# Total Quality Management

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and various listed resources

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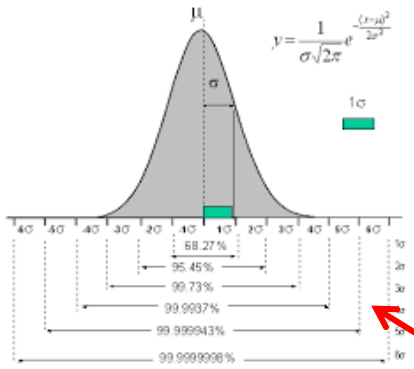
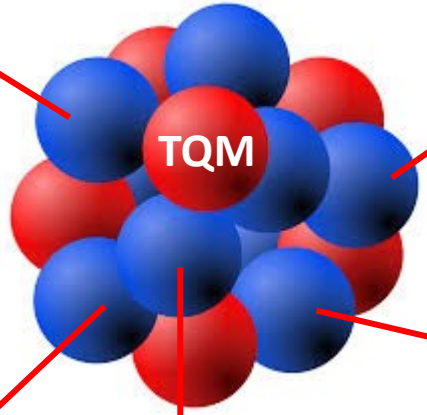
# Basic methods

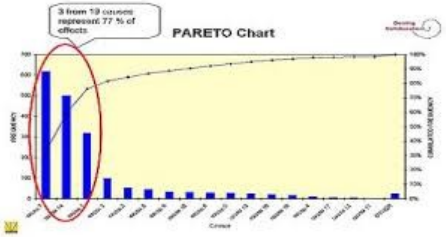



Six sigma

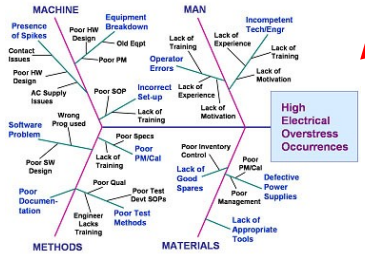

One of the 6σ method


Inspiration of 6σ method



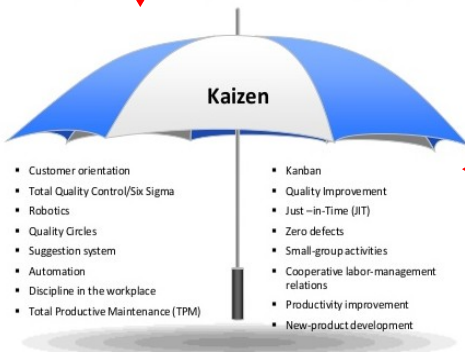




Pareto
(extra session)




Ishikawa FBD
(extra session)

6σ




**Kanban & JIT**
(extra session)

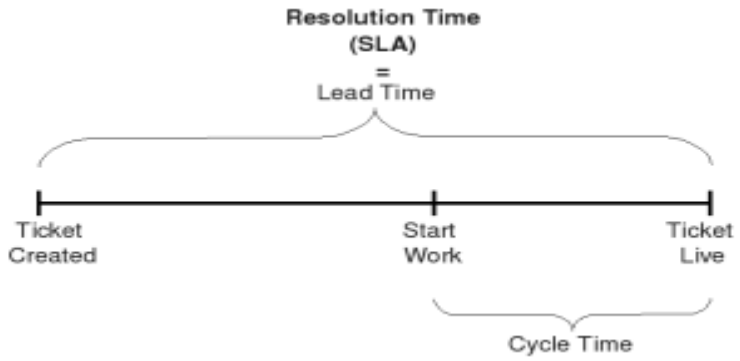
# Dimensions of Quality

- **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 units)

