SIX SIGMA GREEN BELT

Six Sigma Green Belt
Part 6

Six Sigma

Six Sigma Defined

- Six Sigma (σ) is a customer focused, well defined problem solving methodology supported by a handful of powerful analytical tools.
- Continuous improvement is driven by the execution of carefully selected projects. The goal of the Six Sigma approach is to take small steps forward and no steps backward.

The Six Sigma Evolutionary Timeline

1736: French mathematician Abraham de Moivre publishes an article introducing the normal curve.

1818: Gauss uses the normal curve to explore the mathematics of error analysis for measurement, probability analysis, and hypothesis testing.

1941: Alex Osborn, head of BBDO Advertising, fathers a widely-adopted set of rules for "brainstorming".

1949: U. S. DOD issues Military Procedure MIL-P-1629, *Procedures for Performing a Failure Mode Effects and Criticality Analysis*.

1896: Italian sociologist Vilfredo Alfredo Pareto introduces the 80/20 rule and the Pareto distribution in *Cours d'Economie Politique*.

1960: Kaoru Ishikawa introduces his now famous cause-and-effect diagram.

1924: Walter A. Shewhart introduces the control chart and the distinction of special vs. common cause variation as contributors to process problems.

1970s: Dr. Noriaki Kano introduces his two-dimensional quality model and the three types of quality.

1986: Bill Smith, a senior engineer and scientist introduces the concept of Six Sigma at Motorola

MOTOROLA

AlliedSignal

1994: Larry Bossidy launches Six Sigma at Allied Signal.

1995: Jack Welch launches Six Sigma at GE.

GE

From the GE Web Site

- Understand who your customers are
- Understand what you provide for them

Customers are the center of GE's universe: they define quality. They expect performance, reliability, competitive prices, on-time delivery, service, clear and correct transaction processing and more. In every attribute that influences customer perception, we know that just being good is not enough. Delighting our customers is a necessity. Because if we don't do it, someone else will!

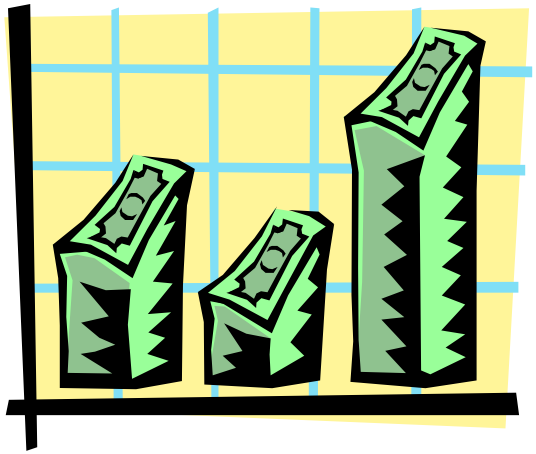
What Distinguishes Six Sigma from the Other Quality Improvement Methods?

a. The use of Greek in its name
b. Better marketing
c. The use of statistics
d. Justifying improvements in the language of management

Does the name Mikel Harry ring a bell?

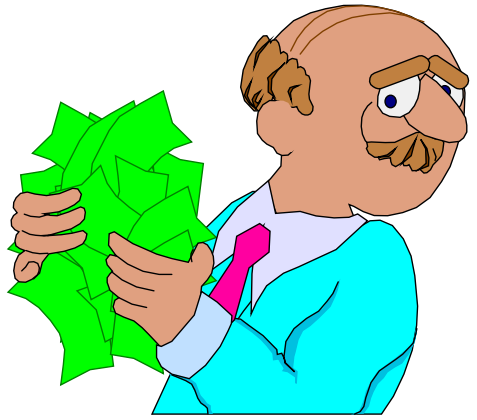
Savings

- A jet engine distributor added approximately $1 million in annual revenue.
- A hospital increased captured revenue by over half a million annually and save over $300,000 yearly by reducing no show and cancellation rates for procedures.
- A soft drink company decreased time for Engineering Change Notice from 56 days to 7 days



More Savings

- A hospital reduced the time required to provide timely information about lab tests and saved over $140,000 annually.
- A drug store chain reduced inventory of perishable pharmaceuticals by $173 million per year.
- A telecommunications company saved $5.2 million annually by improving the scheduling system for technician dispatches.



Six Sigma Structured Approach

- Six Sigma involves a series of steps designed to lead the organization through the gauntlet of process improvement. Major steps include:
  - Define
  - Measure
  - Analyze
  - Improve
  - Implement
  - Control (Standardize and Validate)

Memory Trip

- Can you remember back to your first science class and the scientific method?
- Are there any similarities between the scientific method and DMAIIC?

