QUALITY MANAGEMENT 444

WEEK 6
LECTURE 12

Chapter 15 (&16)

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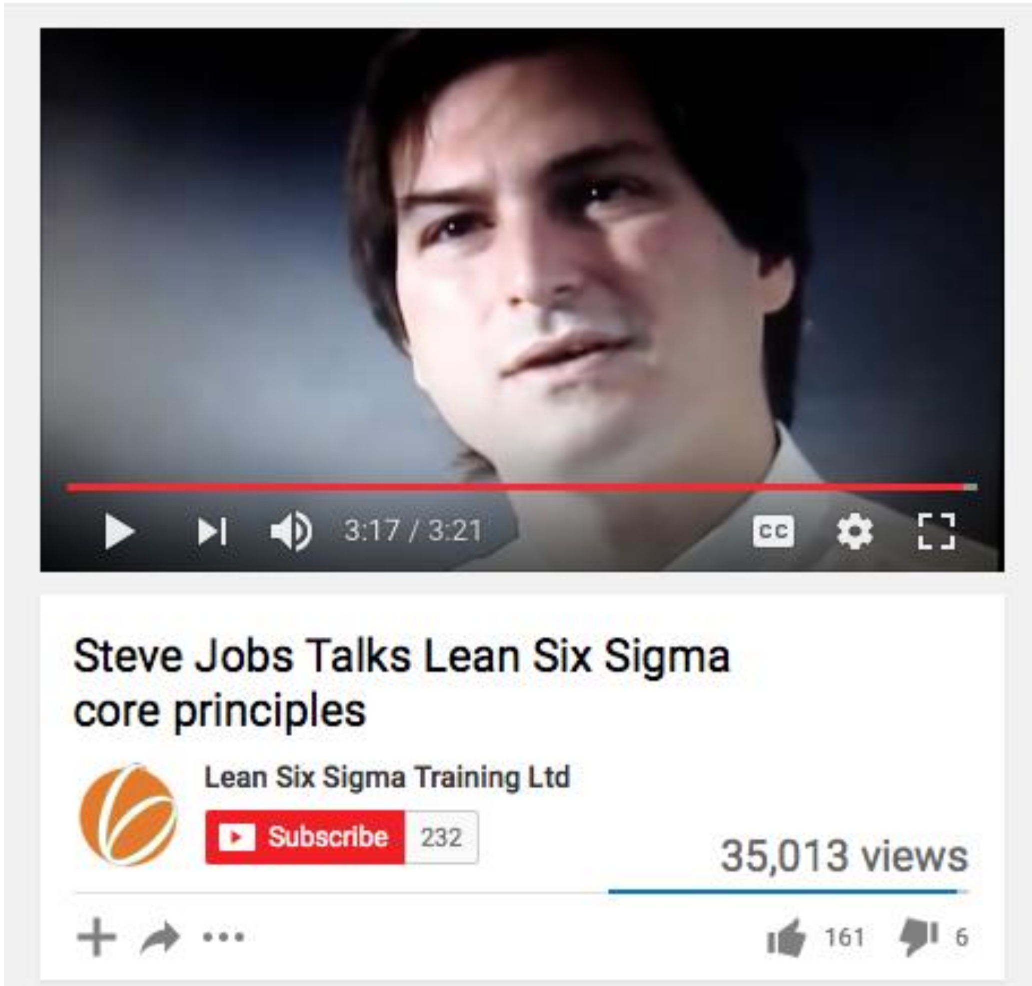
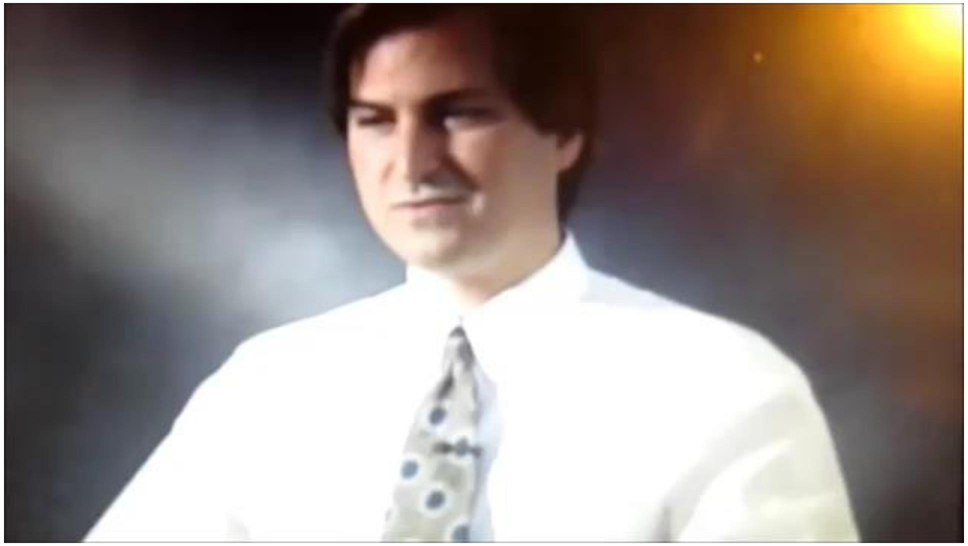
STEVE JOBS ON QUALITY