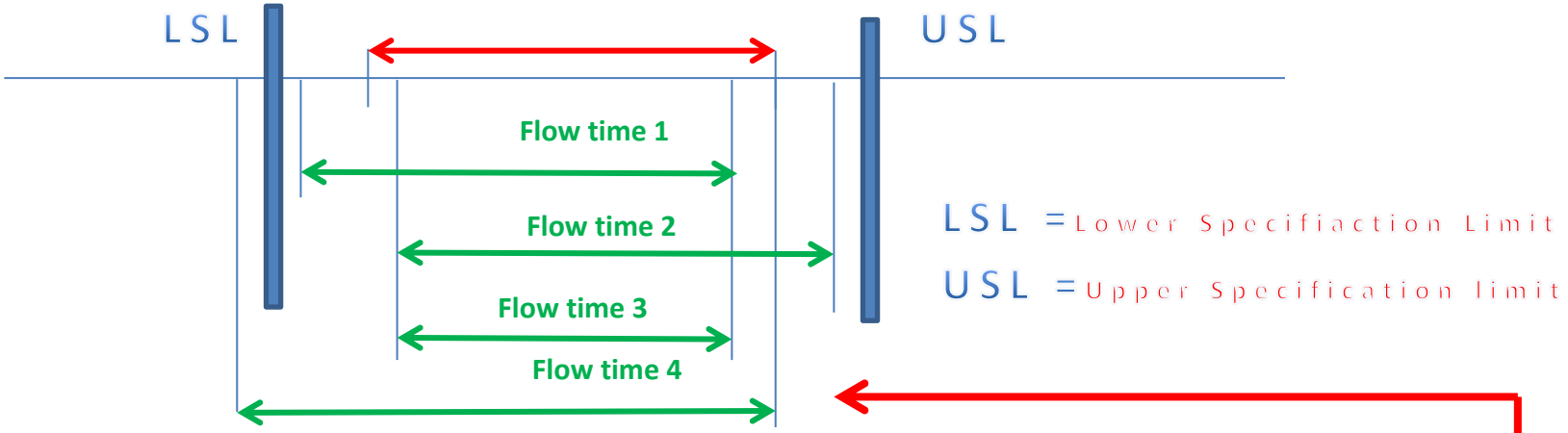
- **Flow Time (FT) is know as a Cycle Time (CT)**
- **Lead Time =LT** (length of the process) – time only, supposed to be constant  used for planning



