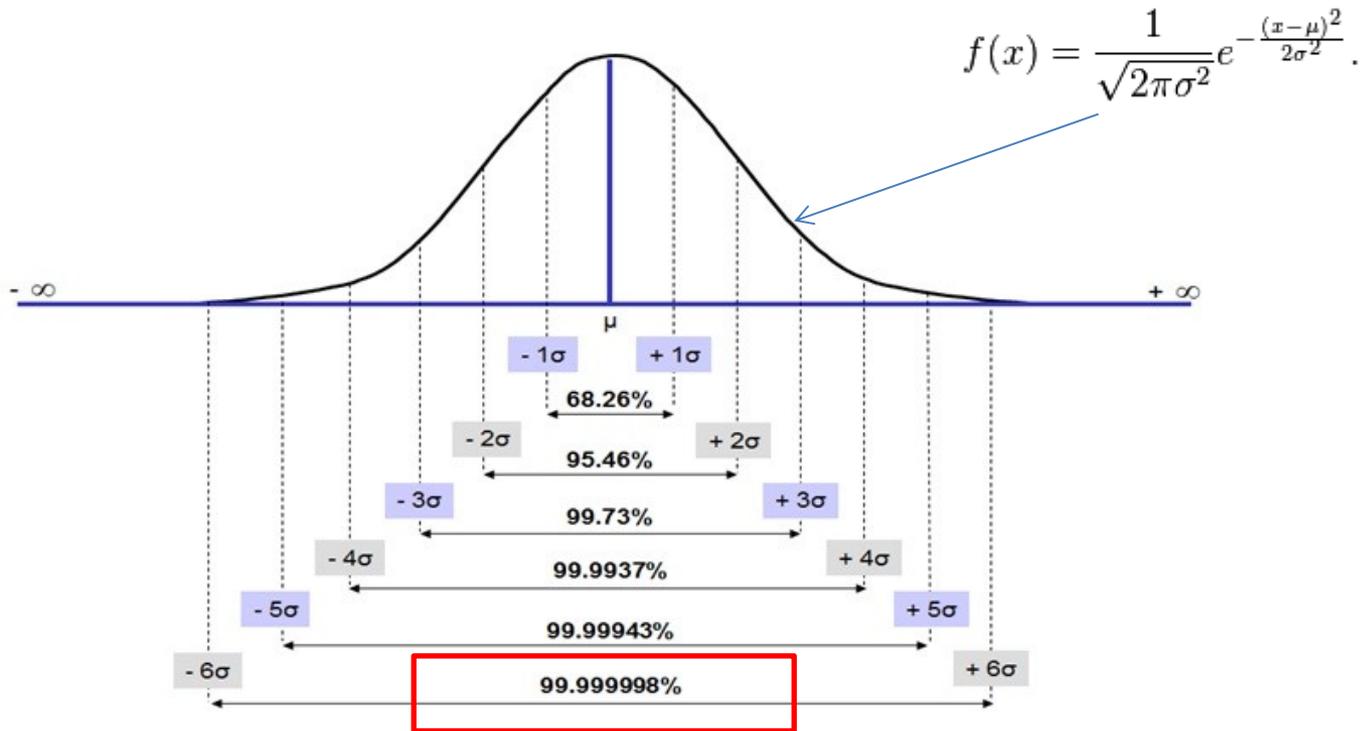
production or replenishment constant

L S L   U S L

Flow time 1

LSL = Lower specification limit

Flow time 2

USL = Upper specification limit

Flow time 3

Flow time 4

The lenght of **flow time** represents a variability (voice of process)

Voice of the Customer
(Design Width)

Voice of the Process
(Process Width)