STEVE JOBS ON QUALITY



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TQM	TQM describes a management approach to long–term success through customer satisfaction. In a TQM effort, all members of an organization participate in improving processes, products, services, and the culture in which they work.
Continuous Improvement	Continuous improvement is an ongoing effort to improve products, services or processes. These efforts can seek “incremental” improvement over time or “radical” improvement all at once.
Lean	Lean manufacturing or lean production, often simply "lean", is a systematic method for waste minimization within a manufacturing system without sacrificing productivity. Lean manufacturing involves never ending efforts to eliminate or reduce waste.
Six Sigma	Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects in any process – from manufacturing to transactional and from product to service. DMAIC improvement cycle is the core tool used to drive Six Sigma projects.
TOC	The Theory of Constraints is a methodology for identifying the most important limiting factor that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor.

Others?

TQM

Business process reengineering

Continuous Improvement

Creative problem solving

Lean (TPS)

Systems Engineering

Six Sigma

...and more

TOC

?

Six sigma approach

6σ

INDICATOR OF

Efficiency and effectiveness of processes

PROBLEM SOLVING METHOD

Systematically, data oriented, (DMAIC-Method, DMADV)

TOOLBOX

Process, Analysis, Statistics, Problem Solving Strategy

PROCESS IMPROVEMENT

Operative and productive processes

CUSTOMER REQUIREMENTS

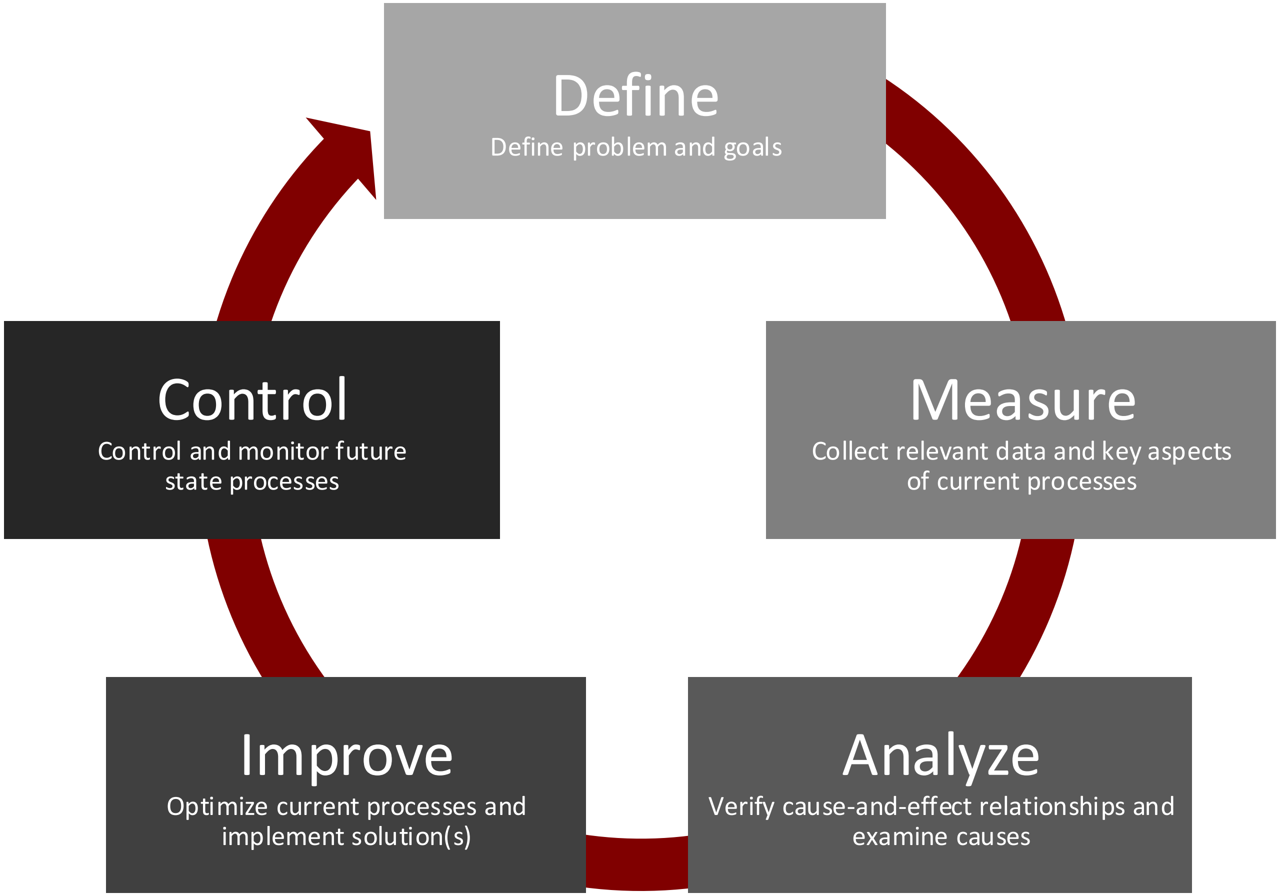
Not quality improvement at all costs

QUALITY INITIATIVE

Resounding measurable success like increased revenue and lowered costs

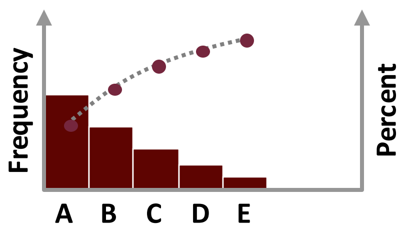
Six sigma – DMAIC method

DMAIC PROBLEM SOLVING

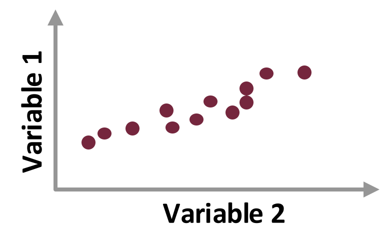


7 classic tools of quality