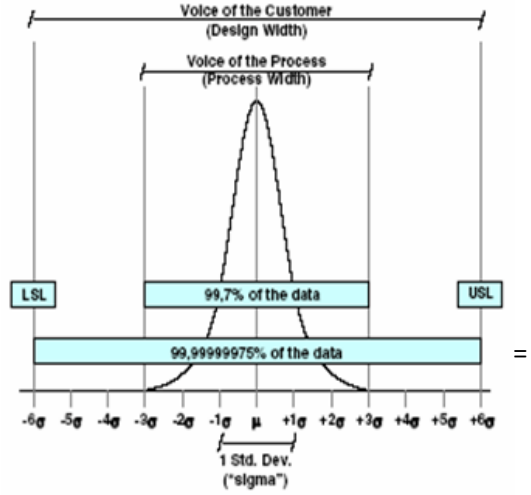
# Six sigma

**Lead time** (expected=voice of customer) = Target quality (expected value)

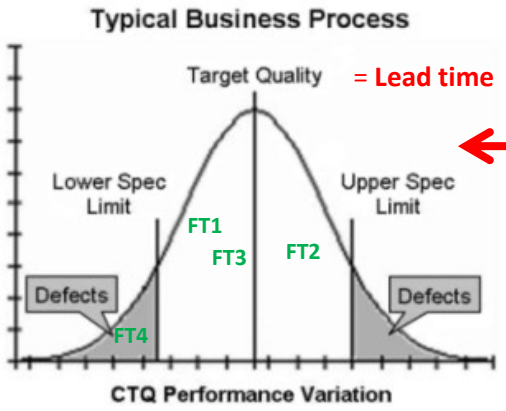
production or replenishment constant




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



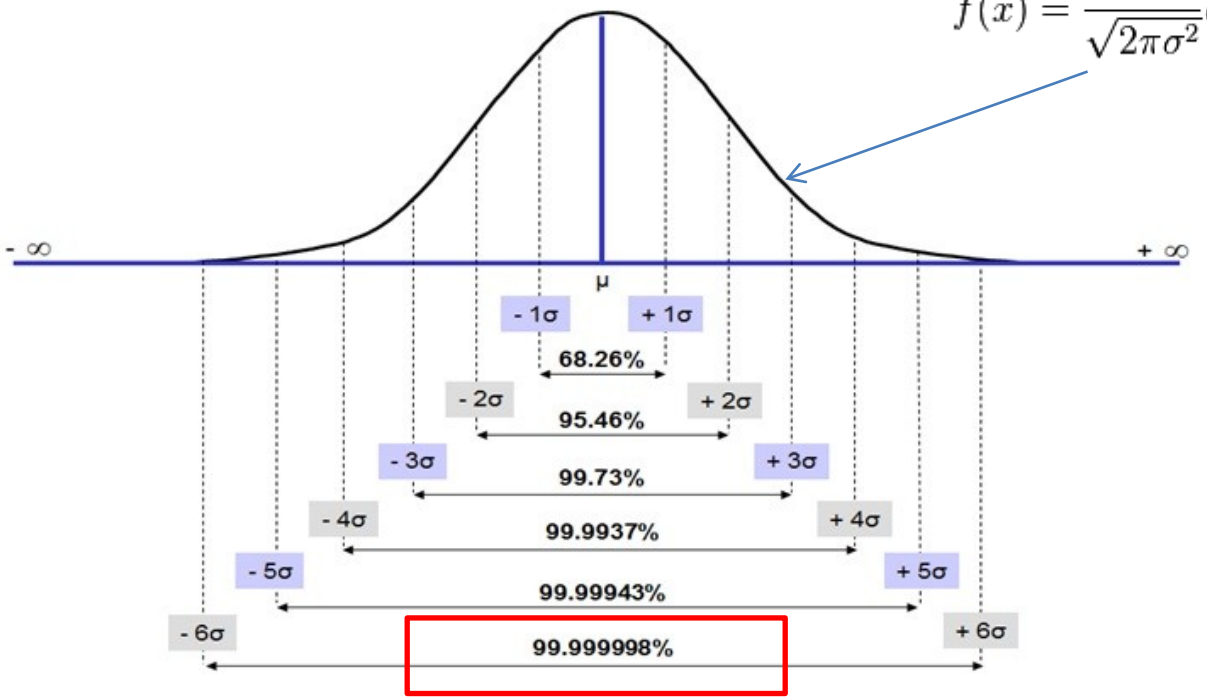

= DPMO=3,4




DPMO=Defect per million opportunities

# Six sigma

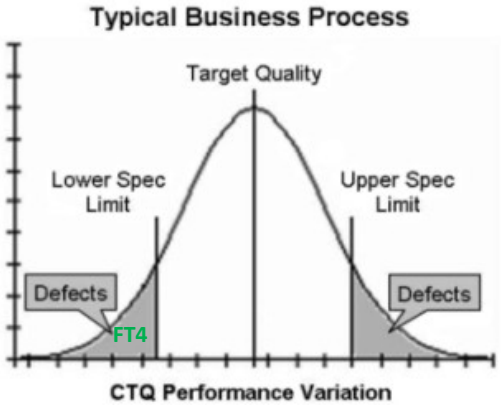
$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}.$$




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

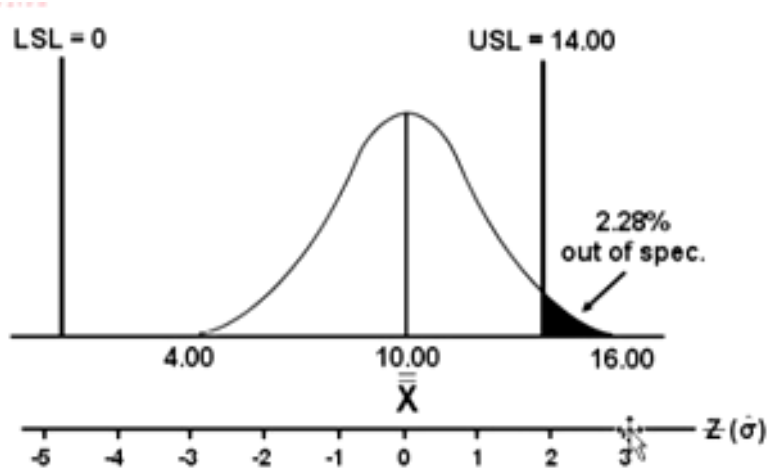
# Process capability ratio

- 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

# Process capability ratio - (example for home study)




$USL = 14$

$LSL = 0$

$\bar{\bar{X}} = 10$

$\hat{\sigma} = 2$

$$C_p = \frac{USL - LSL}{6\hat{\sigma}}$$

$$C_p = \frac{14.00 - 0.00}{6 \times 2.00}$$

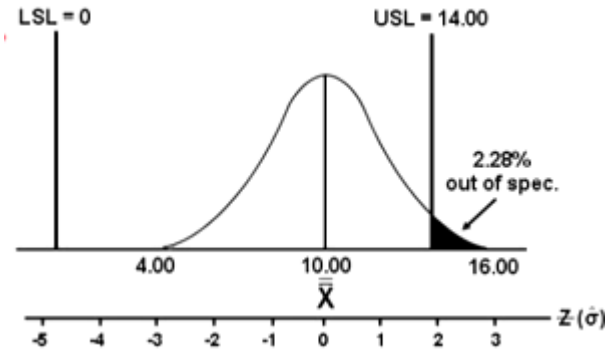
$$C_p = 1.17$$

# 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)/$\sigma$ and  (Mean-LSL)/$\sigma$
  - 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%