Define

The first step is to define. This includes setting the scope. It also includes the following:

- Identifying the process
- Identifying customers and what is important to them
- Determining the problem
- Determining the desired outcomes
- Determining what to measure
- Identifying what is critical to quality
- Determining how to measure what is critical

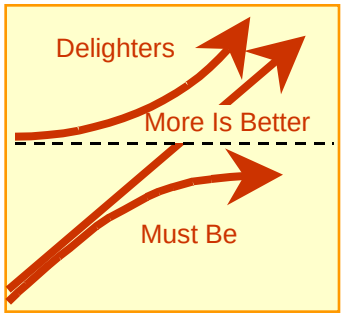
Tools sometimes used

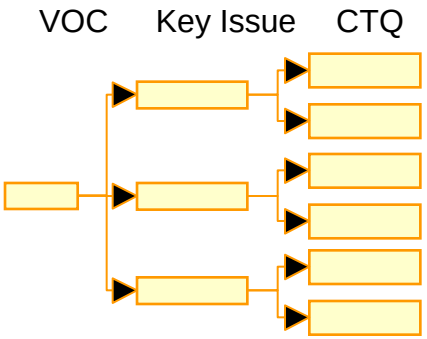
- Process Analysis
- Flow Charts/Check Sheets
- Pareto Analysis
- Fishbones
- FMEA (Failure Mode Effects Analysis)
- SIPOC Diagrams

Define

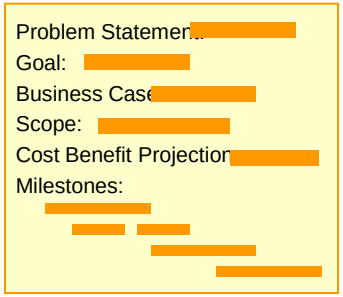
Business Case

Voice of the Customer

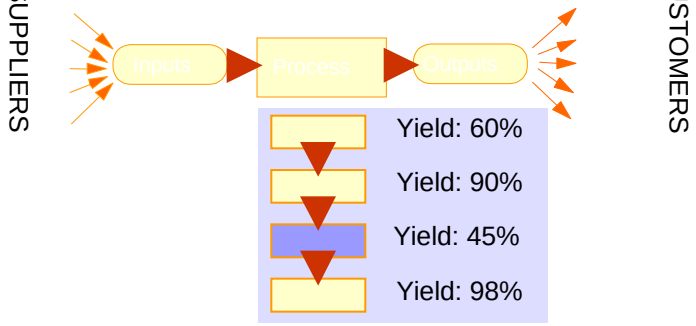




Project Charter



Initial Process Mapping



Measure

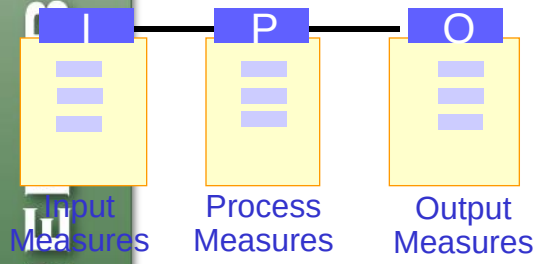
- The second step is to measure
  - Identify and verify critical quality characteristics
  - Estimate current capability
  - Determine where you are relative to desired objectives

Tools Used

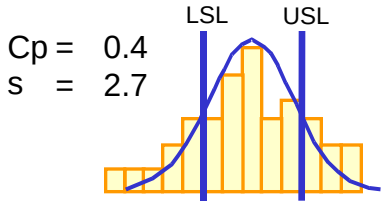
- Process Capability
  - Percent Nonconforming
  - Capability Indices
- Measurement Systems Analysis
  - Gage R&R
  - Operational Definitions
- Cost of Quality
  - Appraisal
  - Detection
  - Failure