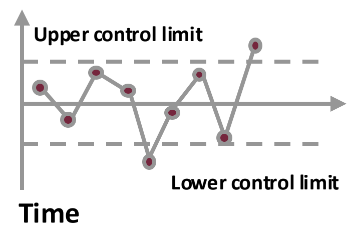
PARETO CHART



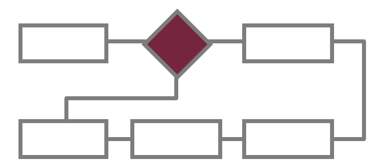
SCATTER DIAGRAM



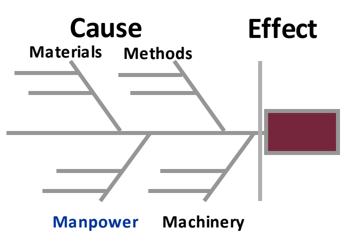
CONTROL CHART



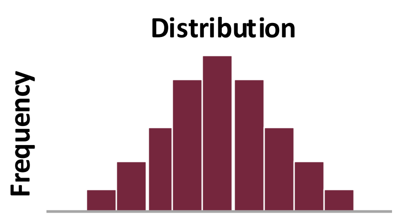
FLOW CHART



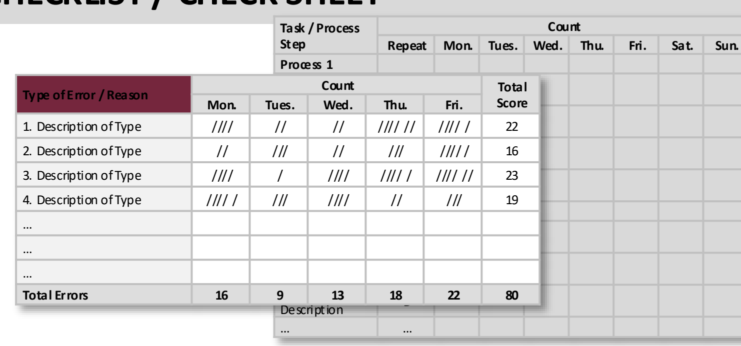
CAUSE-AND-EFFECT



HISTOGRAM



CHECKLIST / CHECK SHEET

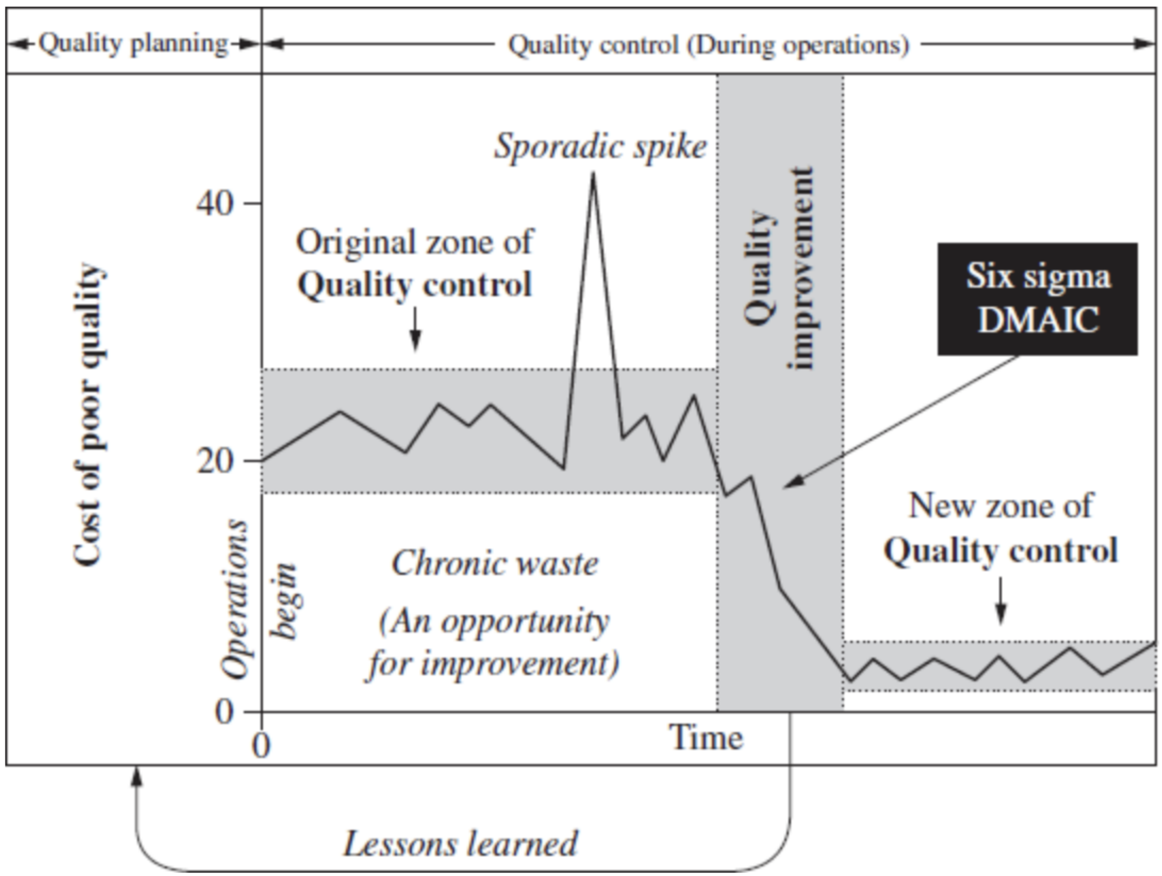


Type of Error / Reason	Count Mon.	Tues.	Wed.	Thu.	Fri.	Total Score
1. Description of Type	////	//	//	//// //	//// /	22
2. Description of Type	//	///	//	///	////	16
3. Description of Type	////	/	////	//// /	//// //	23
4. Description of Type	//// /	///	////	//	///	19
...						
...						
...						
Total Errors	16	9	13	18	22	80

The most common quality tools that can be used to identify and address the vast majority of quality-related issues.

DMAIC cycle

Figure 15.1 *Six Sigma and the Juran Trilogy. (Juran Institute, Inc., Southington, CT.)*



DMAIC cycle

Define the problem as clearly possible.