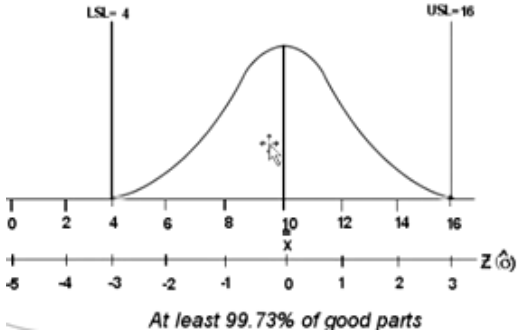
# Cpk=Process Capability Index

USL = 14
LSL = 0
$\bar{\bar{X}}$ = 10
$\hat{\sigma}$ = 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
$\bar{\bar{X}}$ = 10
$\hat{\sigma}$ = 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

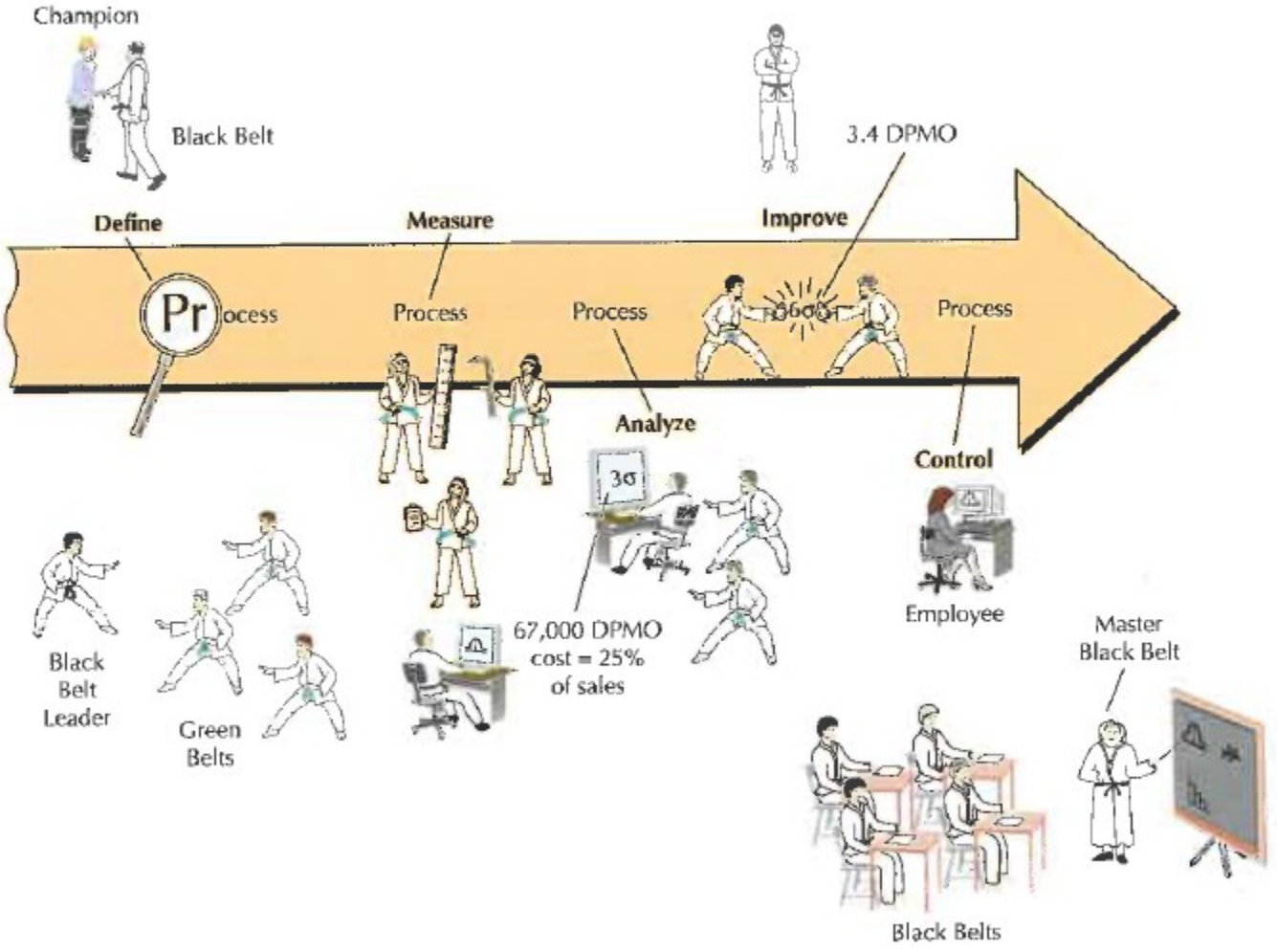

- **DMAIC** is used for projects aimed at improving an existing business process
- DMADV is used for projects aimed at creating new product or process designs

# 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 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