Ieder proces kent niet wenselijke variatie,

kan ik er iets aan doen ?

Introduction

Melotte BV

1994 – 2001
Department Head

Electrical cabinets

2001 - 2006
Quality + BB
Mfg & Dev
Six Sigma (DMAIC)

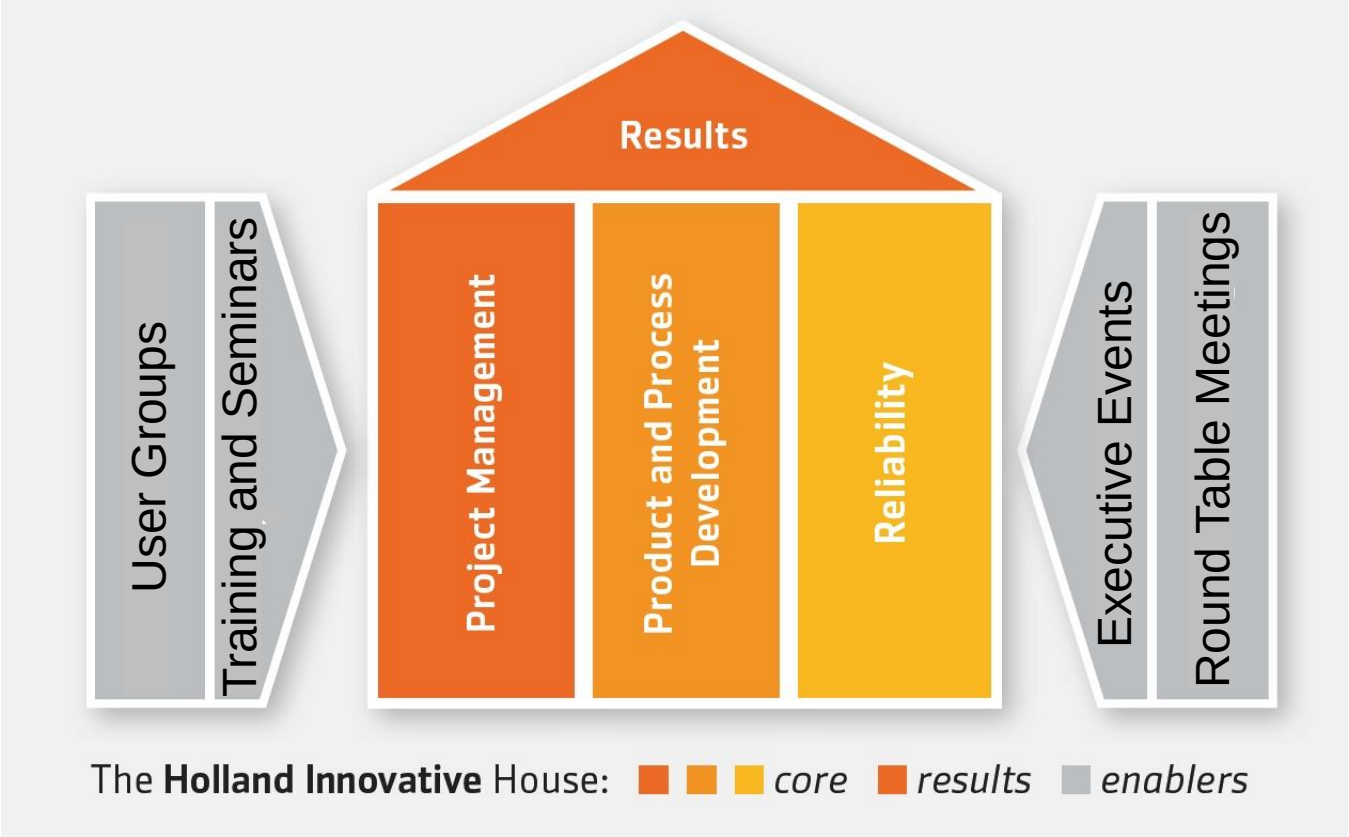
2006 - 2011
MBB; Program Mgr; DfX
Mfg & Dev
Six Sigma (DMAIC & DIDOV)

2011 - 2016
MBB
Log & Business
Lean Six Sigma (DMAIC & DIDOV)

Marcel Logger

www.Holland-innovative.nl

Holland Innovative



ipma-nl platform projectmanagement

IBIS UvA
Instituut voor Bedrijfs- en Industriële Statistiek

Universität Stuttgart

AIAG
The Catalyst for Peak Performance™

holland innovative

Why improve processes?

Typical issues - Cost

(Netherlands: total medical costs are 14% of GNP)

- Examples:
  - Low utilization of high CAPEX resources (MRI, CAT scanners)
  - Inefficient deployment of staff.
  - Long length-of-stay of patients.
  - Waste of food, linen, pharmaceuticals
    → Inefficient inventory management policies (“Just buy a lot …”)
    → Poor process control (<43% of food is actually consumed by patients …)
  - Naïve purchasing policies.
    → Purchase price vs. Total Cost of Ownership

Typical issues- speed

- Examples:
  - Long admission times. Should be < 1 month for a specialist, but is often > 4 months.
  - Long waiting times before a consult.

- Perception:
  - Long waiting and admission times due to insufficient capacity (“We need more doctors and staff”)
  - But … waiting lists and queues are stable (do not grow) ⇒ demand and capacity are balanced.

Typical issues: Safety (& reliability)

- Examples:
  - Netherlands: 8 deaths / day due to medical errors (Compare: 2 deaths / day due to traffic accidents).
  - Besides safety hazards: excessive occurrence of small errors resulting in poor service and waste of time and resources.

Overview quality costs

Internal failure:

- (Yield) losses
- Rework
- Losses due to poor supplies
- Unplanned stops
- Resolving cause of stops
- Retesting

External failure:

- Customer treatment
- Rejects from market
- Keeping a customer service
- Loss of goodwill
- Fines

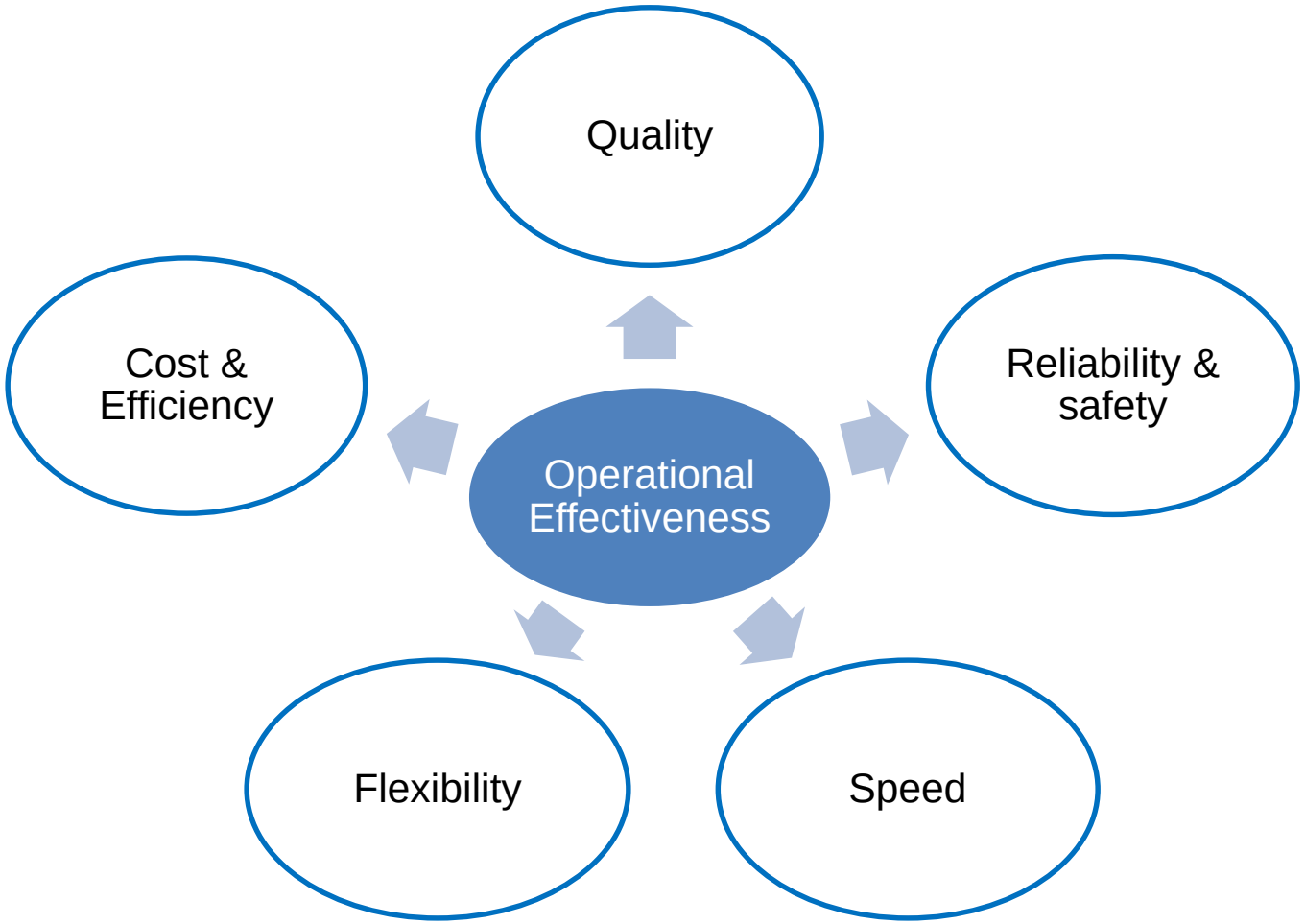
Prevention costs:

- Training and education
- Planning of quality
- Process control
- Pilot series production
- Qualifying supplies
- Customer service

Testing & Examination:

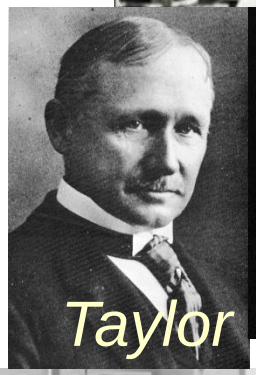
- Inspection of supplies
- Maintenance of equipment
- Calibration
- Quality department
- Testing
- Quality audits

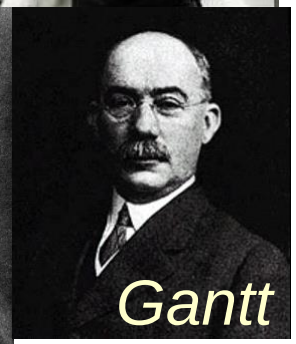
The answer: Operational Effectiveness

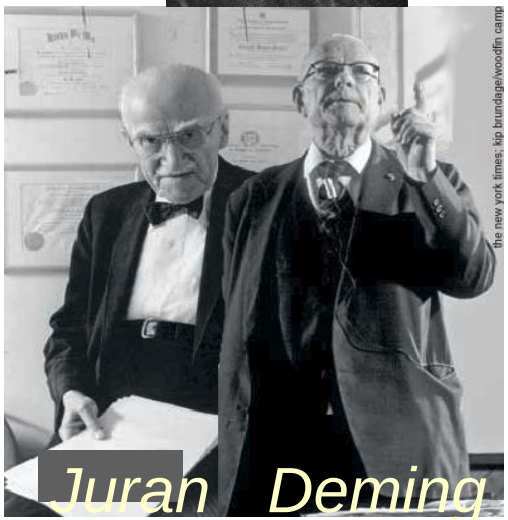


Operational Effectiveness

- **Lean Six Sigma**
- **1990s:**
  - Six Sigma
  - Lean Thinking & Just-In-Time
  - Theory of Constraints (TOC)
  - Business Process Management (BPM)
- **1980s:**
  - Total Quality Management (TQM)
  - Business Process Reengineering (BPR)
- **1920–1950s:**
  - Quality Control
- **1880–1920s:**
  - Scientific management







Operational Effectiveness

Industry

≠

Health Care

- **A lot of variation (‘one-of-a-kind’ jobs) vs less variation (standard jobs)**
- **High vs Low involvement of customer**
- **High vs Low predictable demand**

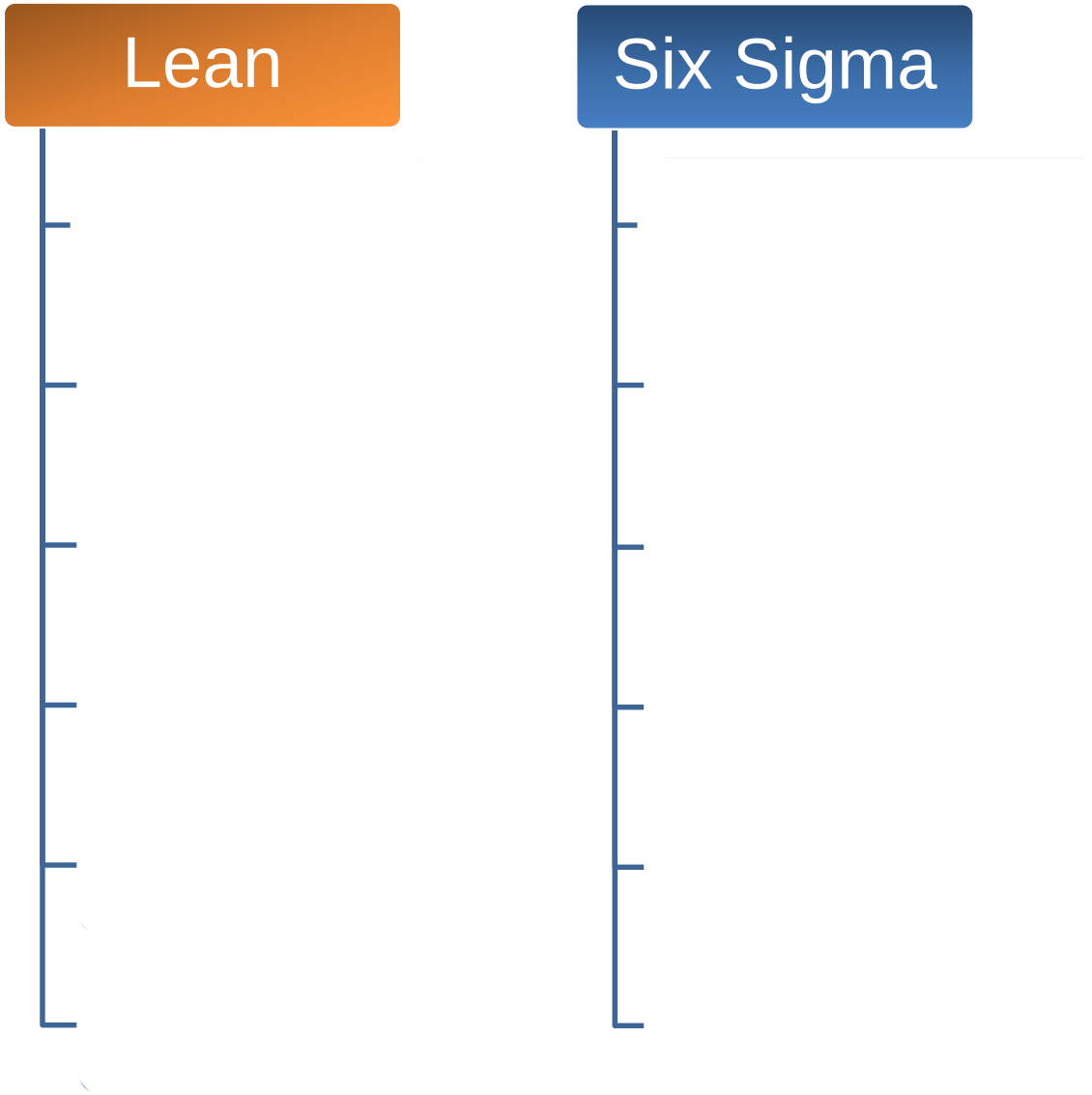
But hospitals are within the normal spectrum of process varieties seen in operations management

Lean Six Sigma

Lean Six Sigma

- Lean Six Sigma is a combination of two powerful methodologies: **Lean and Six Sigma**
- The Lean toolkit provides ways to **streamline** processes by **reducing Waste**.
- The Six Sigma toolkit provides tools to **reduce defects** by conducting root cause analysis.
- Together, they provide the **fastest**, **most effective** way to improve processes.