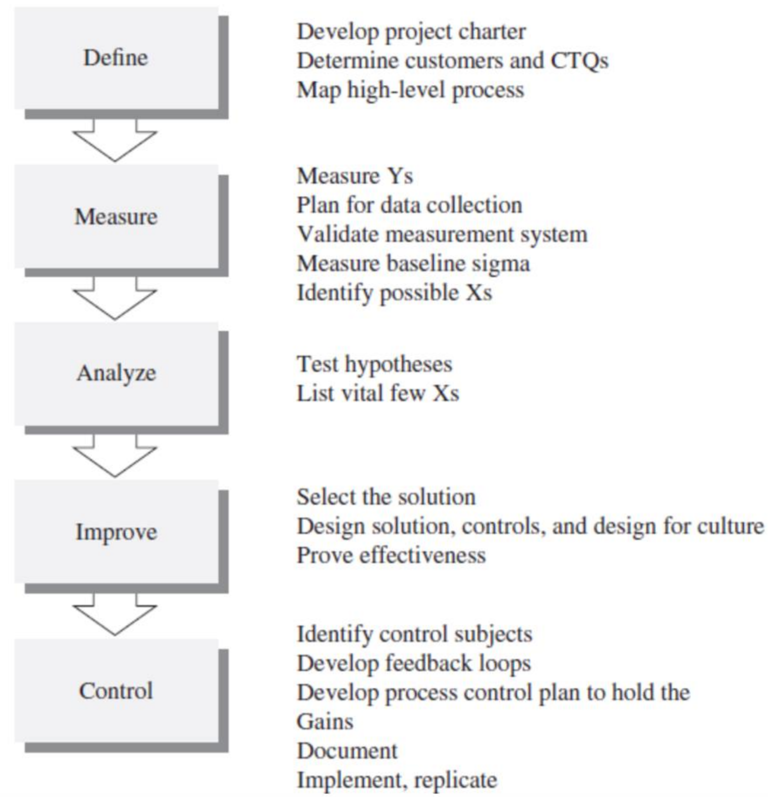
Measure the current level of performance and voice of the customers.

Analyze collected data to determine the cause(s) of the problem.

Improve by selecting the right solutions to solve the problem.

Control to hold the gains.

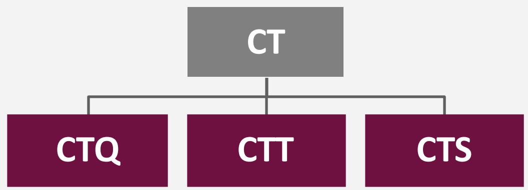
Figure 15.2 Six Sigma phases and steps.



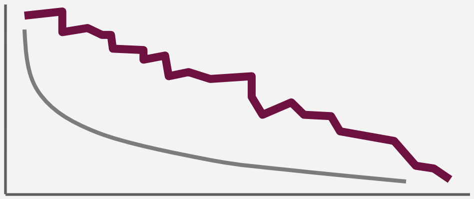
Sources of Six Sigma projects

STRATEGY PLAN

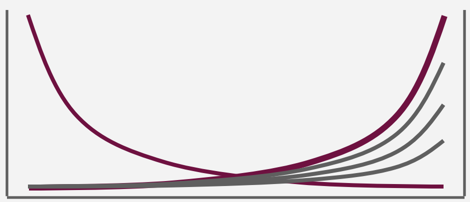
CRITICAL TO-TREES



KEY PERFORMANCE INDICATORS



QUALITY COSTS



CUSTOMER SATISFACTION ANALYSIS

Breakthrough performance

- There have been numerous efforts to create simpler and less intensive improvement methods. Most of them failed to deliver the results. The Six Sigma DMAIC Improvement Model has gained wide acceptance and is the most widely used. Six Sigma: Breakthrough to in-Process Effectiveness. It follows these basic steps:
    i. **Select** the problem and launch a project.
    ii. **Define** the problem.
    iii. **Measure** the magnitude of the symptoms.
    iv. **Analyze** information to discover the root cause(s).
    v. **Improve** by providing a remedy for the cause(s).
    vi. **Control** to hold the gains.

Select the opportunity

- Select: Deliverables
  i. List of potential projects
  ii. ROI and contribution to strategic business objective(s) for each potential project
  iii. Evaluation of projects
  iv. Selected projects
  v. Project problem, goal statements, and a team charter for each project
  vi. Formal project team(s)

- Select: Questions to Be Answered
  i. What customer-related issues confront us?
  ii. What mysterious, costly quality problems do we have that should be solved?
  iii. What are the likely benefits to be reaped by solving each of these problems?
  iv. Which of problems deserves to be tackled first, second, etc.?
  v. What formal problem statement and goal statement should we assign to each project team?
  vi. Who should be the project team members and leader (Black Belt) for each project?