Typical Business Process

Target Quality   **= Lead time**

LSL   99,7% of the data   USL

Lower Spec
Limit

Upper Spec
Limit

FT1

= DPMO=3,4

FT3   FT2

99,99999975% of the data

Defects

Defects

FT4

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

CTQ Performance Variation

1 Std. Dev.
("sigma")

DPMO=Defect per million opportunities, **CTQ**=Critical to Quality

Six sigma

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}.$$

- ∞   + ∞

μ

| - 1σ | + 1σ |

68.26%

| - 2σ | + 2σ |

95.46%

| - 3σ | + 3σ |

99.73%

| - 4σ | + 4σ |

99.9937%

| - 5σ | + 5σ |

99.99943%

| - 6σ | + 6σ |

99.999998%

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad \sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2 \qquad \sigma = \sqrt{\sigma^2}$$

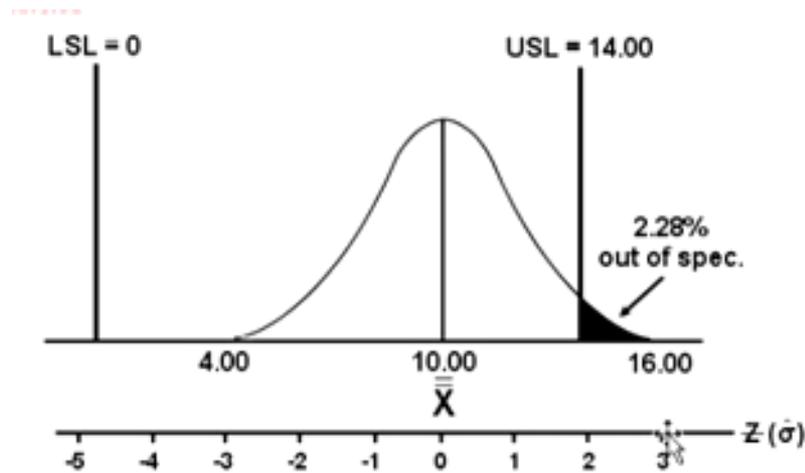Mean of the xi ->(1,3,8,6,2)->20/5=4

Process Capabilty Ratio (Cp)

- **Process Capability Ratio** is a statistical measure of **process capability**: the ability of a process to produce output within specification limits.

- The concept of process capability only holds meaning for processes that are in a state of **statistical control**.

- **Process capability** indices measure how much "natural variation" a process experiences relative to its specification limits and allows different processes to be compared with respect to how well an organization controls them.

Process Capability ratio =Cp

- Cp>=1
- Six sigma requires Cp=2
- It is no focus on whether process is centred in the specific range
- Upper Specification Limit = USL
- Lower Specification Limit = LSL
- Cp= (USL – LSL)/   **6σ**

Cp calculation

Typical Business Process

Target Quality

Lower Spec Limit

Upper Spec Limit

Defects

Defects

FT4

CTQ Performance Variation
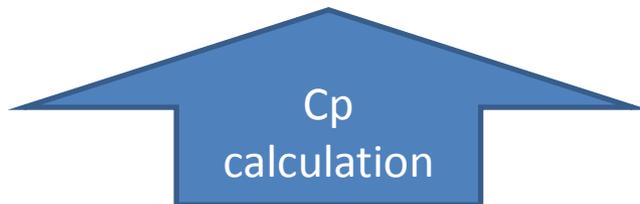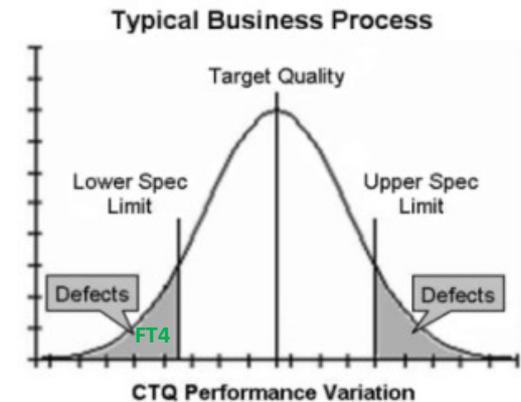
Process capability ratio - (example for home study)