Lean Six Sigma



Benefits

Reductions in:
Defects
Quality issues
Variation
Lead time
Inventory
Waste

Employee Engagement
Quality improvement
Customer satisfaction
Bottom line savings
Customer focused
Data based decisions
Profit
Safety
Responsiveness
Productivity

Lean Six Sigma

Working smarter instead of working harder

Eliminate non-value add activities for the customer

Simple solutions invented by local team

Creating process flow and variation reduction

Realize culture of continuous improvement

Together with the people on the floor

An approach, a philosophy

- An **Attitude**, a structured way to execute activities (a philosophy) to be engraved in your DNA.
- A **Method**, to achieve the first time right development and sustainable improvement.
- A **Metric**, related to variation related to a specification.

Sigma - a Metric

Sigma:

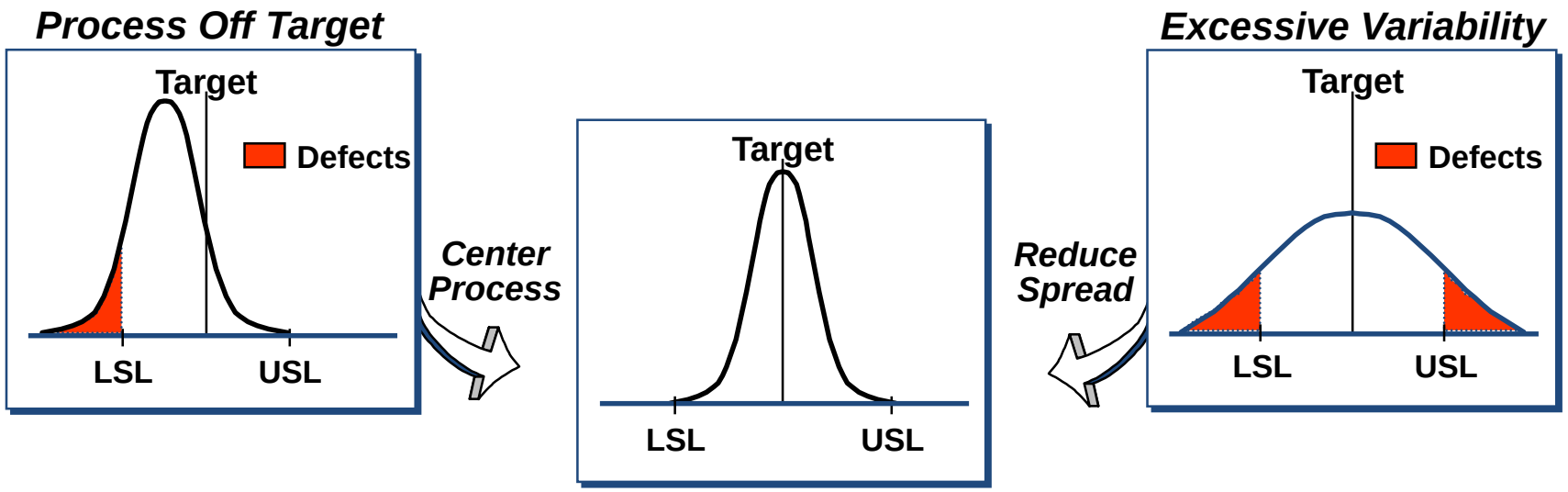
- Greek character “**σ**”
- **Measure** for spread or variation from an mean value

In *statistics*:

- Standard Deviation of a *population*

Six Sigma - a Metric

Understanding variation in relation to functional and design specifications is the essence of Six Sigma



High defects and variability: expensive

Based on…..

- Understanding **customers needs**,
- Understanding **Performance Specifications** at all levels.
- Meeting these needs **every time**, over a specified **lifetime**, under all use **conditions.**

Exercise

- **Purpose: Demonstrates Variation**

- **Instructions:**
  - Read the next page carefully.
  - How many times does the 6th letter of the Alphabet appear in the text?
  - You will have 2 minutes.

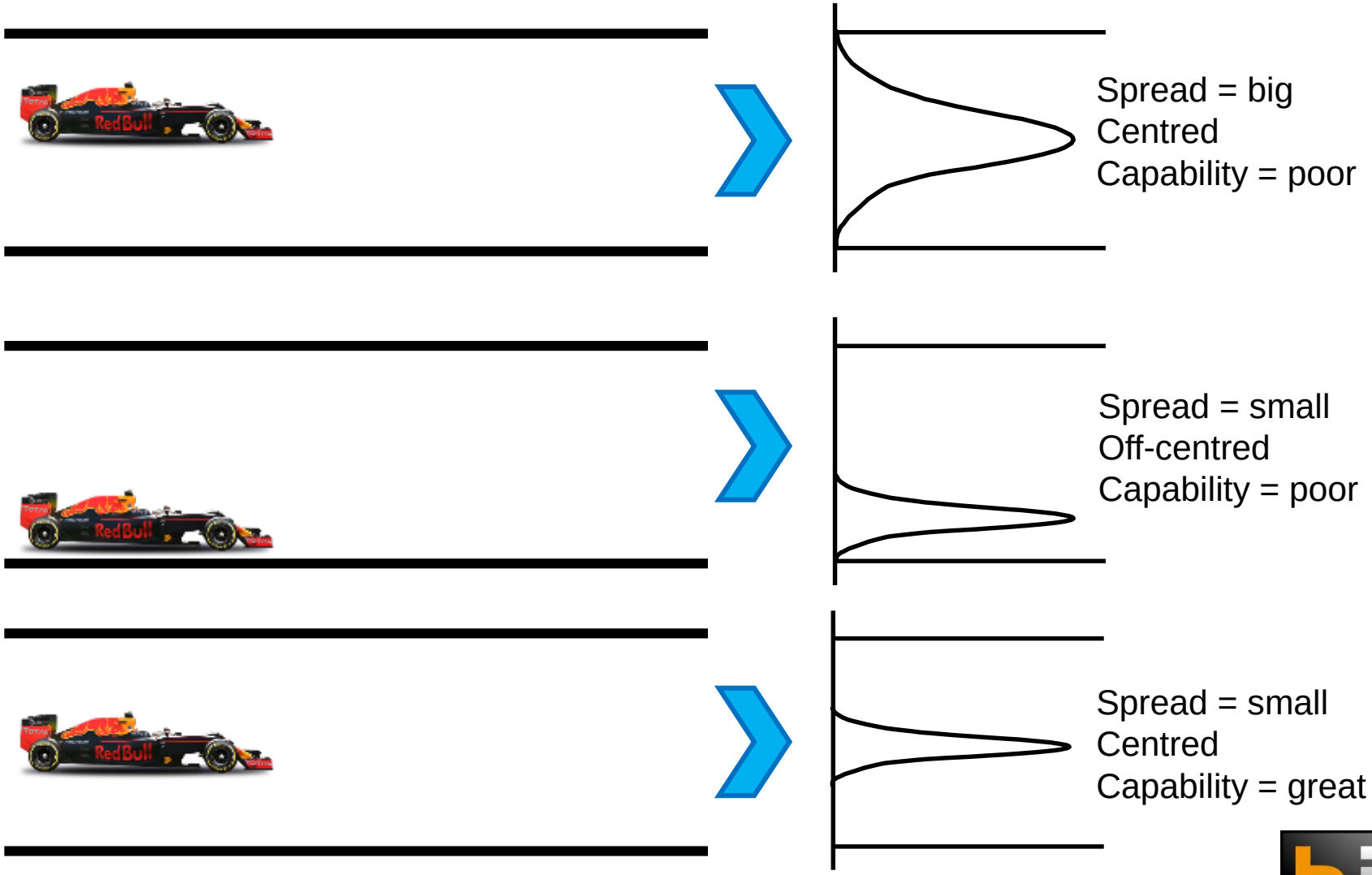
Exercise

The necessity of training farm hands for first class farms in the fatherly handling of farm livestock is foremost in the eyes of farm owners. Since the forefathers of the farm owners trained the farm hands for first class farms in the fatherly handling of farm livestock, the farm owners feel they should carry on with the family tradition of training farm hands of first class farmers in the fatherly handling of farm livestock because they believe it is the basis of good fundamental farm management.

What is variation?

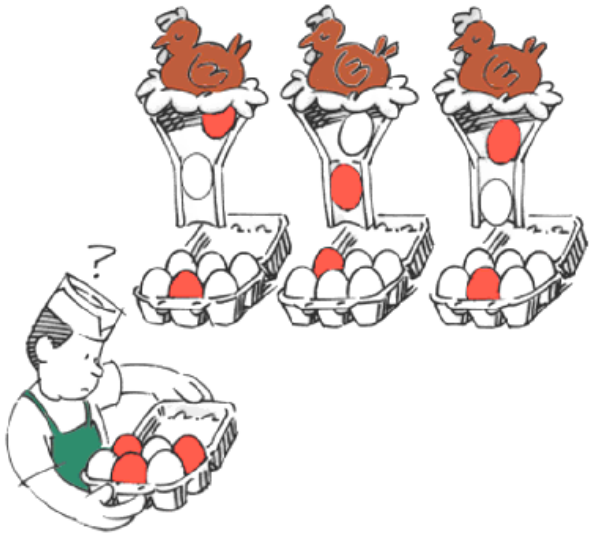
- Variation is **deviation** from expectation.
- It's part of **everydays life** and part of **every organisation**.
- **Inevitable change** in the output or result of a process.
- **All processes** vary over time.
- The goal is to **understand** variation, **control** it, and **minimize** its impact.

Interest in variation



Variation

Common cause variation



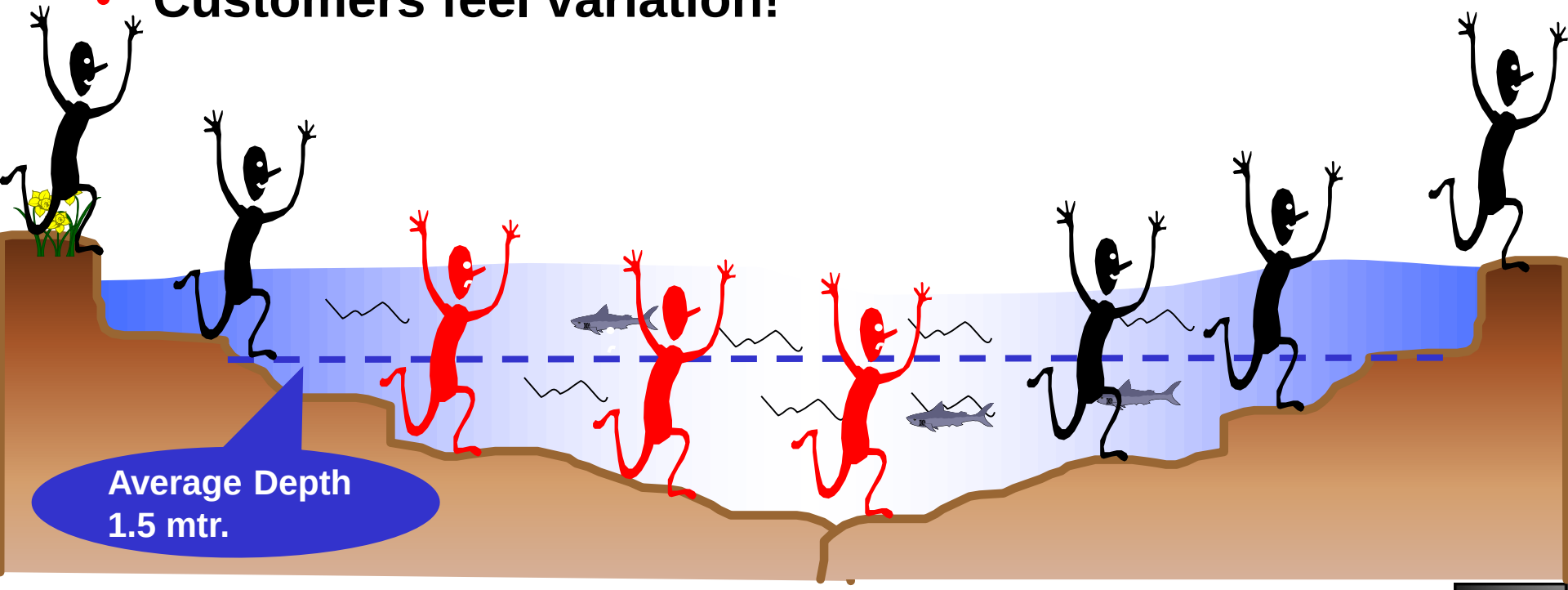
- **Always present** in a process
- Stable and predictable

Special cause variation

- **Different from normal**
- Unstable and unpredictable

Why is it important?

- To see how the process is behaving compared to customers Critical To Quality parameters.
- **Customers feel variation!**



Who is your customer?

What are your customers' requirements?

VOC -> CTQ

Critical to Quality (CTQ) Definition

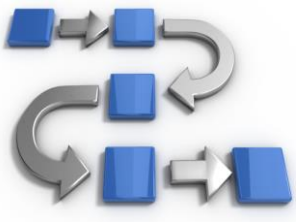
- A CTQ is important for the Customer, in other words it is **a characteristic** that determines whether the overall process or product performance is perceived to meet the Customers Expectation