DMAIC cycle

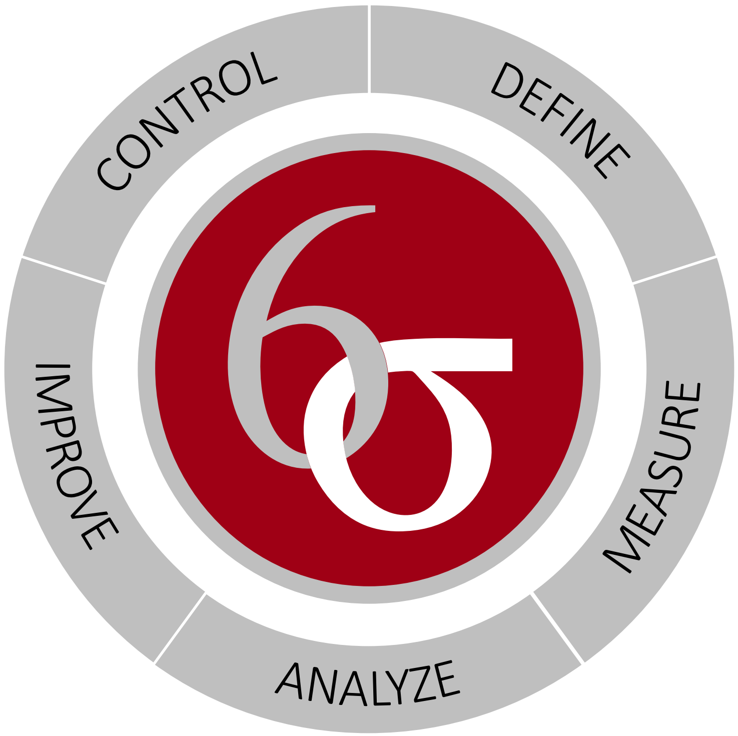
DMAIC-Cycle to Measure Current Projects and Their Sustainable Improvement

IMPROVEMENT AND SUSTAINMENT

Implementation of solution approach, monitoring, controlling and documenting

WHAT IS THE PROBLEM

Problem description and definition of project objective; initiation of project and planning of milestones



SOLUTION

Selection of solution alternatives and implementation of a strategy to reach goals

SEVERITY OF THE PROBLEM

Determination of causes for actual problems and cause variables, quality, data and facts

REASONS

Processing of the results and problem analysis

Define phase

The define phase completes the project definition begun with the charter developed during selection. The team confirms the problem, goal, and scope of the project. The completed definition includes the following:

1. Identify key customers related to the project
2. Determine customer needs with respect to the project in the voice of the customer (VOC)
3. Translate the VOC into CTQ requirement statements
4. Define a high-level process flow to define the project limits

DEFINE: DELIVERABLES

- Confirmed project charter
- Voice of the customer
- CTQ statements
- A high-level flow, usually in the form of a supplier-input-process-output-customer (SIPOC) diagram

DEFINE: QUESTIONS TO BE ANSWERED

- Exactly what is the problem, in measurable terms?
- What is the team's measurable goal?
- What are the limits of the project? What is in and what is out of scope?
- What resources are available—team members, time, finances—to accomplish the project?
- Who are the customers related to this project?
- What are their needs and how do we measure them in practical terms?

Measure phase

The project team begins process characterization by measuring **baseline performance** (and problems) and **documenting the process** as follows:

1. Understand and map the process in detail
2. Measure baseline performance
3. Map and measure the process creating the problem
4. Plan for data collection
5. Measure key product characteristics (outputs; Ys) and process parameters (inputs; Xs)
6. Measure key customer requirements (CTQs)
7. Measure potential failure modes
8. Measure the capability of the measurement system
9. Measure the short-term capability of the process

Measure phase

- **Measure: Deliverables**
  - Baseline performance metrics describing outputs (Ys)
  - Process flow diagram; key process input variables; key process output variables; cause-effect diagram; potential failure mode and effect analysis (FMEA) (to get clues to possible causes [Xs] of the defective outputs [Ys])
  - Data collection plan, including sampling plan
  - Gage reproducibility and repeatability or attribute measurement system analysis (to measure the capability of the measurement system itself)
  - Capability measurement in terms of defect rates, capability indexes, and/or Sigma levels
  - Confirmed or modified project goal
  - Prioritized list of theories of cause based on cause-effect analysis, FMEA, or similar tools

- **Measure: Questions to Be Answered**
  - How well is the current process performing with respect to the specific Ys (outputs) identified to Pareto analyses?
  - What data do we need to obtain in order to assess the capability of (a) the measurement system(s) and (b) the production process(es)?
  - What is the capability of the measurement system(s)?
  - Is the process in statistical control?
  - What is the capability of the process(es)?
  - Does the project goal need to be modified?
  - What are all the possible root causes for the problem?