Measure

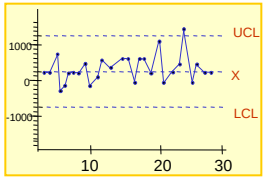
Identify the Metrics

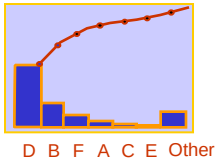


Identify Process Capability



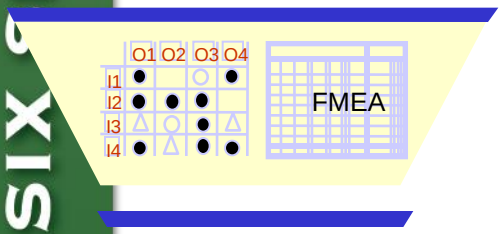
Display Data



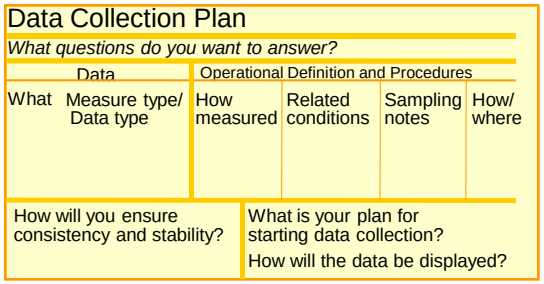


Measure the process

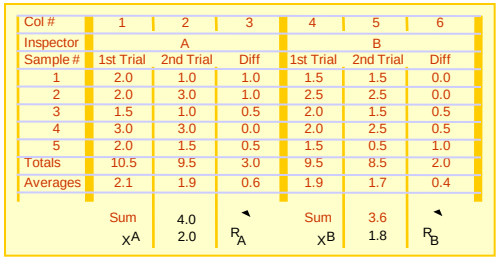
Prioritize the Metrics



Data Collection Plan



Validate Measurement Systems



Col #	1	2	3	4	5	6
Inspector	A			B		
Sample #	1st Trial	2nd Trial	Diff	1st Trial	2nd Trial	Diff
1	2.0	1.0	1.0	1.5	1.5	0.0
2	2.0	3.0	1.0	2.5	2.5	0.0
3	1.5	1.0	0.5	2.0	1.5	0.5
4	3.0	3.0	0.0	2.0	2.5	0.5
5	2.0	1.5	0.5	1.5	0.5	1.0
Totals	10.5	9.5	3.0	9.5	8.5	2.0
Averages	2.1	1.9	0.6	1.9	1.7	0.4
	Sum x^A	4.0 2.0	R_A	Sum x^B	3.6 1.8	R_B

Analyze

- The third step is to analyze. This makes sense out of the data that is collected during measure.
- This shows the areas and amount of improvement that might be possible to make the critical quality characteristic “best in class.”
  - Descriptive Statistics
  - Inferential Statistics
  - Probability

Analyze

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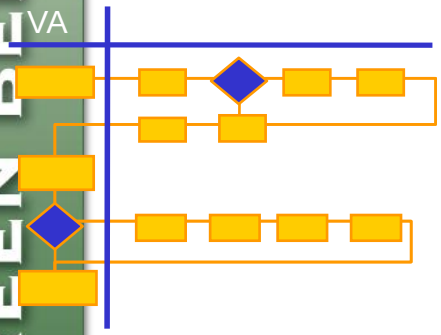
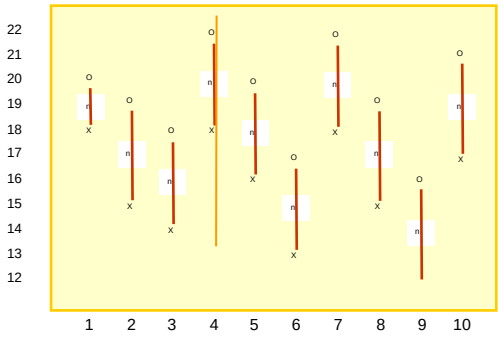
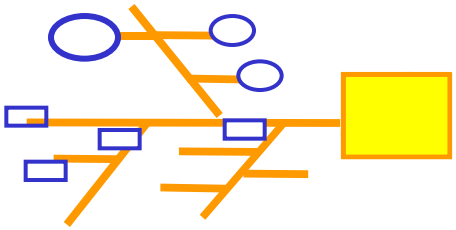
Process Door



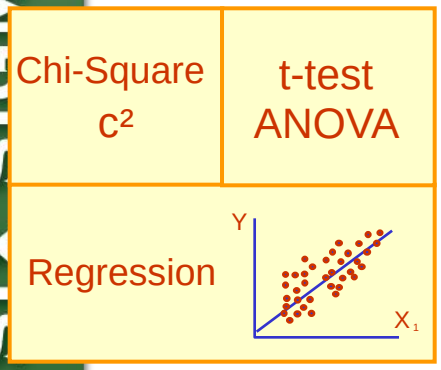
Data Door



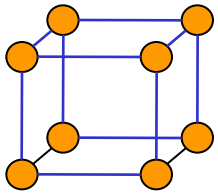
Cause & Effect



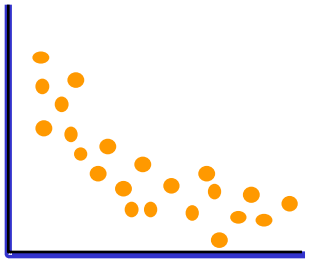
Hypothesis-Testing



Design of Experiments



Regression Analysis



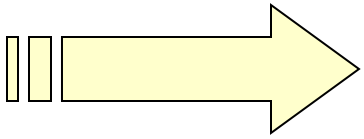
Improvement

In order to improve, possible improvements are developed and evaluated in a logical and planned fashion.