VOC -> CTQ

Voice of customer

People
Equipment
Methods
Material
Environment
Knowledge

The Process



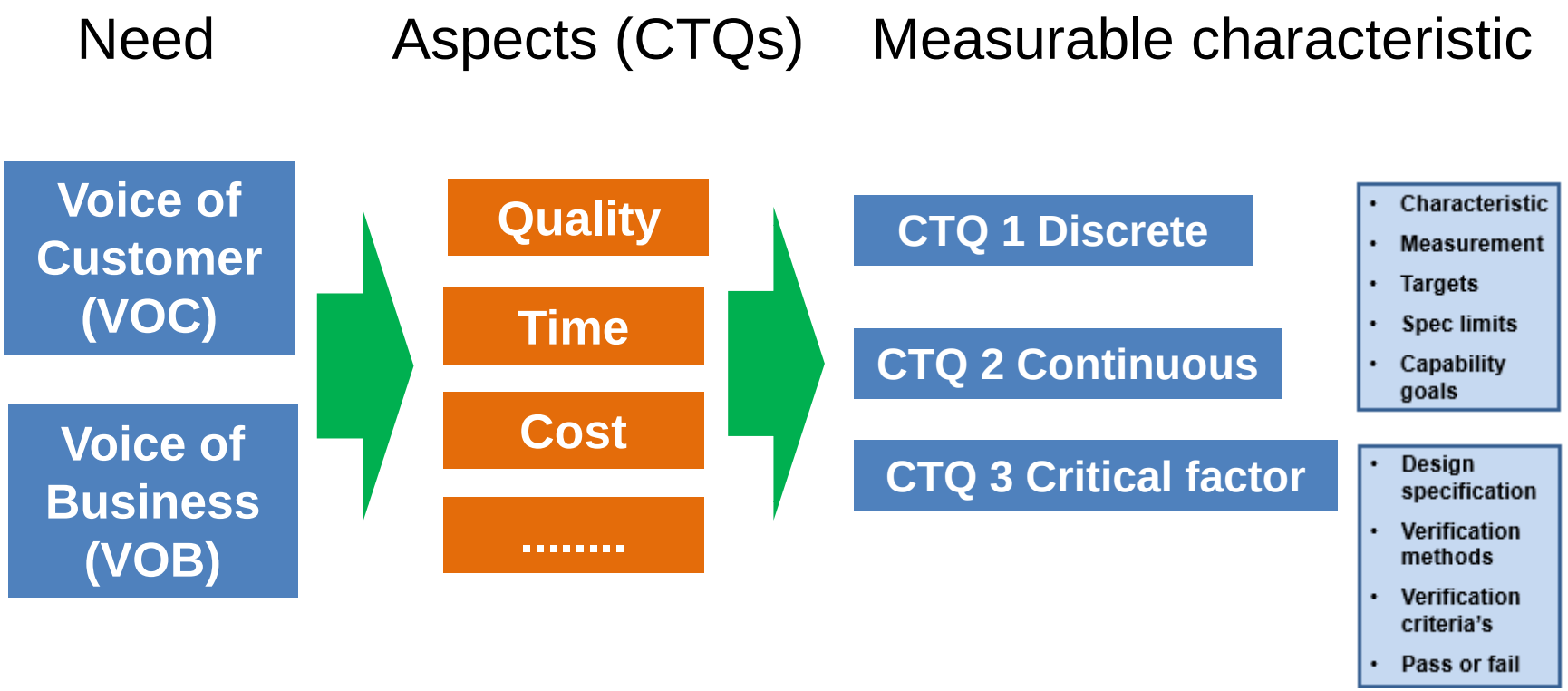
Product or service

The customer

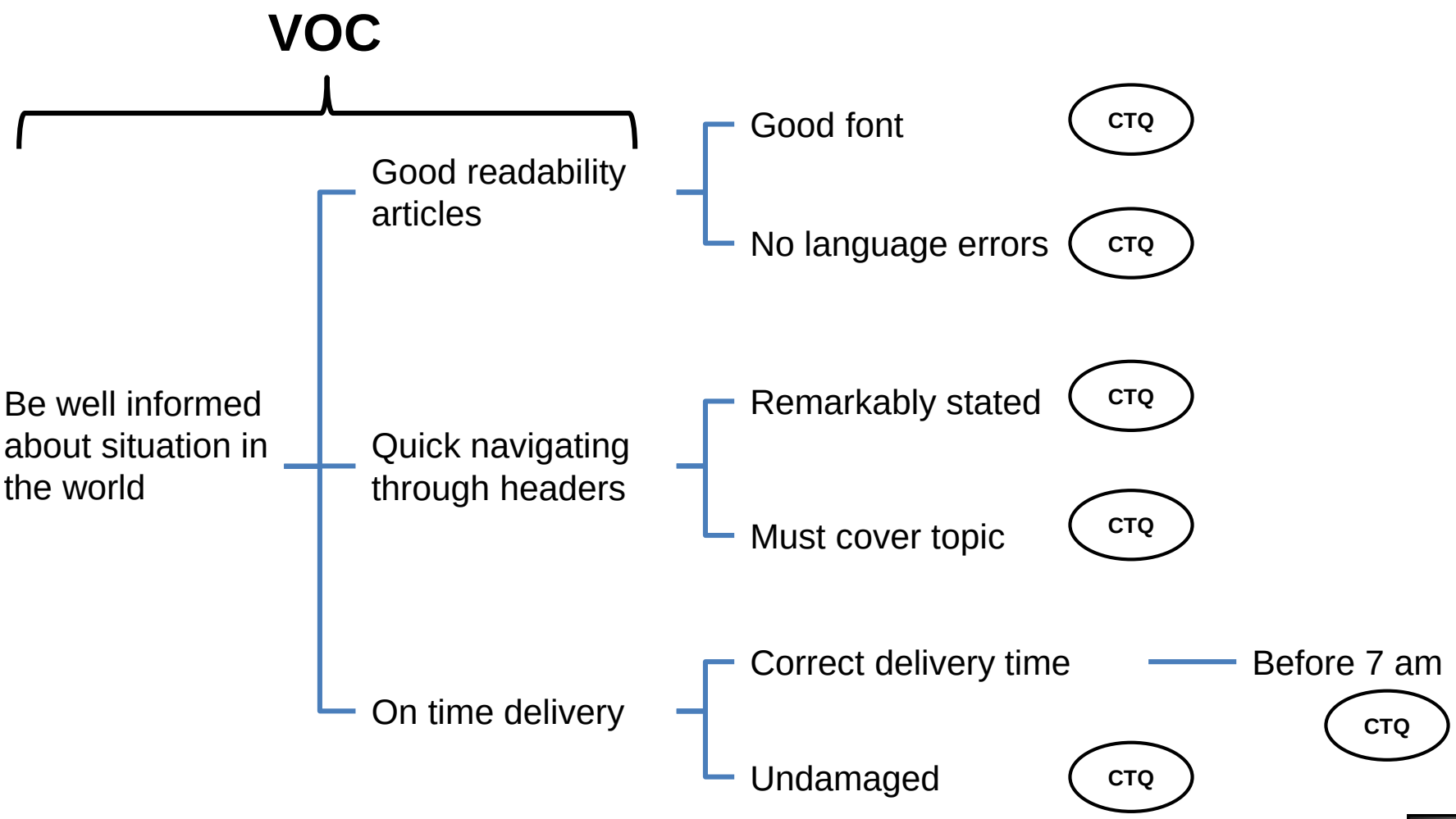
Voice of Process

CTQ Flow Down (1/2)

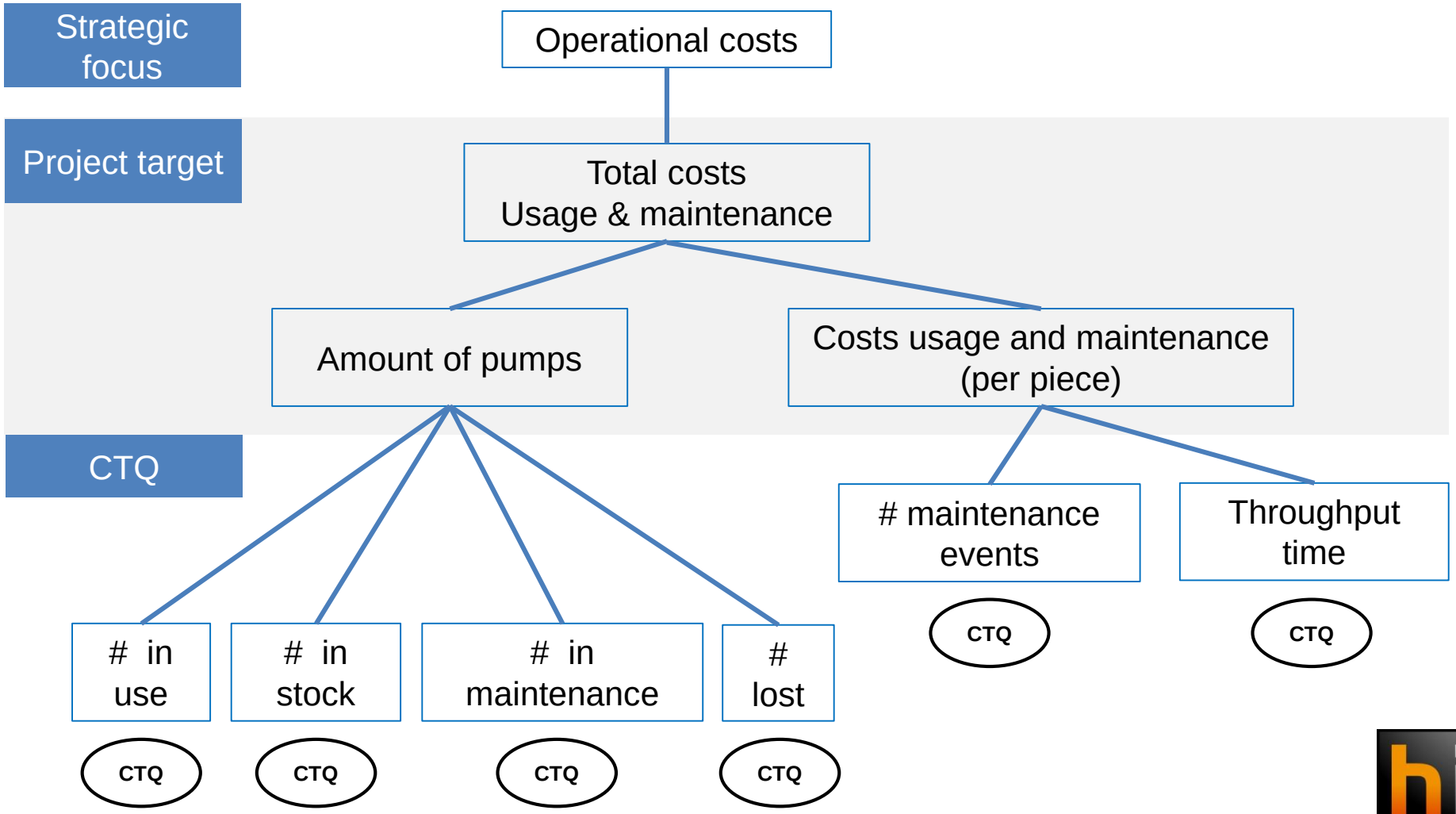
- CTQ flow down is a **method of converting** the Voice of the Customer into specific features for a service or product which have a significant impact on the Customer Experience



CTQ example – newspaper subscriber



CTQ example – infusion pumps



Measurement System Analysis

If you cannot measure, you cannot improve!

“Taguchi”

Where is Data coming from?

OR

Validity of Measurement System

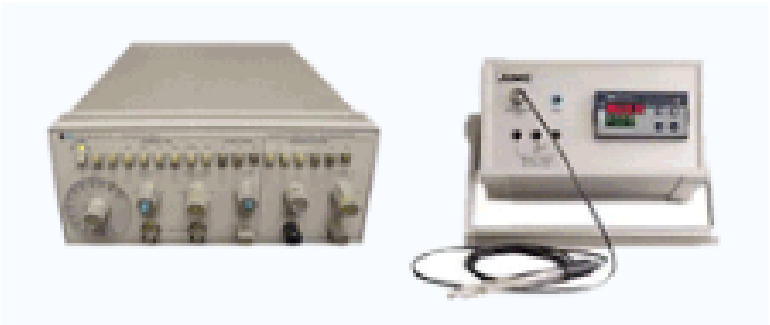
- Do the measurements reflect the property that we think to measure?

- Do disturbing factors make the measurement results invalid?

Measurement Devices

Terminology - Gage

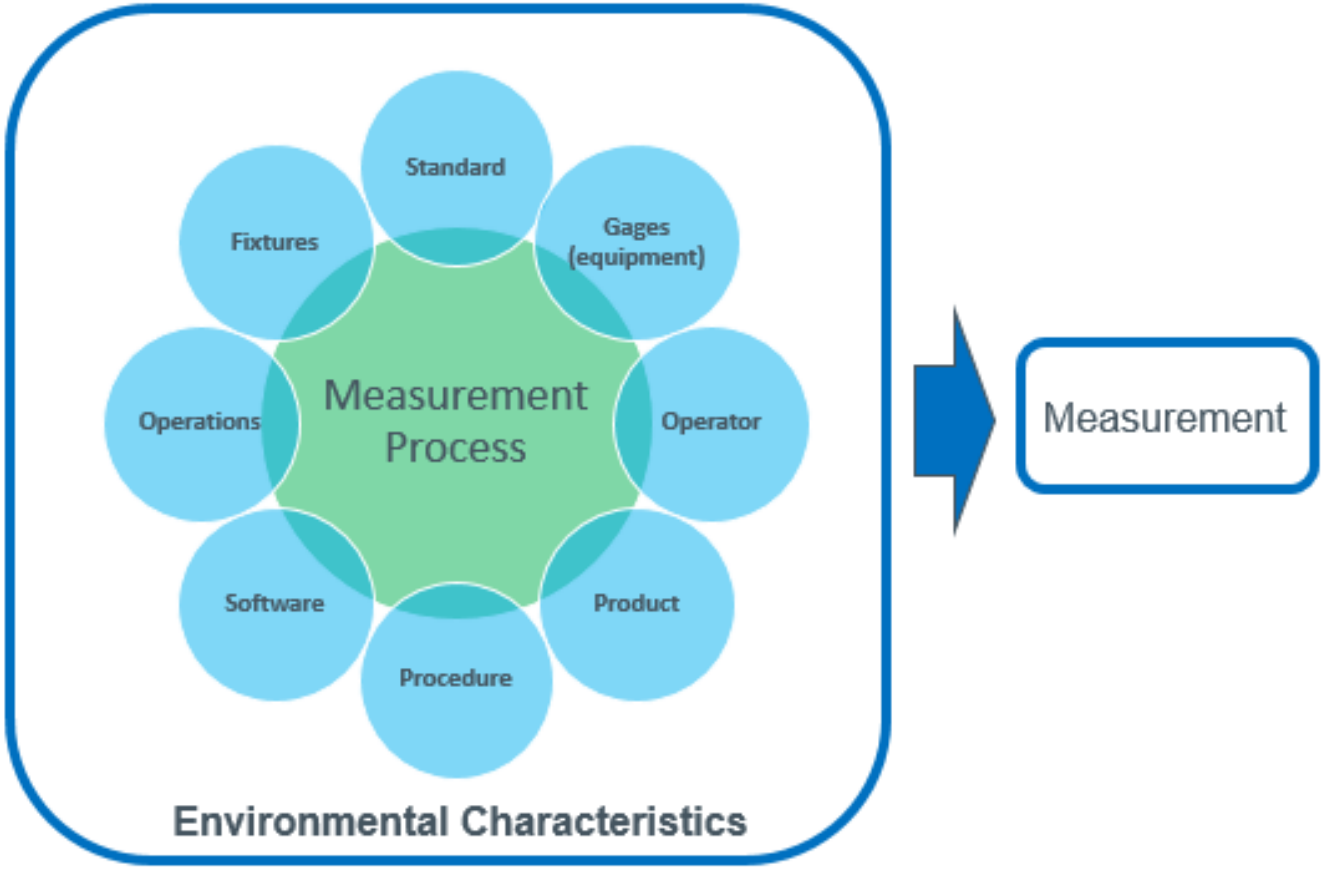
"Gage is any device used to obtain measurements*"



* Measurement System Analysis, Reference Manual, 4th edition

Terminology – Measurement System

"The complete process used to obtain measurements*"



* Measurement System Analysis, Reference Manual, 4th edition

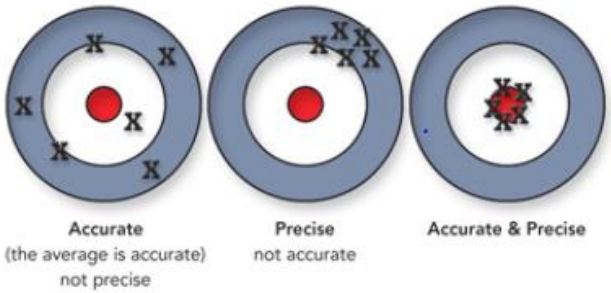
Process of Measurement

- Too many business problems are analyzed with data that is known to be suspect.
- Just as a process has inherent variation, the process of measurement has variation too.
- Process variation observed comprises of the true process variation and the measurement variation.
- When unaware, we face the risk of making a poor decision.

What is a MSA?

- Measurement System Analysis (MSA), is a designed experiment to determine the amount of variation contributed by the measurement system.