Analyze phase

In the analyze phase, the project team analyzes past and current performance data. Key information questions are answered through this analysis. Hypotheses on possible cause-effect relationships are developed and tested.

Appropriate statistical tools and techniques are used: histograms, box plots, other exploratory graphical analysis, correlation and regression, hypothesis testing, contingency tables, analysis of variance (ANOVA), and other graphical and statistical tests may be used. In this way, the team confirms the determinants of process performance (i.e., the key or "vital few" inputs that affect response variable[s] of interest are identified). It is possible that the team may not have to carry out designed experiments (DOEs) in the next (Improve) phase if the exact cause-effect relationships can be established by analyzing past and current performance data.

- Procedure to analyze response variables (outputs, Ys) and input variables (Xs):
  - Perform graphical analysis using tools such as histograms, box plots, and Pareto analysis.
  - Visually narrow the list of important categorically discrete input variables (Xs).
  - Learn the effects of categorically discrete inputs (Xs) on variable outputs (Ys) and display the effects graphically.
  - Perform correlation and regression to narrow the list of important continuous input variables (Xs) specifically to learn the "strength of association" between a specific variable input (Xs) and a specific variable output (Ys).
  - Calculate confidence intervals
  - Perform hypothesis testing

Analyze phase

- **Analyze: Deliverables**
  - Histograms, box plots, scatter diagrams, Pareto analysis, correlation and regression analyses (to analyze relationships between response variables [Ys] and potential causes [Xs])
  - Results of hypothesis testing (to establish relationships between response variables [Ys] and input variables [Xs])
  - List of vital few process inputs (Xs) that are proven root causes of the observed problem

- **Analyze: Questions to Be Answered**
  - What patterns, if any, are demonstrated by current process outputs (Ys) of interest to the project team?
    - Analyze response variables (outputs; Ys).
    - Analyze input variables (Xs).
    - Analyze relationships between specific Ys and Xs, identifying cause-effect relationships.
  - What are the key determinants of process performance (vital few Xs)?
  - What process inputs (Xs) seem to determine each of the outputs (Ys)?
  - What are the vital few Xs on which the project team should focus?

Improve phase

In the improve phase, the project team seeks to **quantify the cause-effect relationship** (mathematical relationship between input variables and the response variable of interest) so that **process performance can be predicted, improved, and optimized**. The team may utilize DOEs if applicable to the particular project. Screening experiments (fractional factorial designs) are used to identify the critical or “vital few” causes or determinants. A mathematical model of process performance is then established using 2k factorial experiments. If necessary, full factorial experiments are carried out. The operational range of input or process parameter settings is then determined. The team can further fine-tune or optimize process performance by using such techniques as response surface methods (RSM) and evolutionary operation (EVOP).

- Procedures to define, design, and implement improvements include
    1. Plan designed experiments
    2. Conduct screening experiments to identify the critical, vital few process determinants (Xs)
    3. Conduct designed experiments to establish a mathematic model of process performance
    4. Optimize process performance
    5. Evaluate alternative improvements
    6. Design the improvement

Improve phase

- **Improve: Deliverables**
  - Plan for designed experiments
  - Reduced list of vital few inputs (Xs)
  - Mathematical prediction model(s)
  - Established process parameter settings
  - Designed improvements
  - Implementation plan
  - Plans to deal with cultural resistance

- **Improve: Questions to Be Answered**
  - What specific experiments should be conducted to arrive ultimately at the discovery of what the optional process parameter settings should be?
  - What are the vital few inputs (Xs, narrowed down still further by experimentation) that have the greatest impact on the outputs (Ys) of interest?
  - What is the mathematical model that describes and predicts relationships between specific Xs and Ys?
  - What are the ideal (optimal) process parameter settings for the process to produce output(s) at Six Sigma levels?
  - Have improvements been considered and selected that will address each of the vital few Xs proven during the analyze phase?
  - Has expected cultural resistance to change been evaluated and plans made to overcome it?
  - Has a pilot plan been developed and executed and the solutions appropriately adjusted based on the results?
  - Have all solutions been fully implemented along with required training, procedural changes, and revisions to tools and processes?