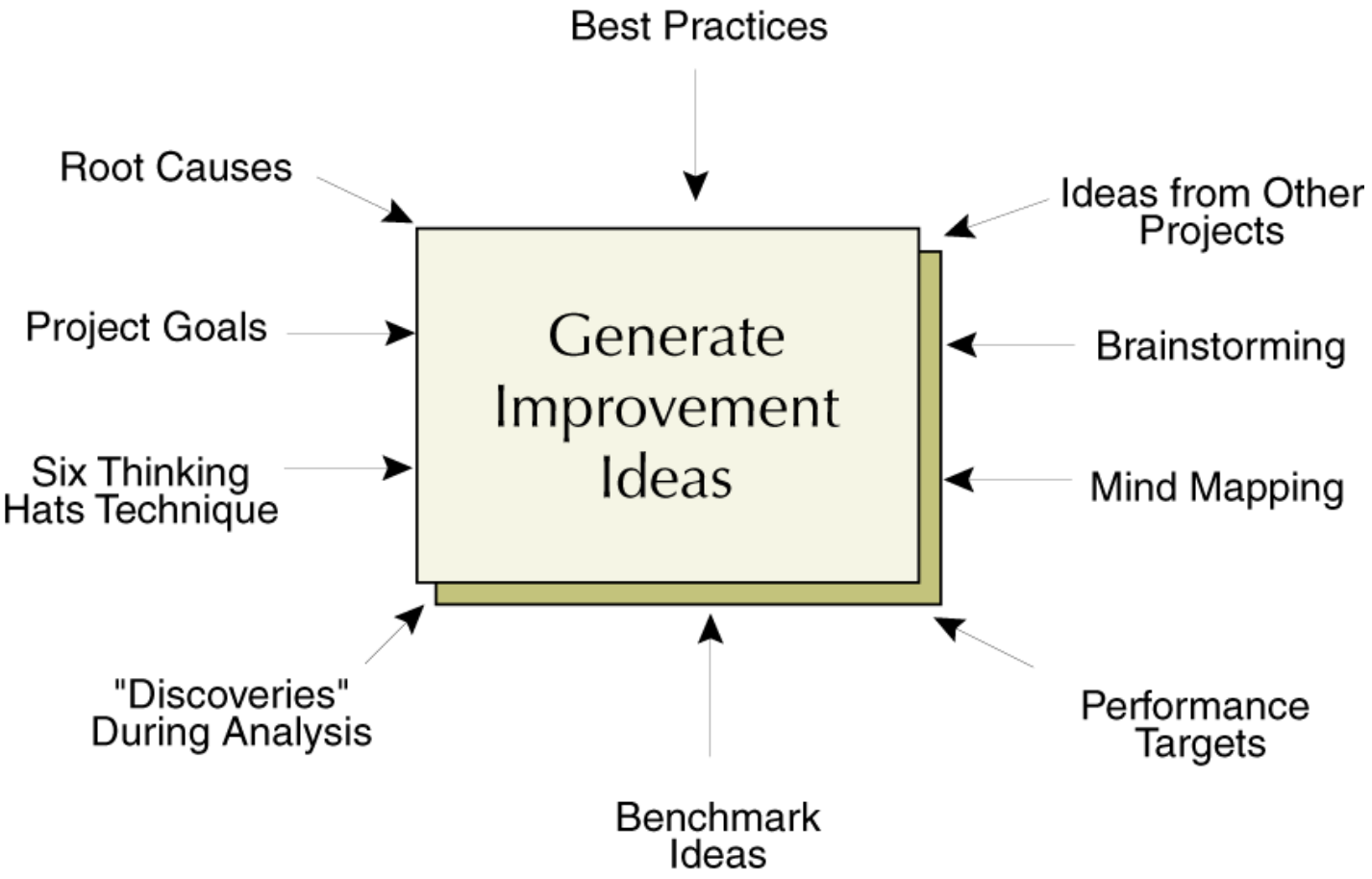
Improvement Tools

- Design of Experiments
  - ANOVA
  - Factorial
- Simulation
- Cost Justification
- Project Management
- Correlation
- Regression
  - Linear
  - Multivariate

Improvements come from



Sources of Improvements



Improve and Implement

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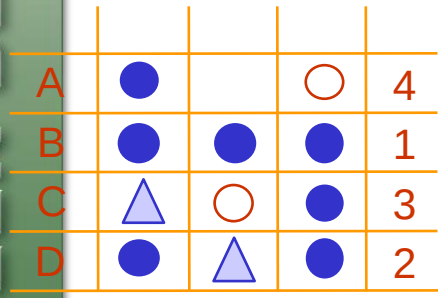
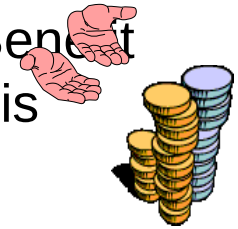
Generate Solutions