- Objective:
  - Confirm that the measurement system used to collect the data is valid (fit for use)
  - Minimize the measurement system variation,
  - And its impact on the total variation so the amount of process variation can be understood as precisely as possible



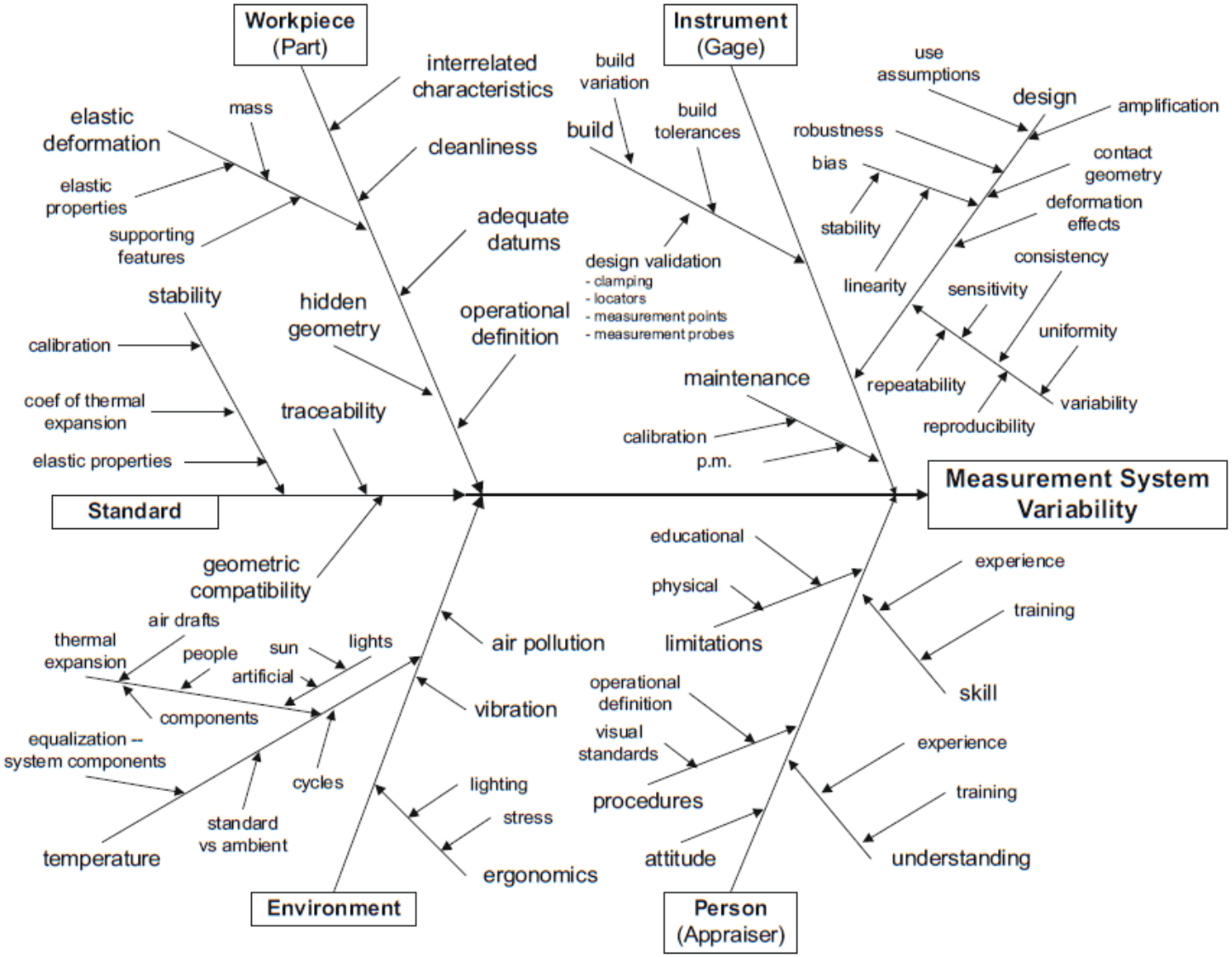
Sources of Variation

- Observed variation is the sum of all variation-sources:
  - Part-to-Part variation
  - Measurement system variation

- **If** measurement system variation is large compared to the total observed variation
  then
  - your measurements will not tell much about process quality
  - It is not possible to distinguish between part-to-part variation and measurement system variation
  - you cannot predict if your customer will get satisfactory products.

“Measurement variation is often the biggest source of variation”

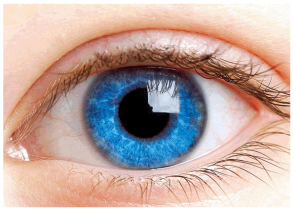
Sources of Variability



Measurement System Analysis, Reference Manual, 4th edition

All MSAs involve:

- Measuring equipment (gage):

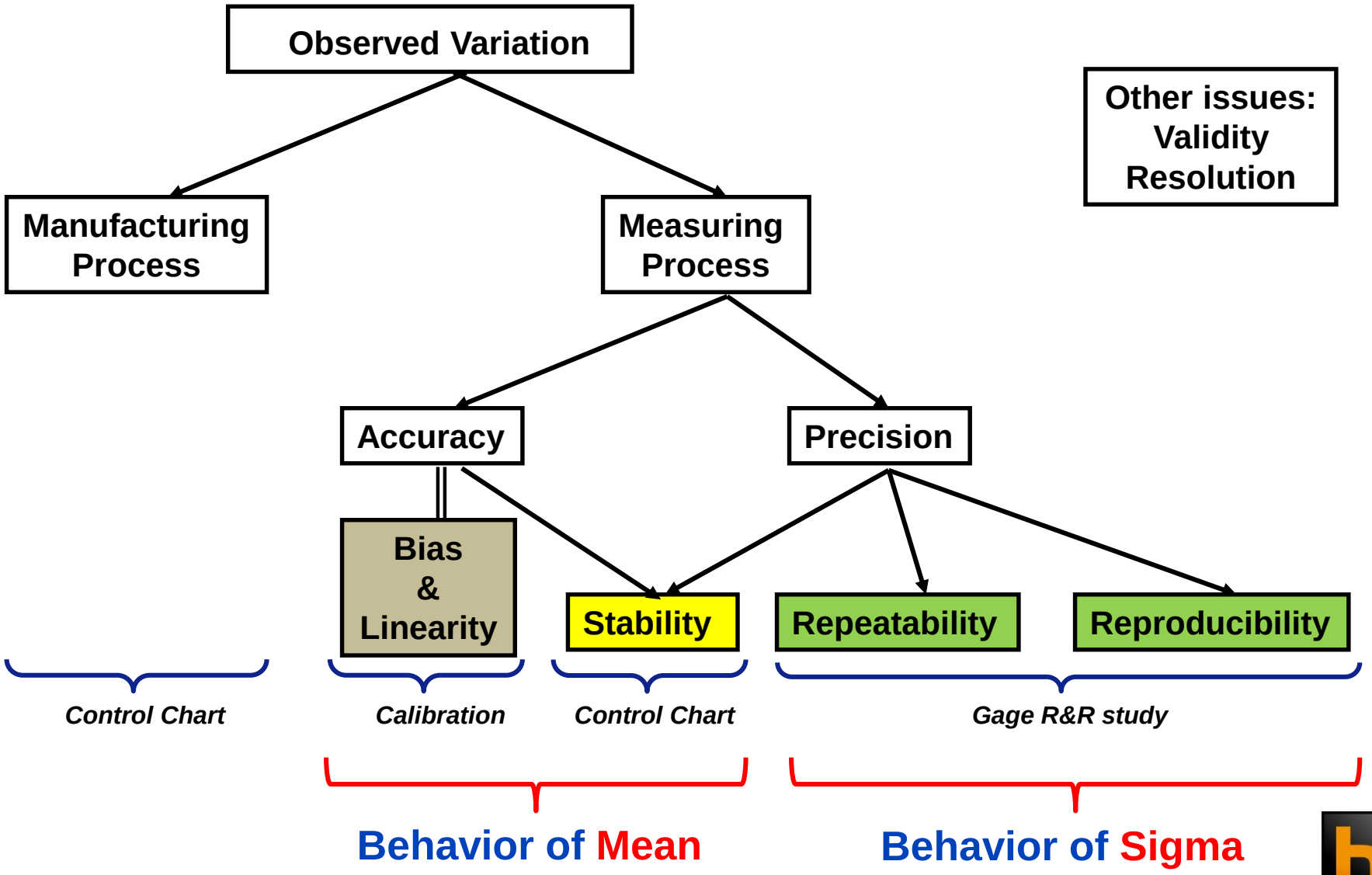




- Items / parts being measured:



- Appraisers (testers):

Overview Variation



Measurement System Evaluation - GR&R

Purpose

- To check whether your measurement system and measurement process is accurate, repeatable and reproducible enough in relation to the specifications of the CTQ to be measured.

Activities

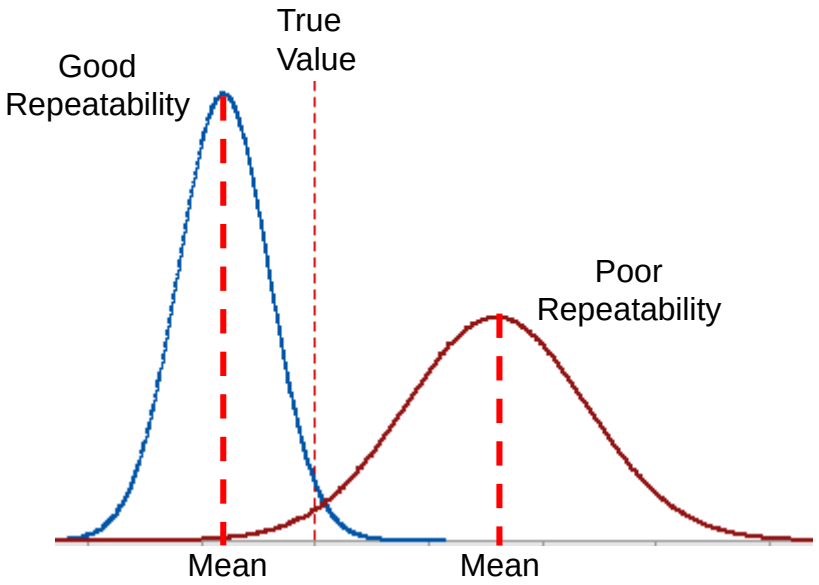
- Repeatability and Reproducibility evaluation, also called a GR&R, Gage Repeatability & Reproducibility, is to be executed by repeatedly measuring CTQs by different operators. Several other WoWs are possible for destructive measurements, or discrete measurements.

Results

- A quantitative analysis, which percentage of variation measured can be attributed to the measurement system and its operators.
- A statement whether the measured data can be trusted.
- A statement whether the measurement system needs improvement .

Repeatability

- **Repeatability** is measurement error obtained when one operator (one appraiser) repeats measurement with same gage on same part. (All variation sources are identical)
- This variation can be caused by operator and/or gage under assumption that *part does not change*!!! (non-destructive measurement)
- "Gage R&R study" investigates this variation



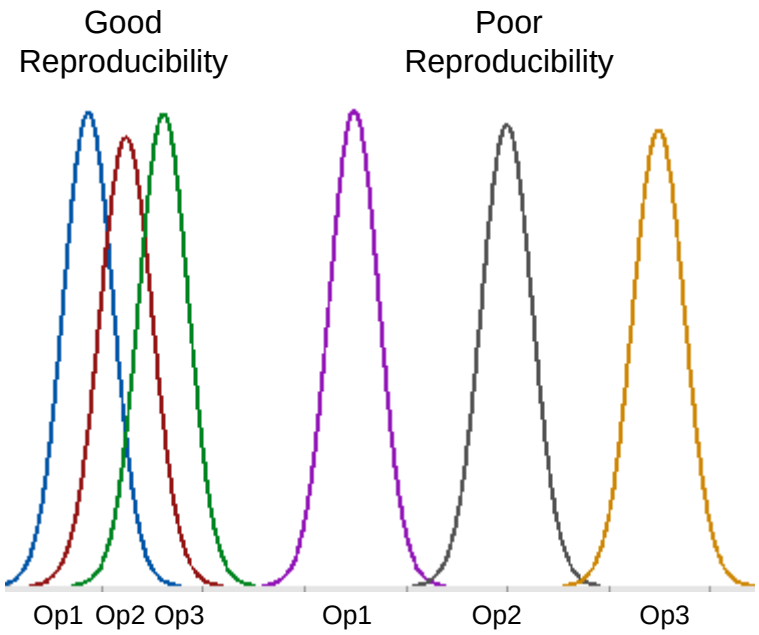
Repeatability: Differences in the values determined if one person measures the same characteristic on one and the same part on a number of occasions using the same measuring device.
Repeatability generally depends on the design of the measuring device.

Reproducibility

- **Reproducibility** is measurement error obtained when different operators (appraisers) reproduce measurement with same gage on same part.
  (One variation source is changed!!)

- This variation can be caused by operator and/or gage under assumption that *part does not change*!!! (non-destructive measurement)

- "Gage R&R study" is used to investigate this variation



Reproducibility: Difference between the average measured values determined with the same measuring device by different persons or at different locations if the same characteristic is measured on the same part.

Risk Analysis

Why Risk analyses?

Why should companies invest time and money in Risk analyses?

Need for FMEA

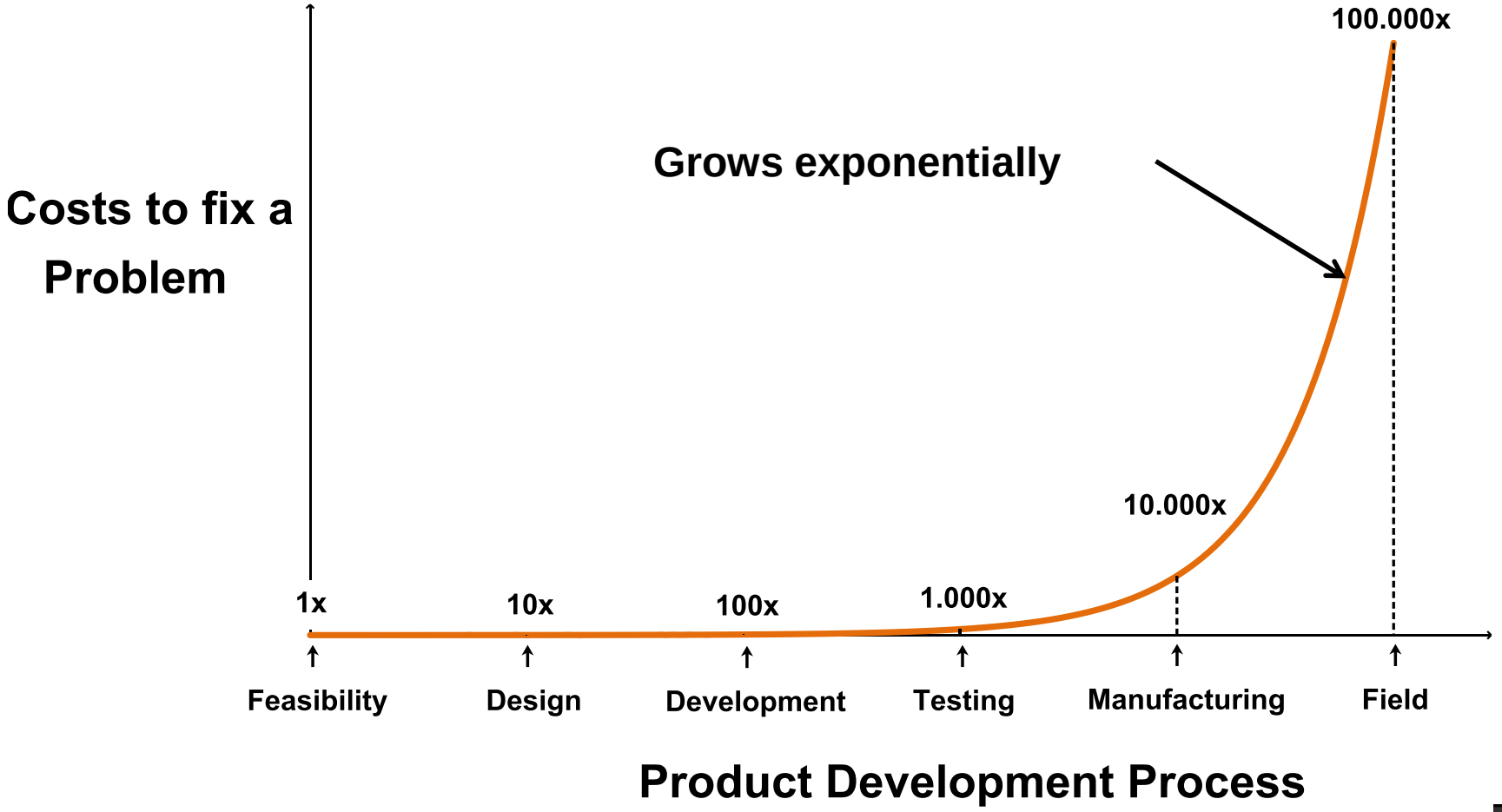
Failure Mode and Effects Analysis is the key tool that supports high Reliability, ensures Safety and achieves Customer Satisfaction

- It is required by standards…
- It is required by customers…
- It is required by your company …

But most of all …

Benefit for you and your company!