Control phase

The project team designs and documents the necessary controls to ensure that gains from the improvement effort can be sustained once the changes are implemented. Sound quality principles and techniques are used, including the concepts of self-control and dominance, the feedback loop, mistake proofing, and statistical process control. Process documentations are updated (e.g., the failure mode and effects analysis), and process control plans are developed. Standard operating procedures (SOP) and work instructions are revised accordingly. The measurement system is validated, and the improved process capability is established. Implementation is monitored, and process performance is audited over a period to ensure that the gains are held. The project team reports the goal accomplished to management, and upon approval, turns the process totally over to the operating forces and disbands.

- The activities required to complete the control step include
  1. Design controls and document the improved process
  2. Design for culture
  3. Validate the measurement system
  4. Establish the process capability
  5. Implement and monitor

Control phase

- **Control: Deliverables**
  - Updated FMEA, process control plans, and standard operating procedures
  - Validated capable measurement system(s)
  - Production process in statistical control and able to get as close to Six Sigma levels as is optimally achievable, at a minimum accomplishing the project goal
  - Updated project documentation, final project reports, and periodic audits to monitor success and hold the gains

- **Control: Questions to Be Answered**
  - What should be the plan to ensure the process remains in statistical control and produces defects only at or near Six Sigma levels?
  - Is our measurement system capable of providing accurate and precise data with which to manage the process?
  - Is our new process capable of meeting the established process performance goal?
  - How do we ensure that all people who have a role in the process are in a state of self-control (have all the means to be successful on the job)?
  - What standard procedures should be in place, and followed, to hold the gains?

Summary

- The quality improvement process addresses **chronic quality problems**
- The six sigma sequence and the breakthrough sequence are **strategic approaches** to improvement
  - Strategic because the projects selected are based on gaps between actual performance and goals
  - The two approaches are complementary in both objective and content
- The **six sigma steps** are define, measure, analyze, improve, and control
- The **breakthrough steps** are
  - proving the need,
  - identifying projects,
  - organizing project teams,
  - verifying the project need and mission,
  - diagnosing the causes,
  - providing a remedy and proving its effectiveness,
  - dealing with resistance to change, and
  - instituting control to hold the gains
- Understand what the **activities**, **deliverables** and **'questions to be answered'** of each phase are and the **tools** that are available to assist during each phase

Others?

- TQM
- Business process reengineering
- Continuous Improvement
- Creative problem solving
- Lean (TPS)
- Systems Engineering
- Six Sigma
- ...and more
- TOC

?

How to implement change

- Consideration of maturity of the system / culture
  - Adaptive learning capability

- Slowly
  - To allow adaptation
    - Don't shock the system
    - Pilot efforts

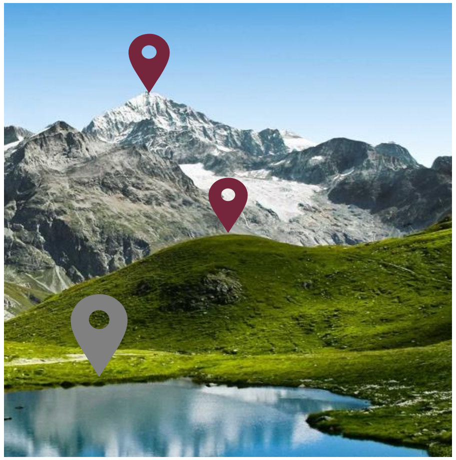
- Resistance to change

Why, what and how

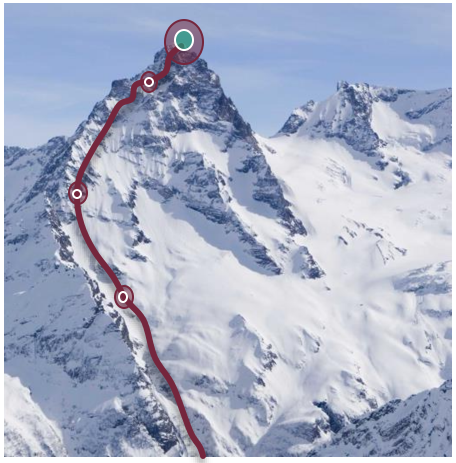
WHY?	WHAT?	HOW?
The need for change	What are we trying to do (our strategy)? (Effectiveness vs. efficiency)	How to address the problems?
The vision	What are we dealing with? (Types of problems)	How to implement change?

Why, what and how

AIM



OBJECTIVES



ROADMAP / METHODOLOGY

END GOAL

AND KEEP IN MIND:

- ✓ THINGS CAN (AND THEY WILL) CHANGE
- ✓ THERE IS MORE THAN ONE WAY