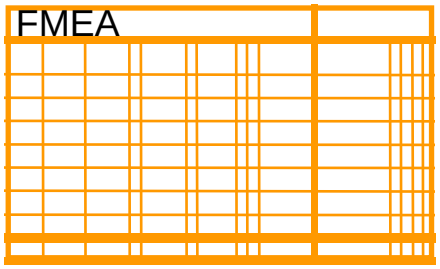


Perform Cost-Benefit Analysis

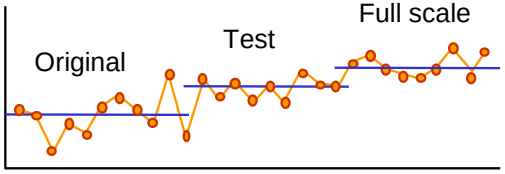


Select the Solution

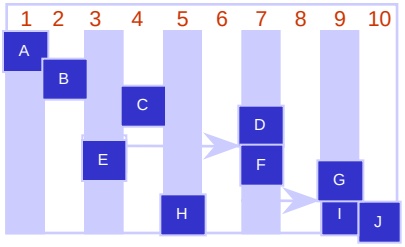
Assess Risks



Run Pilot



Plan Implementation



Implement

- Improvements are implemented in a logical and planned fashion
- A project plan is developed and managed

Control

- The final stage is control. In the control phase measures have been implemented and steps are taken to make sure improvements are maintained.
- Improvements are standardized and verified.
- Some Tools
  - Statistical Process Control
  - Cost Analysis
  - ISO 9000

Control

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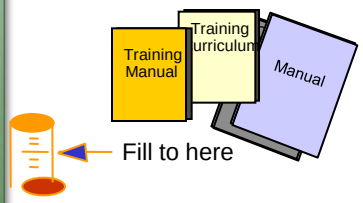
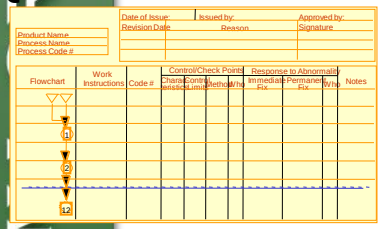
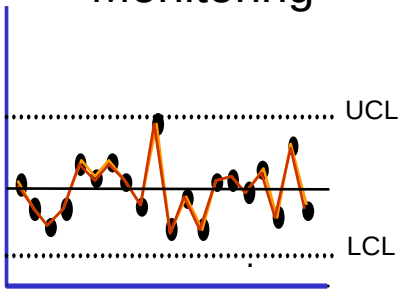
Document & Standardize