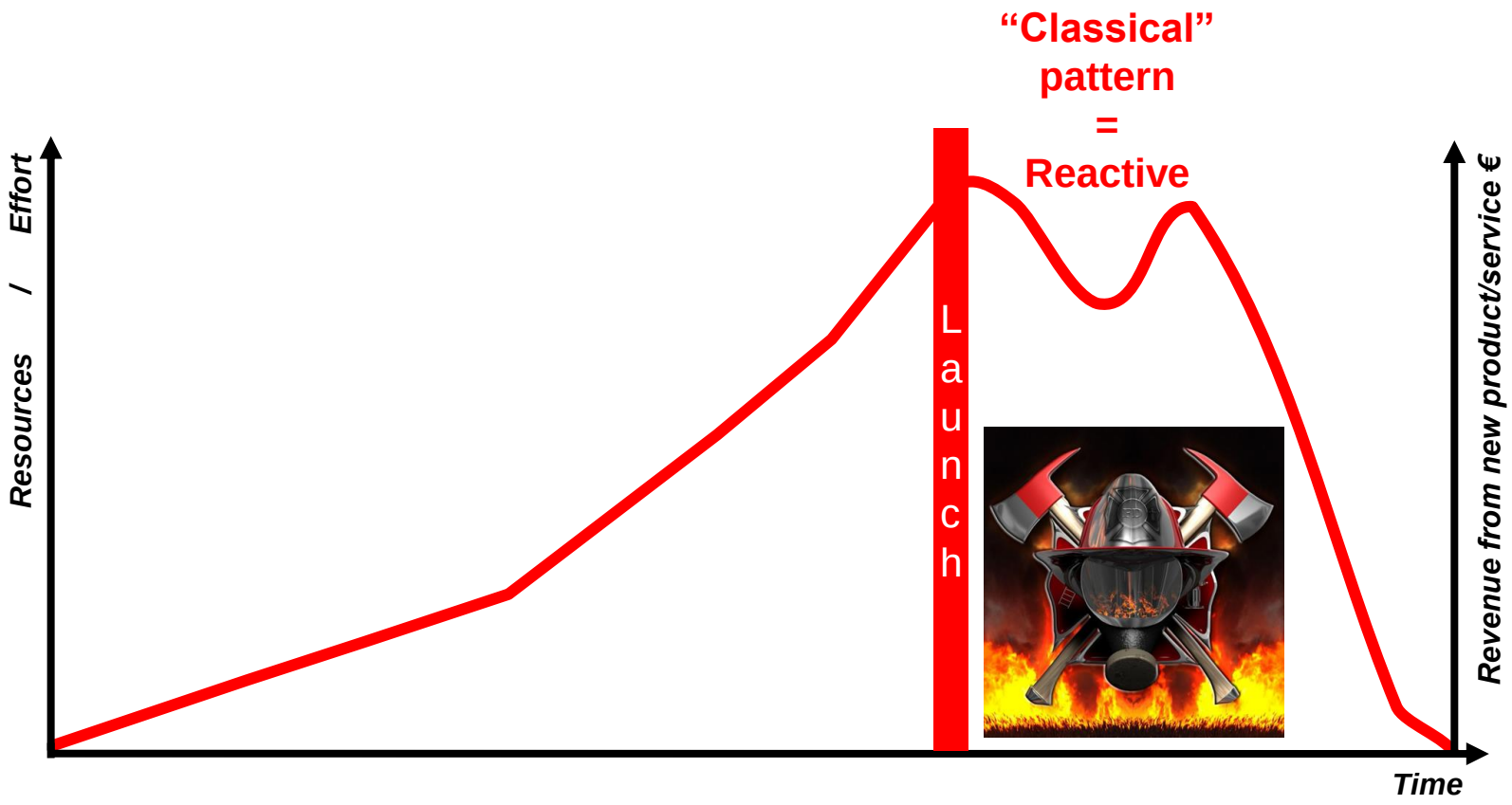
The factor of 10 rule



Other benefits

- Effective FMEA studies are **powerful tools** that benefit the organization, customers, and end users by:
  - Improving Yield and profit margins
  - Reducing time to market
  - Increasing machine and human resource availability
  - Ensuring employee and customer safety
  - Identifying necessary controls and developing test procedures
  - Supporting due diligence claims in legal disputes

Reactive = after the fact



Firefighting close to launch and after-launch

Some after-the-fact ‘firefighting’

Space Shuttle Challenger Explosion
(Jan. 28th 1986)

O-ring seals used in a joint were not designed to handle the unusually cold conditions

Deep Water Horizon Explosion
(April 20th 2010)

Fail-safe on seabed wellhead (blowout preventer) was unable to close due to presence of off-centre drill pipe

Samsung – Galaxy Note 7 Battery fire
(2016)

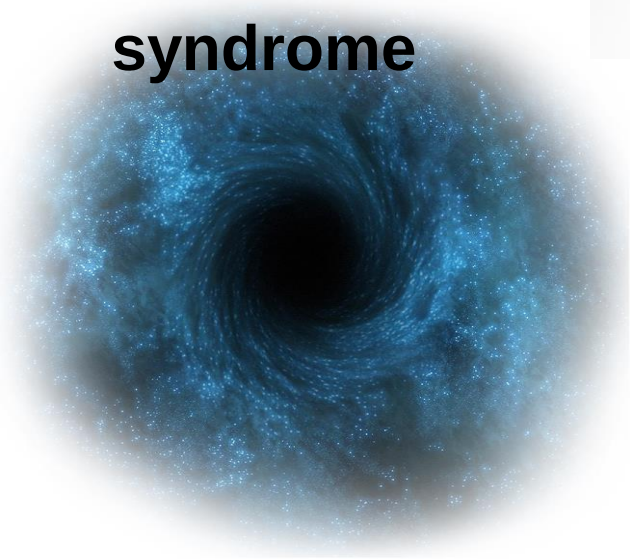
Weakened separator between electrodes causing short circuit (2.5 million phones affected)

Typical FMEA frustrations....

In the project

Time pressure

Black Hole syndrome

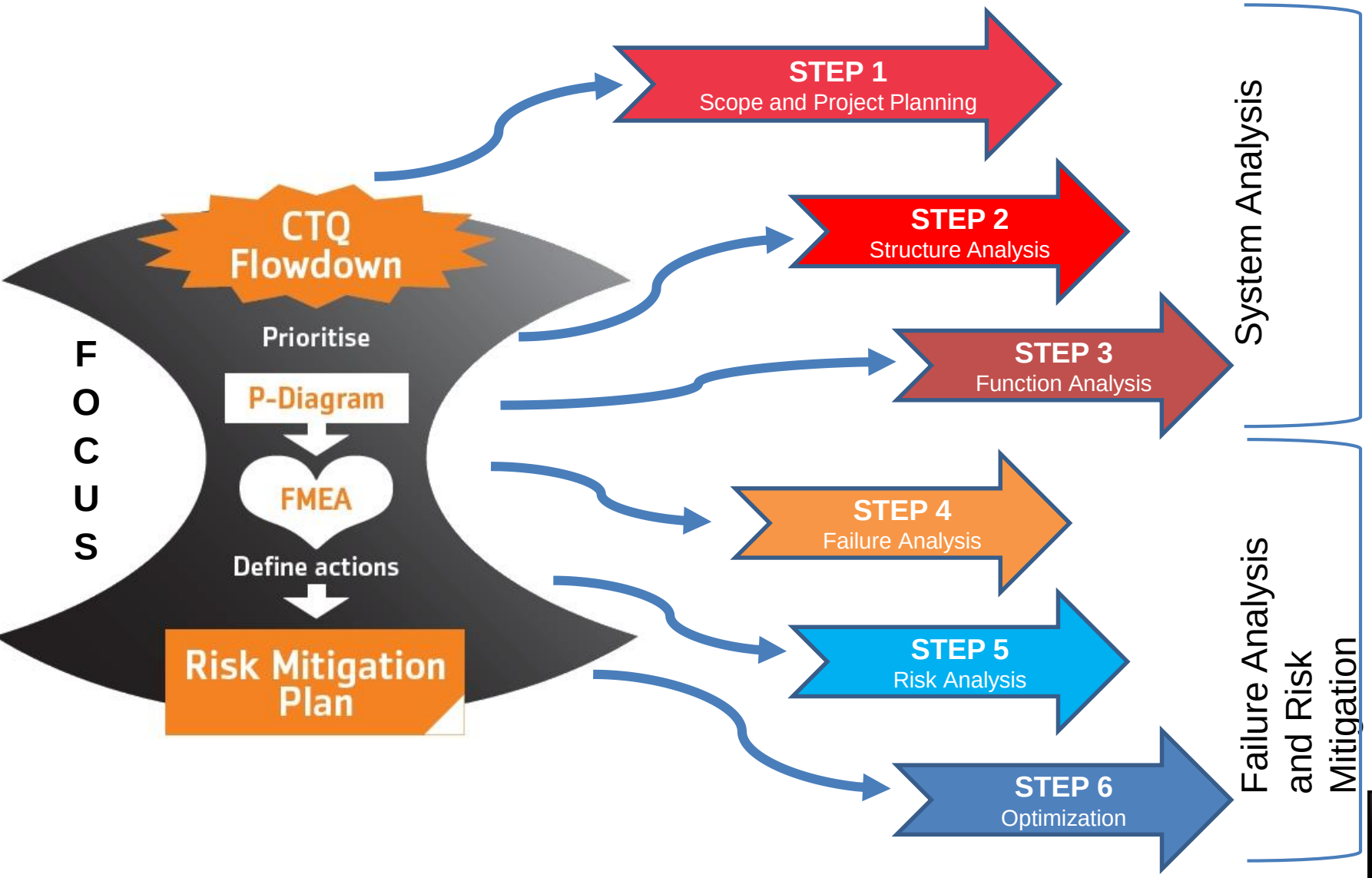


Lack of involvement

Too many participants


TIME TO BE PROACTIVE

Proactive approach



1st Step: Scope Definition

- Important points in the scope steps are:

SCOPE

5T's

FMEA Team
– Who needs to be on the team?

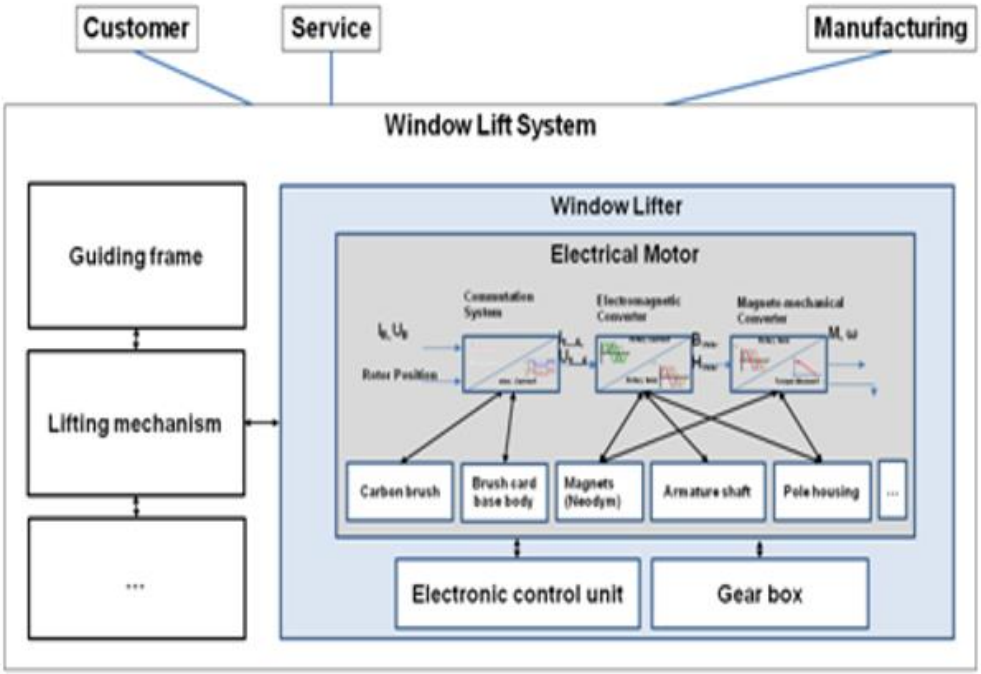
FMEA Timing
– When is this due?

FMEA InTent
– Why are we here?

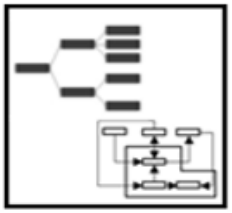
FMEA Tool
– How do we conduct the analysis?

FMEA Task
– What work needs to be done?

Five T's

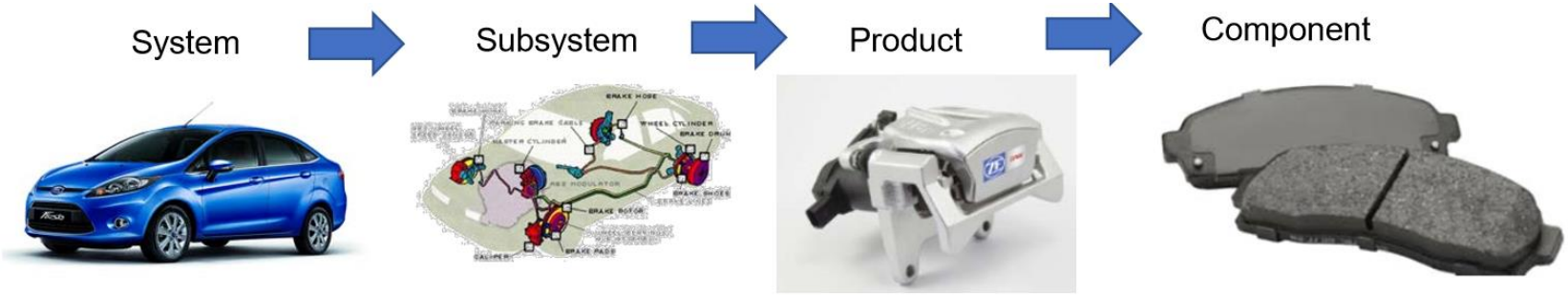


Block Diagram



2nd Step: Structure Analysis

- The Structure Analysis transfers the information gathered in the scoping step to visualize the relationships and interactions between the design or process elements
- The structure analysis is the basis for the next step (function analysis)

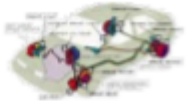


3rd Step: Function Analysis

- In this step the functionality of the product or processes are ensured by allocating a description of the activities, purposes or tasks intended for the product performance.

System

Vehicle:
Safe Stop passengers



Subsystem

Brake System:
Provide Vehicle Deceleration

Product

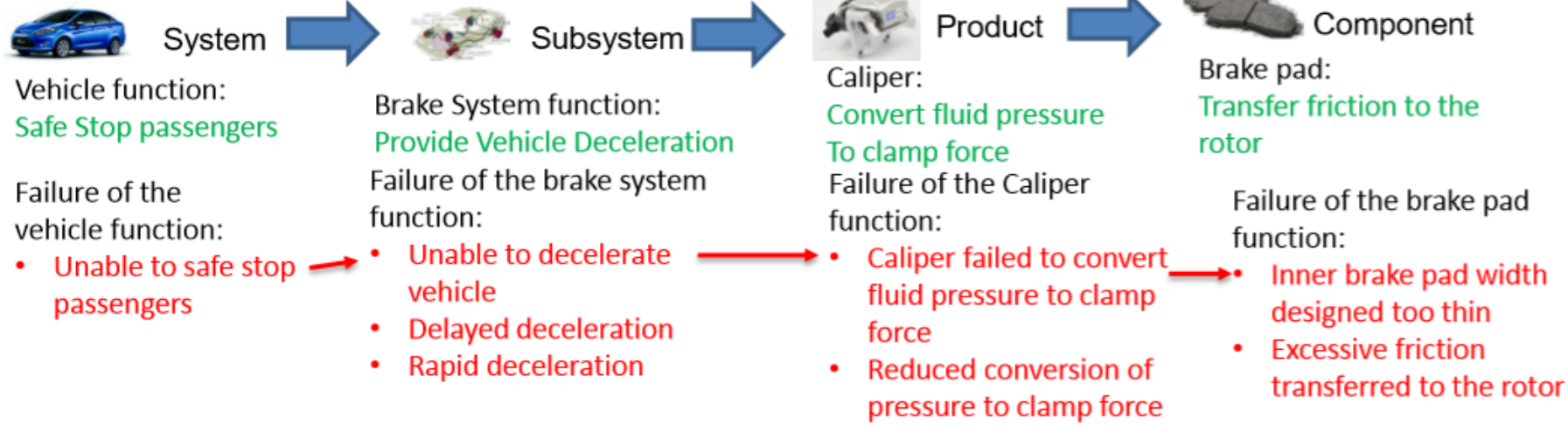
Caliper:
Convert fluid pressure to clamp force

Component

Brake pad:
Transfer friction to the rotor

4th Step: Failure Analysis

- The failures of the functions are deducted from the functions already identified in step # 3.
- Step # 4 is to identify failure causes, modes, and effects, and show their relationships to enable risk assessment.