# Cpk=Process Capability Index

- It is a standard index to state capability of one process
- The higher value of Cpk a better process
- Formula
- Cpk=Zmin/3 where Zmin is smallest of these values:
  - (USL-Mean)/σ and (Mean-LSL)/σ
  - Mean is an average of the part
  - Sigma represents process variation
  - Cpk = 1,0 is equivalent to yield 99,73%
  - Cpk = 1,2 is equivalent to yield 99,97%

Cpk=Process Capability Index

USL = 14
LSL = 0
$\bar{X} = 10$
$\dot{\sigma} = 2$
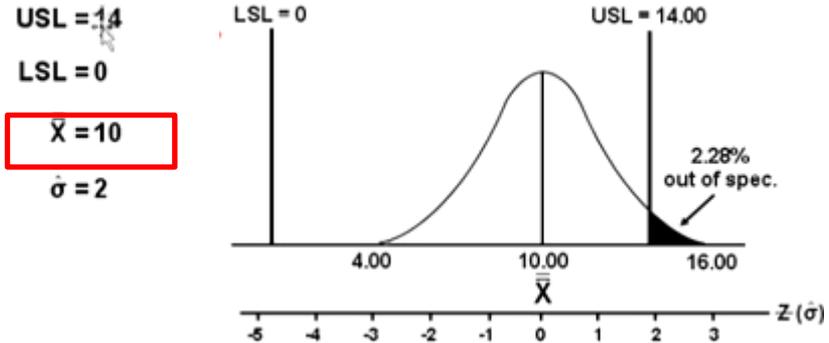
Zusl =(USL-Mean)/ σ = (14-10)/2=2 and Zlsl=(Mean-LSL)=(10-0)/2=5
so Cpk=2/3=**0,67**. Mind you, that Mean = X is our example !!!

USL = 16
LSL = 4
$\bar{X} = 10$
$\dot{\sigma} = 2$

This process is better
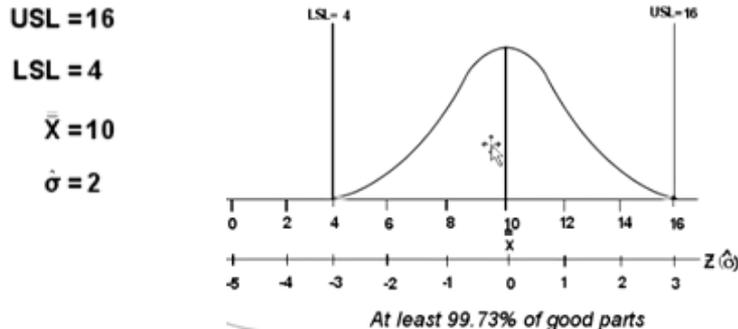
Zusl =(USL-Mean)/ σ = (16-10)/2=3 and Zlsl=(Mean-LSL)=(10-4)/2=3
so Cpk=3/3=**1,0**. Mind you, that Mean = X is our example !!!

Six sigma

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV

- **DMAIC** is used for projects aimed at improving an existing business process
- DMADV is used for projects aimed at creating new product or process designs

Six sigma

- **Define** the system, the voice of the customer and their requirements, and the project goals, specifically.

- **Measure** key aspects of the current process and collect relevant data; calculate the 'as-is' Process Capability.

- **Analyze** the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.

- **Improve** or optimize the current process based upon data analysis using techniques such as poka yoke (see next slide) .

- **Control** the future state process to ensure that any deviations from the target are corrected **before** they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process.