QC Process Chart

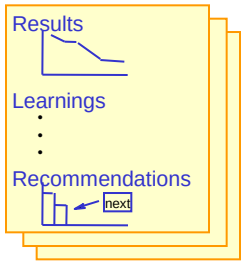


Ownership & Monitoring



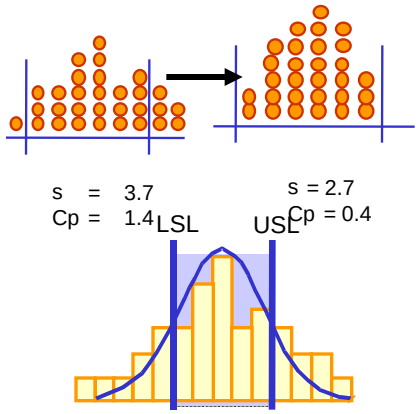
Process Owner

Key Learnings

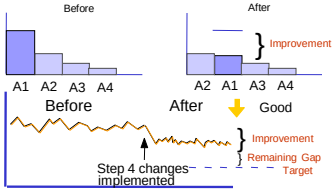


Closure

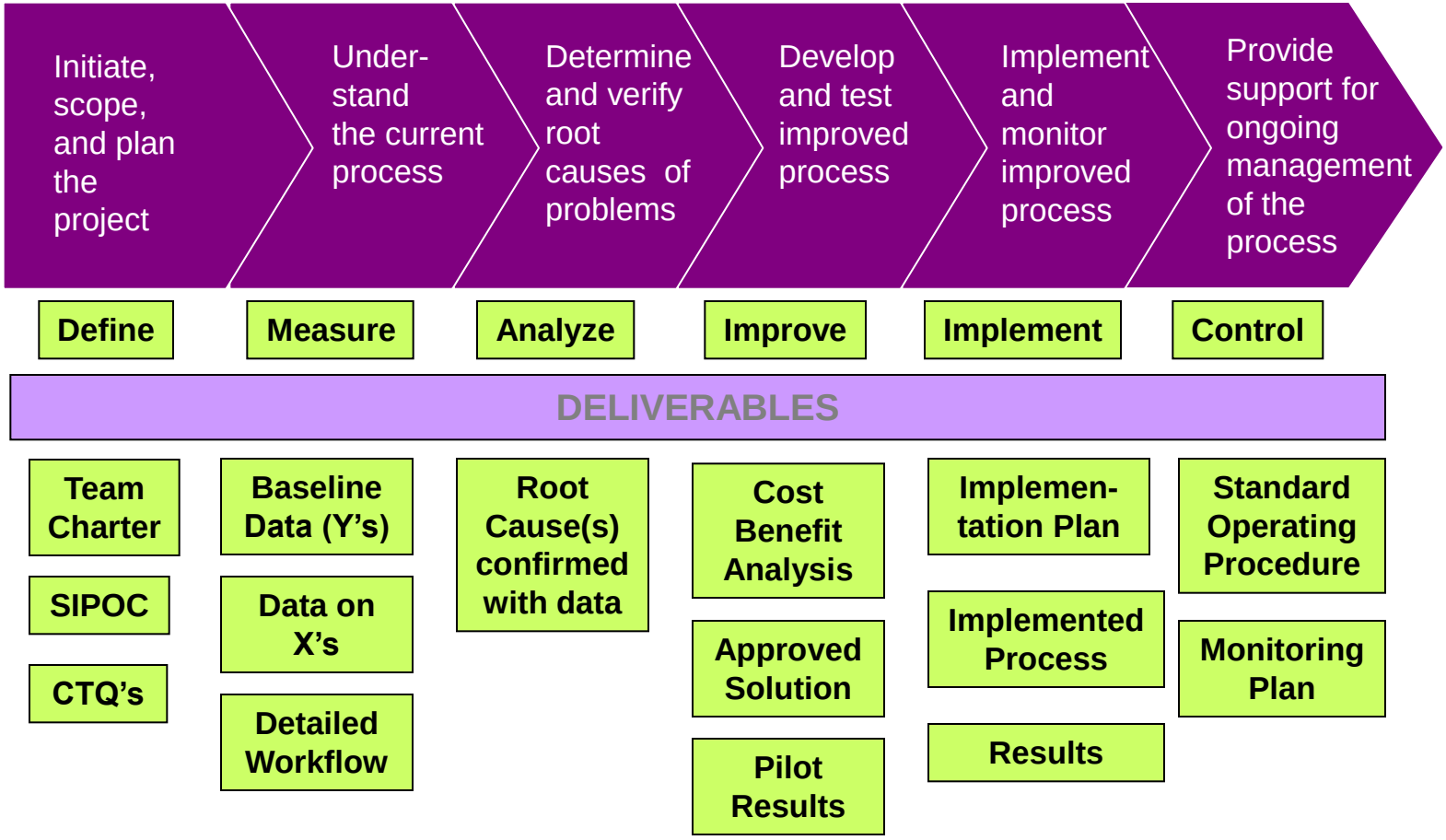
Evaluate Project Results



Process Change Management



The DMAIIC Methodology and Tools



Implementation Strategy

- Top Management Support and Participation
- Project Identification
- Resource Allocation
- Data Based Decision Making
- Measurement and Feedback

Implementation

The process of implementing Six Sigma must be a top down approach. Responsibility must lie with senior management. Senior management must drive the process through the organization. Elements of this include careful selection of projects, allocation of resources, and decisions based on the measurements.

- Senior leadership establishes its Six Sigma vision, customer satisfaction promise, goal, and new measurement indices
- This vision should fit within context of existing quality policy
- Establishes the common goal of reducing variability

Top Management Support / Participation

Leaders of successful Six Sigma implementations make it a top priority. They devote enormous amounts of thought, energy, time, and personal resources to making sure the Six Sigma succeeds.

In effect, they challenge employees.

"Would you tell me please which way I ought to go from here?" asked Alice. "That depends a good deal on where you want to get to," said the Cat. "I don't much care," said Alice. "Then it doesn't matter which way you go," said the Cat.

Develop Structure

Six Sigma has used the organizational titles:

- Steering Committee
- Champion
- Yellow Belt or White Belt
- Green Belt
- Black Belt
- Master Black Belt
- Master Black Belt Trainer
- Process owner

Steering Committee

- Identifies projects
- Identifies black belts
- Allocates resources
- Monitors progress
- Reviews effectiveness
- Establish implementation strategy and policies

Champions

- Key management personnel who provide support, resources, and encouragement for the process
- Champions require a more in-depth understanding of the methods used, especially the measurements and the interpretation of the process measurements

Green Belt

A green belt is an introductory participant in the process. Green belts understand concepts of problem solving, data collection, data interpretation, variation, process capability, and cost analysis.