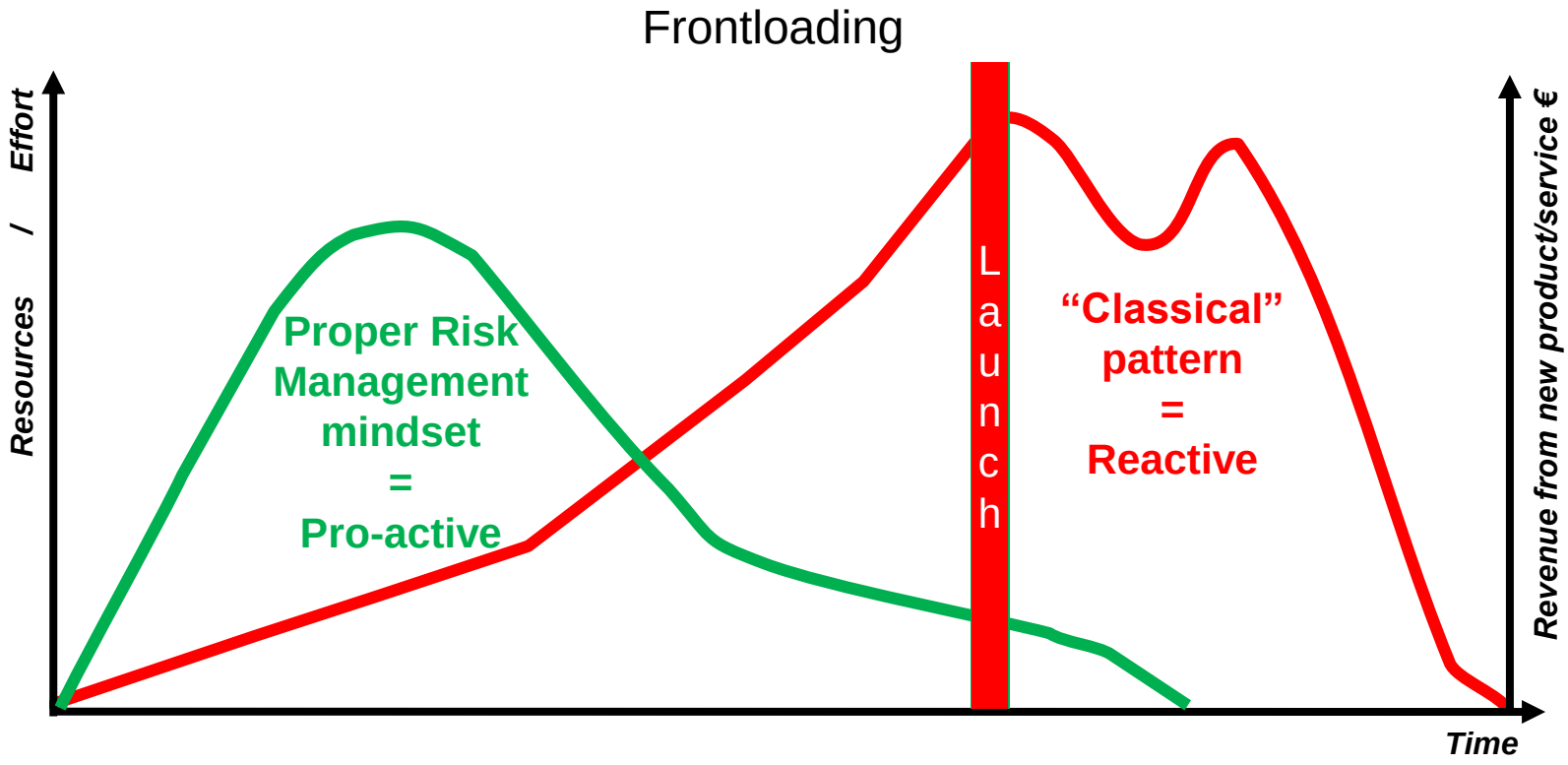
5th Step: Risk Analysis

- In this step prevention and detection controls are assigned, as well as the rankings for severity, occurrence and detection
- Risk Priority Number is calculated and decided when to take action – action prioritization.

6th Step: Optimization

- The primary objective of optimization is to develop actions that reduce risk and increase customer satisfaction by improving the design or process.
- The FMEA can be used as the basis for continuous improvement for design or process.

Frontloading



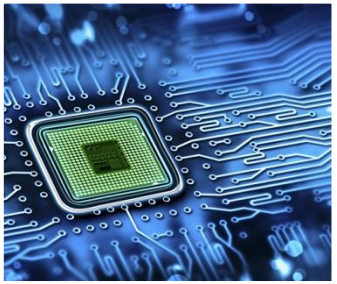
Stay ahead of the game!

- On time!
- Less time pressure!
- Better involvement!

Applications

Aerospace

Energy



ICT

Transport

Medical

Automotive

Production

More…

Why utilize Lean Six Sigma?

Why Lean Six Sigma?

- Unlike industry, where a defective product can be rejected without any problem, in healthcare defects and rework directly affect the patient and therefore, the patient's perception of quality.

- Decisions are often based on assumptions and feelings and on inaccurate and incomplete information.

- Utilising Lean Six Sigma personnel can take responsibility and provide management with solutions based on facts and data.

* Van den Heuvel, J., Does, R.J.M.M and Verver, J.P.S (2005) 'Six Sigma in healthcare: Lessons learned from a hospital'

Why Lean Six Sigma

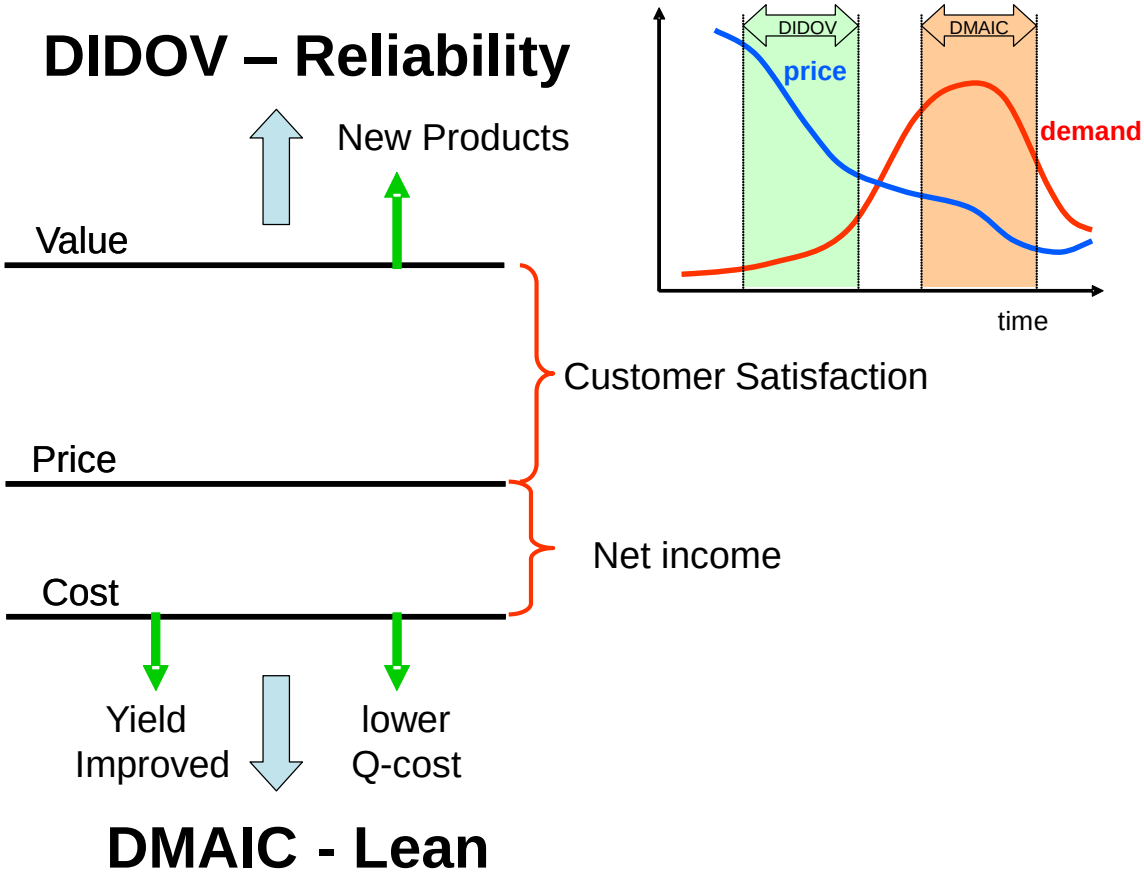
- Progress of LSS projects is very easy to manage due to the uniformity of the project approach in 12 steps and well defined outcomes.
  - This transparency has proven to be a very powerful management tool.
  - It limits developing each and every time a project approach, project documentation, planning, etc.

* Van den Heuvel, J., Does, R.J.M.M and Verver, J.P.S (2005) 'Six Sigma in healthcare: Lessons learned from a hospital'

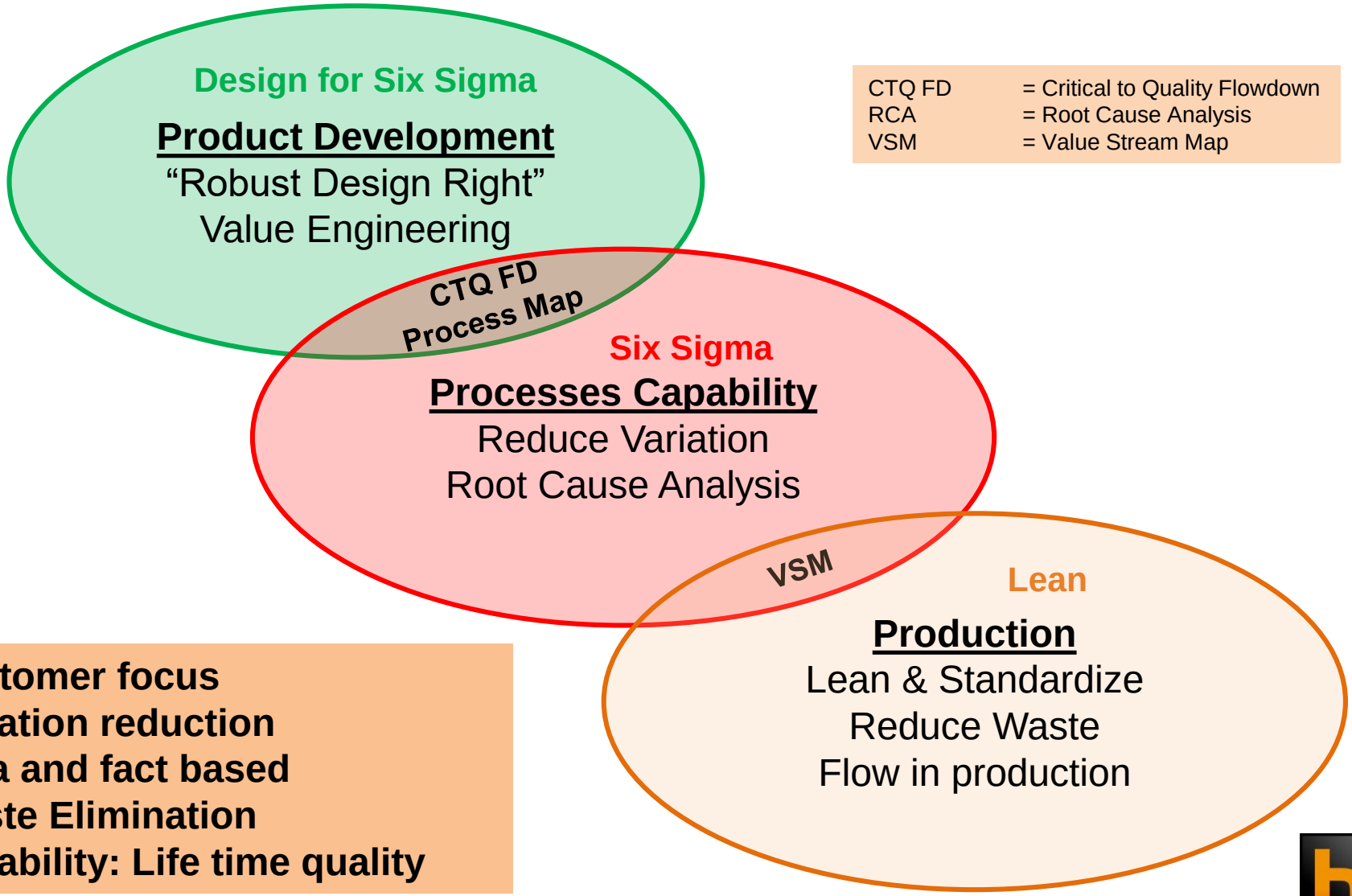
(Design for) Six Sigma Benefits

Benefits

- Value creation by Customer focus
- Capable processes
- Quality products meeting Customer Expectation
- Knowledge building by fact based and structured way of working
- Awareness of design rules & risk management
- Focus: Robustness, error proneness and tolerance
- Shorter time to market



Overview of Six Sigma Methods



CTQ FD	= Critical to Quality Flowdown
RCA	= Root Cause Analysis
VSM	= Value Stream Map

Customer focus
Variation reduction
Data and fact based
Waste Elimination
Reliability: Life time quality

Potential area's to improve*

- Shortening the length of stay of patients
  - Reducing admission time
  - Analysing full content of a clinical pathway
  - Potential result:
    - Positive net effect on budget
    - More patients can be admitted using the same capacity
    - Optimal usage of available bed capacity
- Minimising the use of materials and devices
  - Intravenous medication change to oral medication at the earliest possible moment
  - Reducing the number of intravenous pumps by pooling

* Van den Heuvel, J., Does, R.J.M.M and Verver, J.P.S (2005) 'Six Sigma in healthcare: Lessons learned from a hospital'

Potential area's to improve*

- Optimising the use of available capacities
  - Optimising capacity of the operating theatre
  - Optimising the use of costly diagnostic scanners such are MRI and CT
- Improving cash flow
  - Reducing accounts receivable
  - Revision of terms of payment
- Additional benefits apart from financial benefits linked to the quality of healthcare and directly affect the patient:
  - Shorter waiting lists
  - Elimination of unnecessary examinations
  - Reducing number of complications

* Van den Heuvel, J., Does, R.J.M.M and Verver, J.P.S (2005) 'Six Sigma in healthcare: Lessons learned from a hospital'

Example projects

Shortening the length of stay of gynaecology patients

Background*

- In The Netherlands, hospitals receive, as part of their budgets, a fixed amount of money for every admission. Therefore, reducing the length of stay of patients has a direct impact on the financial results of the hospital because more patients can be admitted.

- The objective of this project was to shorten the stay of gynaecologypatients who had to undergoan abdominal uterus extirpation (AUE) or a vaginal uterus extirpation (VUE).

* Van den Heuvel J., Does R.J.M.M, and Vermaat T.M.B. ‘Six Sigma in a Hospital : does it work in a nursing department’?”