Six Sigma basics
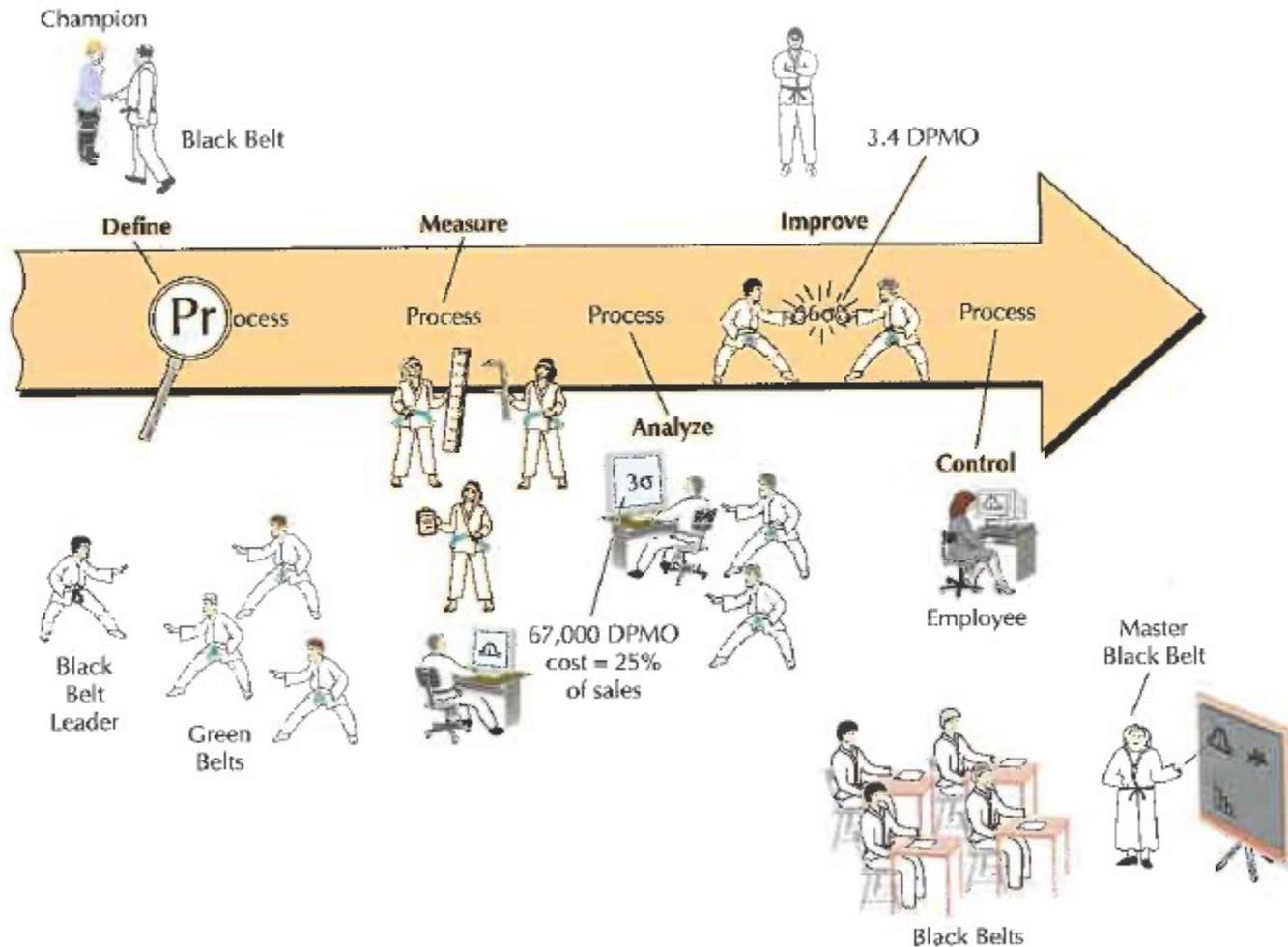
Poka yoke

- **Poka yoke** is a Japanese term that means "mistake-proofing„ that helps an equipment operator avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to [human errors](#) as they occur

Poka-yoke example: Ethernet cable plug is designed to be plugged in only one orientation.