Black Belt

- Black belts are “thoroughly” trained individuals expert (knowledgeable) in all the analysis tools
- Black belt training is typically structured around a project where the analysis tools are applied as part of the training

Black Belt

Black belts perform the following tasks:

- Teach
- Coach
- Transfer knowledge
- Identify opportunities
- Influence the organizational use of the Six Sigma methods

Black Belt

Week 1	Week 2	Week 3
Project Chartering	Progress Report	Progress Report
Descriptive Statistics	Sampling	Goodness of Fit Testing
Probability	Statistical Process Control	Project Management
Inferential Statistics	Short Run SPC	Team Processes
Reliability	Design of Experiments	FMEA
Regression and Correlation	Simulation	Cost of Quality
Computer Applications		Exam

Master Black Belt

- The master black belt has demonstrated proficiency by documenting saving in excess of a predetermined amount and showing competency in several areas such as:
  - Statistics
  - Coaching
  - Mentoring
  - Instructing
- Title is one given as recognition for outstanding performance or as the result of additional training, including train the trainer.

Process Owner

- A **process owner** is the individual who has the ultimate authority to change a process.
- The process owner should be identified for every project or task that is entered onto an organizational metric tracking system.
- The process owner:
  - Monitors the performance of his/her process through key indicators
  - Works with all Six Sigma project teams in the area to enable them to successfully complete their projects
  - Manages the process after completion to the Six Sigma project to sustain the gains made.
  - Continues to improve and/or innovate the process through the application of the PDCA cycle.

Six Sigma Project Characteristics

- Clearly connected to business priorities
- Linked to strategic and annual operating plans
- The projects is of major importance to the organization
- Represents a major process improvement in performance
- Represents major financial improvement
- Reasonable scope (3-6 months)
- Defines quantitative measures of success
- Baseline and goals are well defined
- Importance is clear to the organization
- Support and approval of management

Project Structure

- Major Projects led by black belts
- Project teams include stakeholders including finance (many of whom are Green Belts)
- Each project has a champion
- Initially 'outside' expertise (often called a subject matter expert) may be required to assist with the analysis
- Problem statement
- Quantifiable and measurable objectives Achievable
- Supportive of business requirements
- Addresses critical customer needs
- Tangible or Financial payback
  (e.g. reduction in the cost of poor quality)

DFSS – The Design Methodology

Design for Six Sigma

- Uses
  - Design new processes, products, and/or services from scratch
  - Replace old processes where improvement will not suffice
- Differences between DFSS and DMAIC
  - Projects typically longer than 4-6 months
  - Extensive definition of Customer Requirements (CTQs)
  - Heavy emphasis on benchmarking and simulation; less emphasis on baselining
- Key Tools
  - Multi-Generational Planning (MGP)
  - Quality Function Deployment (QFD)

Design For Six Sigma…defined

The *Concurrent Development and Introduction* of a new or radically redesigned product or service and all of the processes (Design, Procurement, Production, Logistics and Distribution, Service and Sales) that enable the product or service to achieve Six Sigma business performance.

A Phased Methodology which includes both the design tools and innovative tools for designing products (goods, information or services) and processes that generate customer value.

The phases are **D**efine, **M**easure, **A**nalyze, **D**esign, **V**erify

DMADV

What Is Design For Six Sigma (DFSS)?

- Customer-driven design of processes with 6σ capability.
- Predicting design quality up front.
- Top down requirements flowdown (CTQ flowdown) matched by capability flowup.
- Cross-functional integrated design involvement.
- Drives quality measurement and predictability improvement in early design phases.
- Utilizes process capabilities to make final design decisions.
- Monitors process variances to verify 6σ customer requirements are met.

Define customer requirements and goals for the process, product or service.

Measure and match performance to customer requirements.

Analyze and assess the design for the process, product or service.

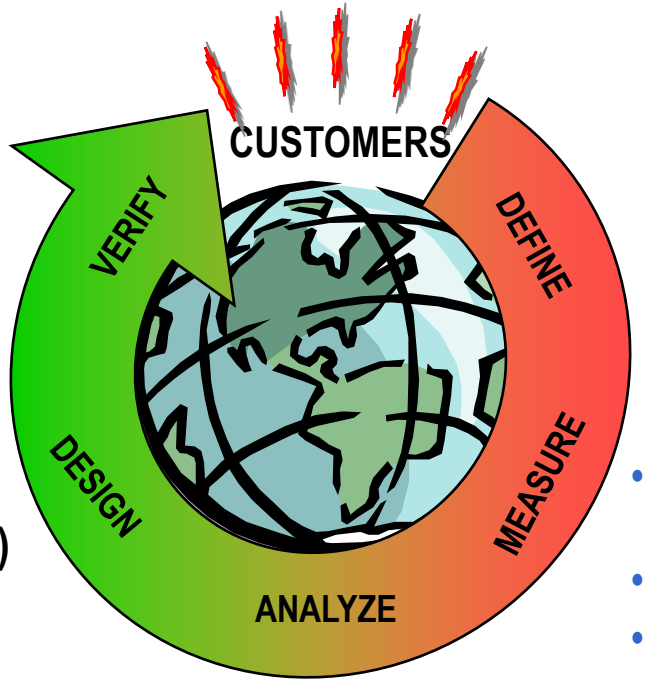
Design and implement the array of new processes required for the new process, product or service.