Six Sigma: *DMAIC* model

Define	
Measure	1. Define the CTQs (Critical To Quality charact.s) 2. Validate measurement procedures
Analyze	3. Diagnose the current process 4. Identify potential influence factors
Improve	5. Establish the effect of influence factors 6. Design improvement actions
Control	7. Improve / design process control 8. Close the project

Six Sigma: *DMAIC* model

Define

Measure

1. Define th… …tical To Quality charact.s)

Analyze

Improve

Control

8. Close the project

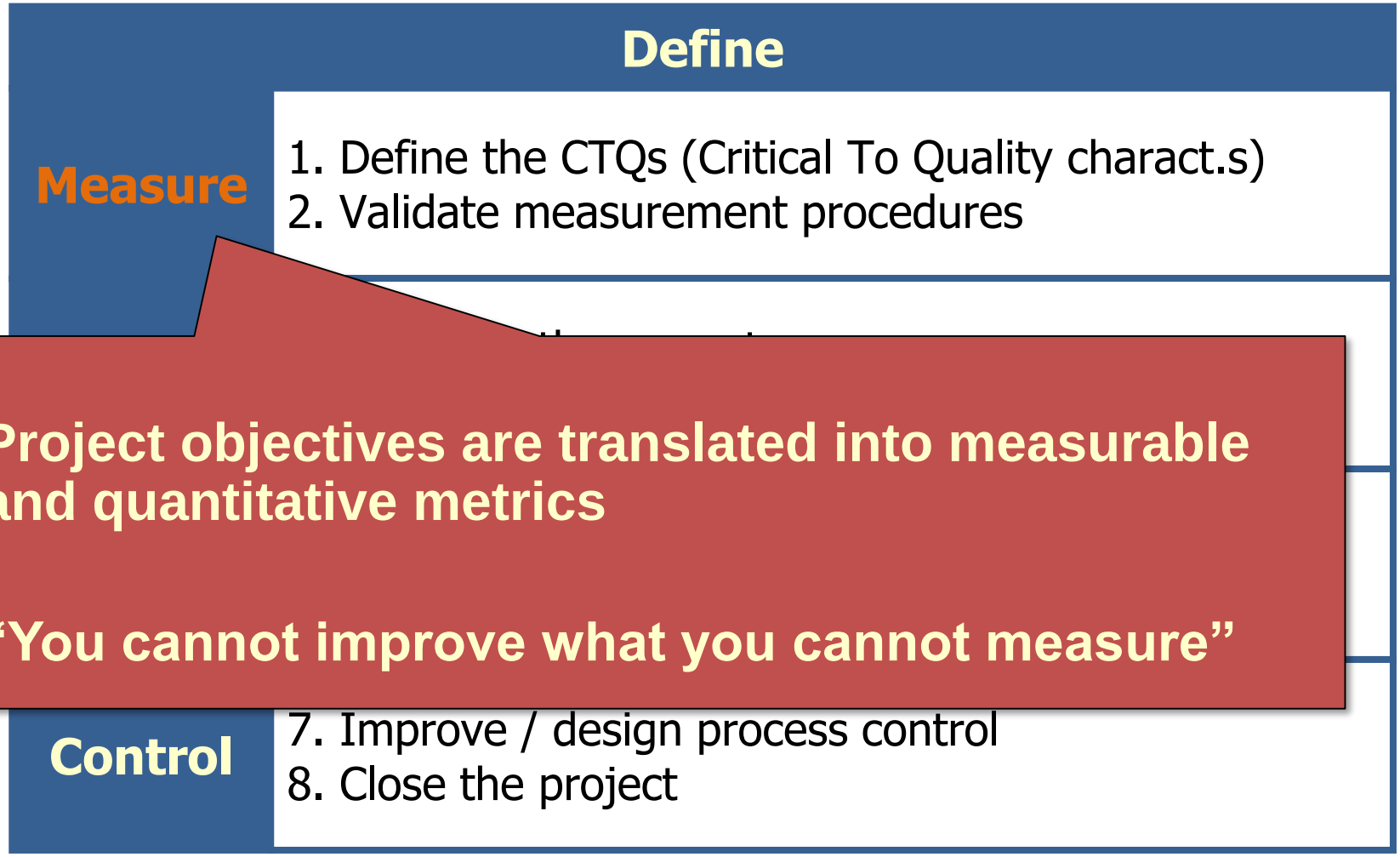
Objective: Shorten stay of gynaecology patients

Financial benefit estimation: € 57 800
Additional benefit: Reduction in waiting lists

Project duration estimated: 6 month

Carried out by two Green Belts in training

Six Sigma: *DMAIC* model



Six Sigma: *DMAIC* model

- CTQ characteristic is the length of stay of patients with AUE or VUE. This CTQ was defined as the length of the stay measured in days.
- Only patients who had to undergo an AUE or VUE were included.
- The measurement of the length of stay by means of the computer system had to be validated. This was done by comparing the length of stay measuring 30 patient dossiers.
- There were no differencesfoundin this sample. Based on these observations we concludedthat the measurementsystem was valid.

Six Sigma: *DMAIC* model

Define	
Measure	1. Define the CTQs (Critical To Quality charact.s) 2. Validate measurement procedures
Analyze	3. Diagnose the current process 4. Identify potential influence factors
	8. Close the project

Attempts at improvement should be preceded by a data-based diagnosis

“What is the nature of the main bottleneck?”

Six Sigma: *DMAIC* model

- Data for one year was used.
- There appeared to be a few outliers, which were analyses and excluded from the data by performing capability analysis.
- The average stay of patients with VUE or AUE was 7 days, and the standard deviation was 2 days.
- Factors influencing the length of stay were listed by using a cause and effect diagram and a failure mode and effect analysis (FMEA)

Six Sigma: *DMAIC* model

Define	
	.s)
Improve	5. Establish the effect of influence factors 6. Design improvement actions
Control	7. Improve / design process control 8. Close the project

The effectiveness of proposed interventions must be demonstrated:

Evidence-based intervention

“In God we trust, all others must bring data”

Six Sigma: *DMAIC* model

- The most relevant factors influencing the length of the stay were found to be:
  - Treatment protocols of patients; and
  - Situation at home, i.e. whether there are relatives who can take care of the patients after discharge.

- The most fruitful improvements were:
  - An out-patient clinic to prepare the patient for the operation (this action reduces the length of stay of patients by one day);
  - Improved protocols;
  - Check on the situation at home and offer home care if needed; and
  - Information about the length of the stay given to the patient in advance

Six Sigma: *DMAIC* model

Structures for continued control and improvement of the process

"It takes all the running you can do to stay in the same place"

Previous suggested improvements were implemented and resulted in:

- **The average length of stay reduced to 5.2 days**
- **The standard deviation reduced to 0.9 days**

	…provement actions
Control	7. Improve / design process control 8. Close the project

Improving a CAT scan process

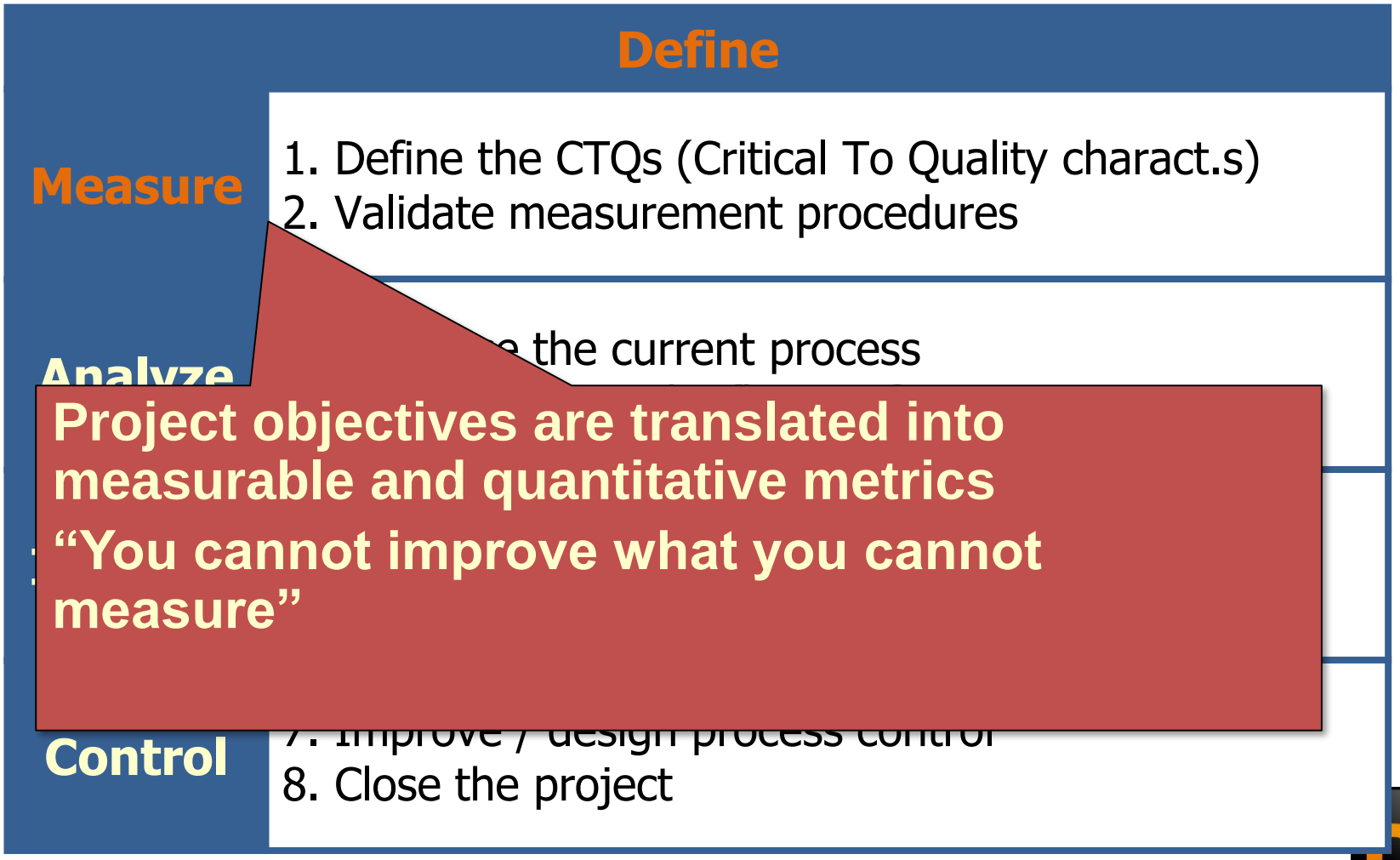
Background

- CAT scan process in a hospital
- Objectives:
  - Capacity should be increased (current: 19 patients / day)
  - Lower costs.

Six Sigma: *DMAIC* model

	Define
Measure	1. Define the CTQs (Critical To Quality charact.s) 2. Validate measurement procedures
Analyze	3. Diagnose the current process 4. Identify potential influence factors
Improve	5. Establish the effect of influence factors 6. Design improvement actions
Control	7. Improve / design process control 8. Close the project

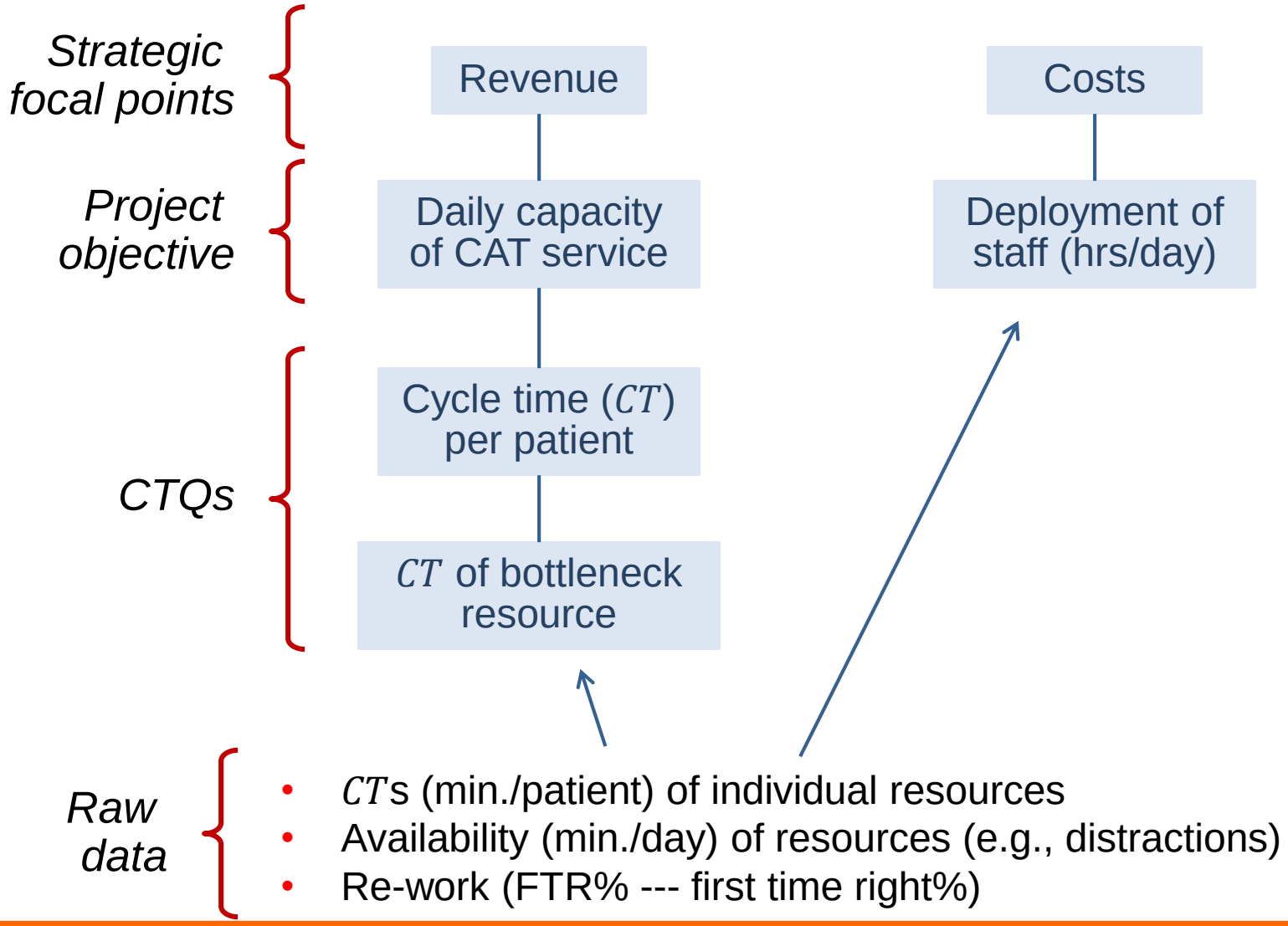
Six Sigma: *DMAIC* model



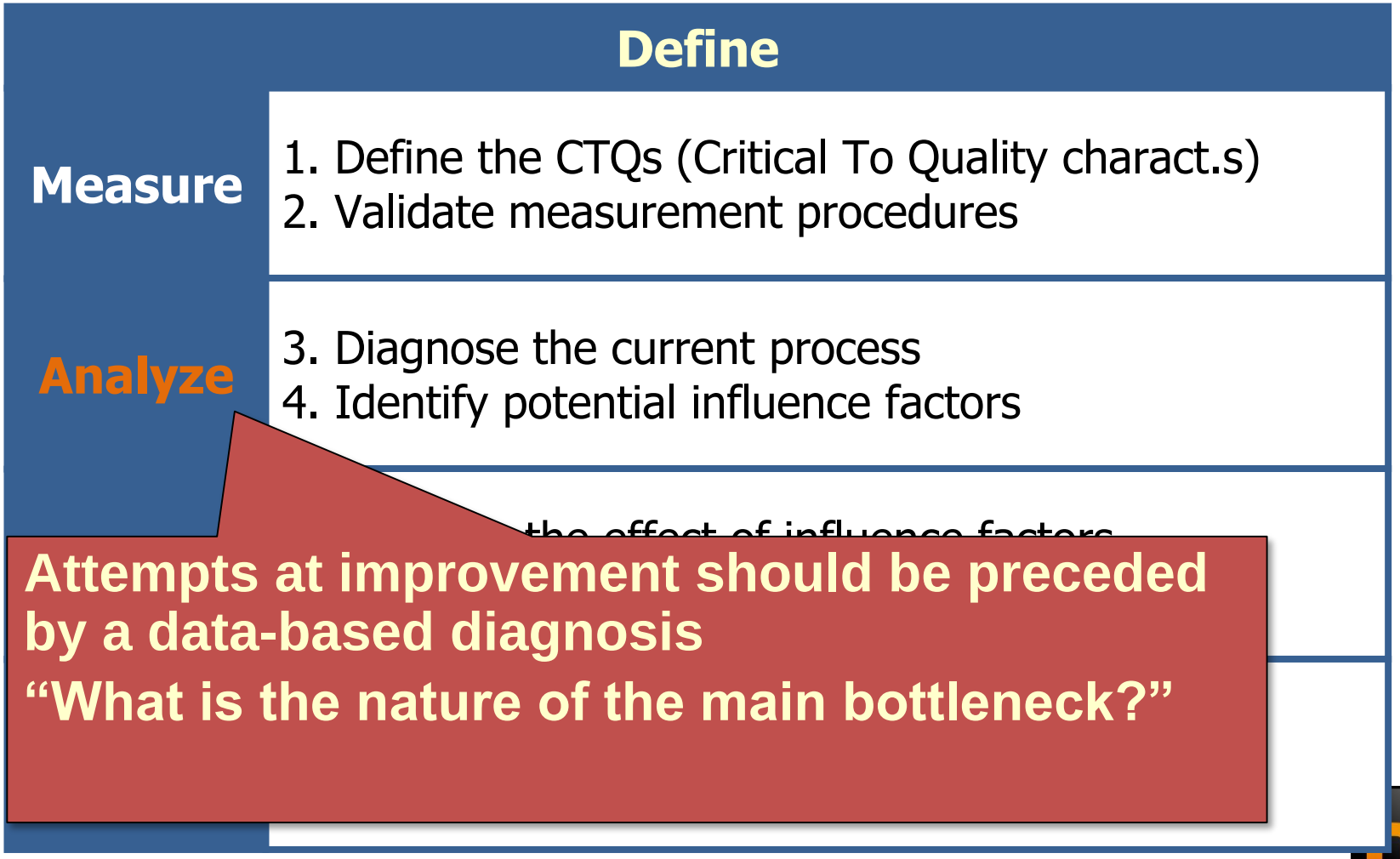
Project objectives are translated into measurable and quantitative metrics