Kaizen

• **Kaizen** (Continuous Improvement) is a strategy where employees at all levels of a company work together proactively to achieve regular, incremental improvements to the manufacturing process. In a sense, it combines the collective talents within a company to create a powerful engine for improvement.
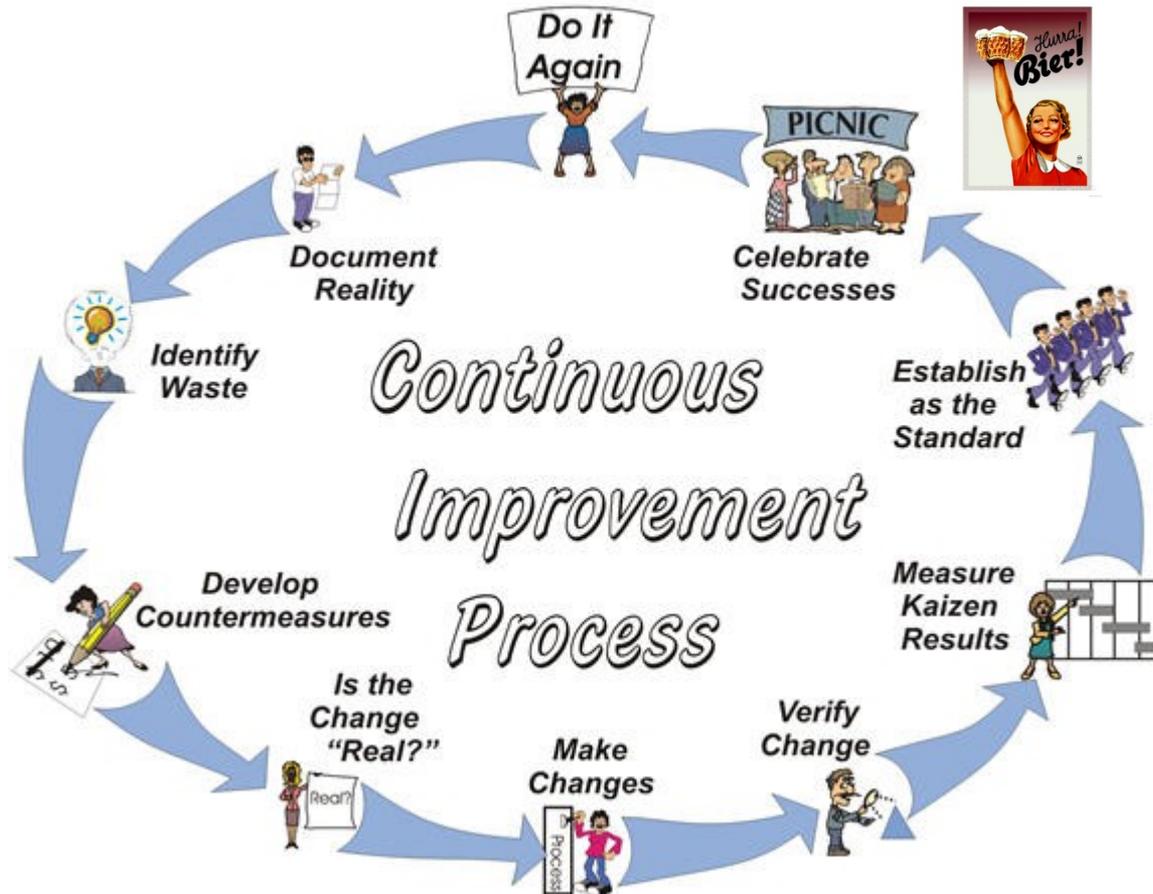

Kaizen Event Process

1. Orientation
2. Understand Current Situation
3. Develop Future State Design
4. Make the Improvements
5. Report & Celebrate

Kaizen events (P-D-C-A)

- Set goals and provide any necessary background.

- Review the current state and develop a plan for improvements.

- Implement improvements.

- Review and fix what doesn't work.

- Report results and determine any follow-up items.

Kaizen – improvement steps

End of section