"You cannot improve what you cannot measure"

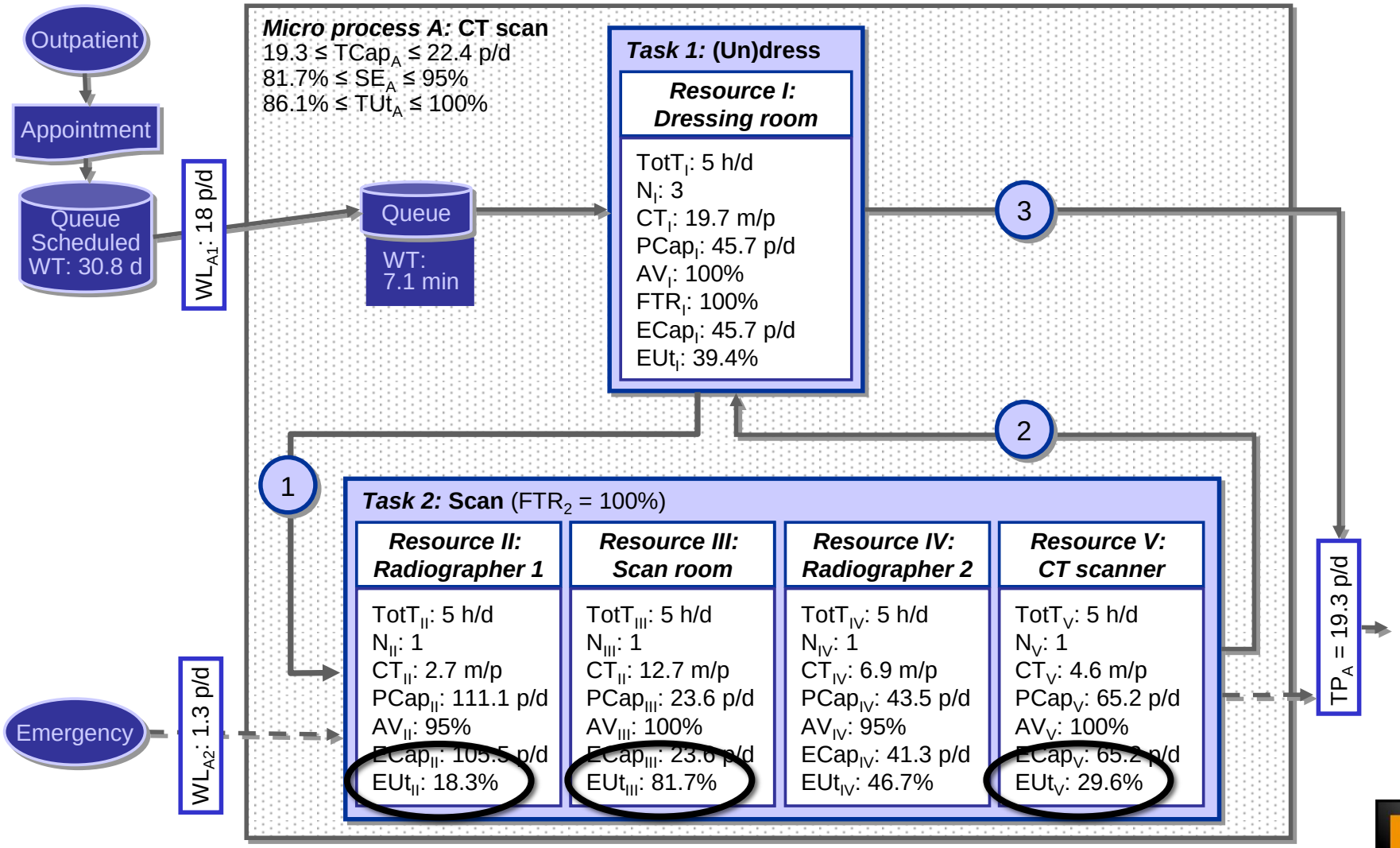
CAT-scan example: *DMAIC*



Six Sigma: *DMAIC* model

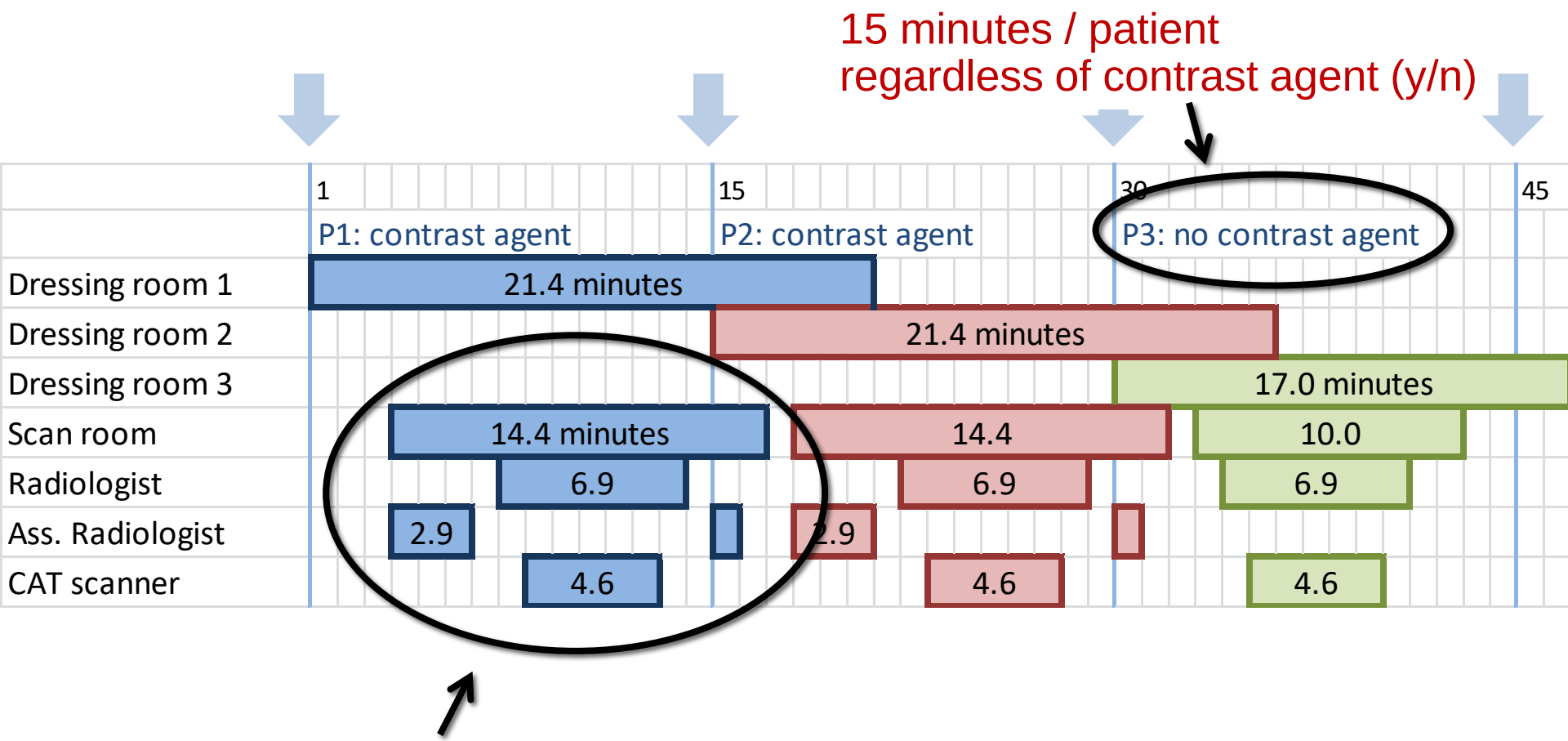


CAT-scan example: *DMAIC*



h/d = hours per day; m/p = minutes per patient; p/d = patients per day

CAT-scan example: *DMAIC*



Scan room is the bottleneck.
Scan room cycle time: 14.4 min / patient.
Includes injection with contrast agent.

Six Sigma: *DMAIC* model

Define	
	ract.s)
Improve	5. Establish the effect of influence factors 6. Design improvement actions
Control	7. Improve / design process control 8. Close the project

The effectiveness of proposed interventions must be demonstrated:

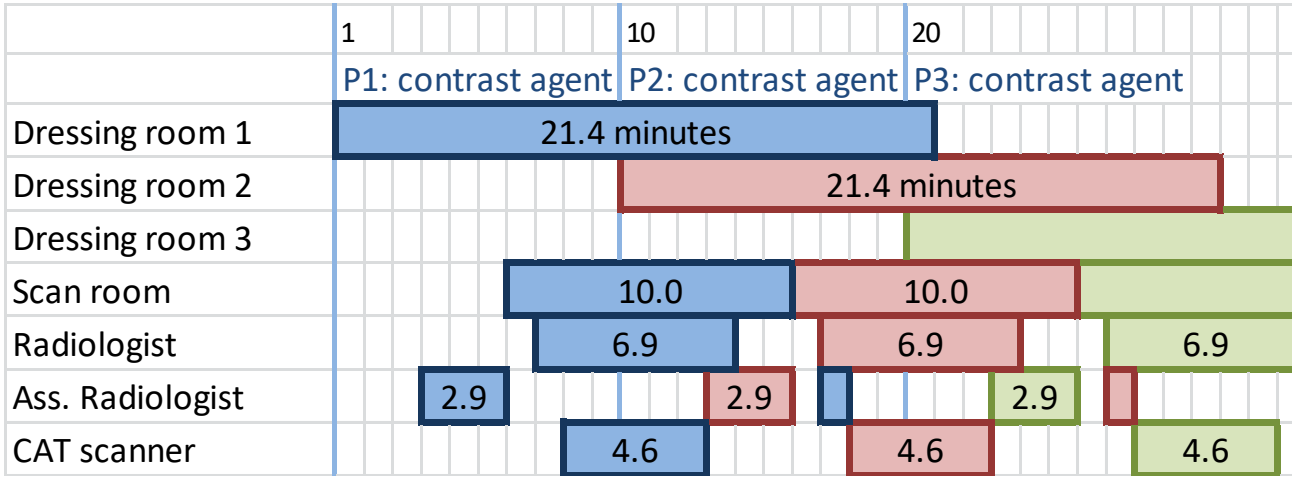
Evidence-based intervention

“In God we trust, all others must bring data”

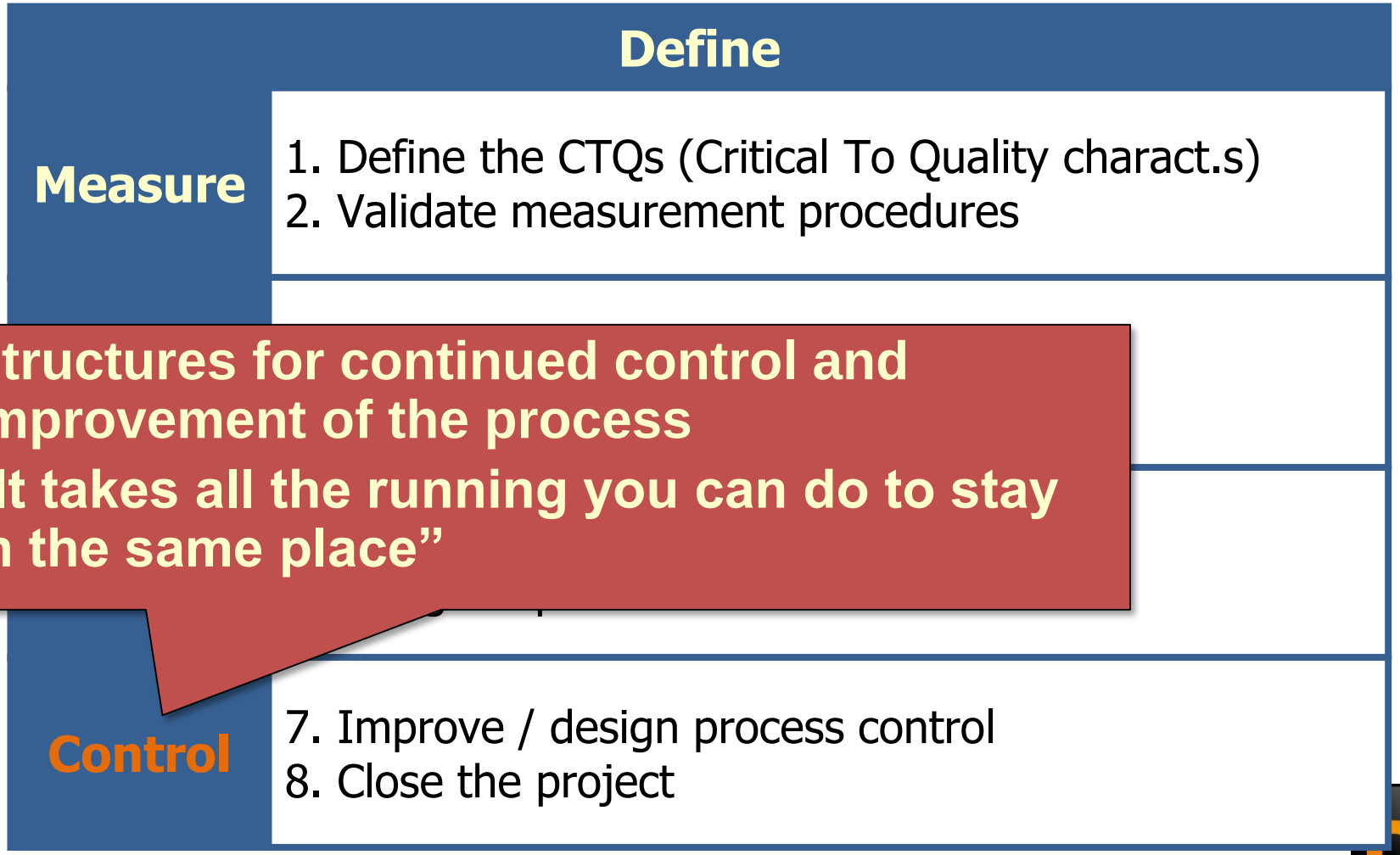
CAT-scan example: *DMAIC*

- The scan room is the bottleneck, so should be the focus:
  - Move tasks (injection) from the scan room elsewhere:
- Schedule patients without contrast agent in shorter time slot.
- Assist. Radiologist is not needed for patients without contrast agent
  - Schedule patients without contrast agent in one block; the assist. radiologist is not needed in this time slot.

⇒ Capacity from 19 to 30 patients / day.



Six Sigma: *DMAIC* model



Summary

- Focus on: Variation & Waste
- How?
  - Measure data with adequate measurement method -> Performance
  - Aquire customer requirements
- Performance + Requirements = potential performane gap
- Which could be the start of an improvement event
- Choose any method.....
  - Lean
  - Six Sigma
  - Design for Six Sigma
  - 8D
  - .....

Appendix

Exercise – letter “f” counting

*The necessity **of** training **f**arm hands **f**or **f**irst class **f**arms in the **f**atherly handling **of** **f**arm livestock is **f**oremost in the eyes **of** **f**arm owners. Since the **f**ore**f**athers **of** the **f**arm owners trained the **f**arm hands **f**or **f**irst class **f**arms in the **f**atherly handling **of** **f**arm livestock, the **f**arm owners **f**eel they should carry on with the **f**amily tradition **of** training **f**arm hands **of** **f**irst class **f**armers in the **f**atherly handling **of** **f**arm livestock because they believe it is the basis **of** good **f**undamental **f**arm management.*