Verify results and maintain performance.

Customer to Customer Circle

DMADV is a closed loop that starts and ends with customers

- Track & Improve Field Performance



- Verify Product Performance
- Verify Process Performance

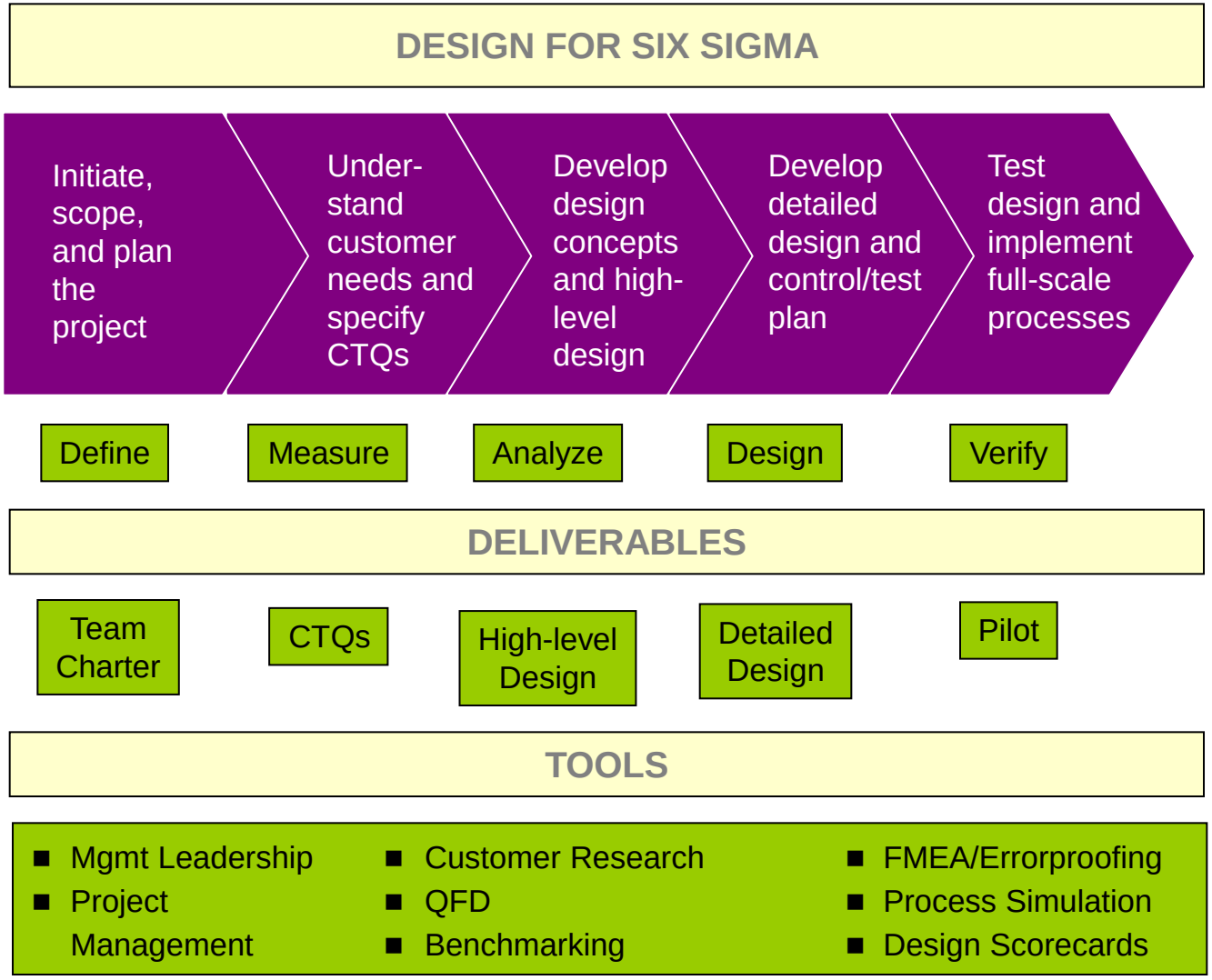
- Identify the business case for the project
- Create Project Charter
- Develop Project Plan
- Form Team

- Optimize the Product/Process Design for Robustness (Parameter Design)
- Optimize Tolerances (Tolerance Design)

- Define Customers (Internal & External)
- Define Customer Requirements
- Translate Customer Requirements into Engineering Requirements

- Generate & Evaluate Concepts (Conceptualization Phase)
- Select Concept (Concept Selection Phase)

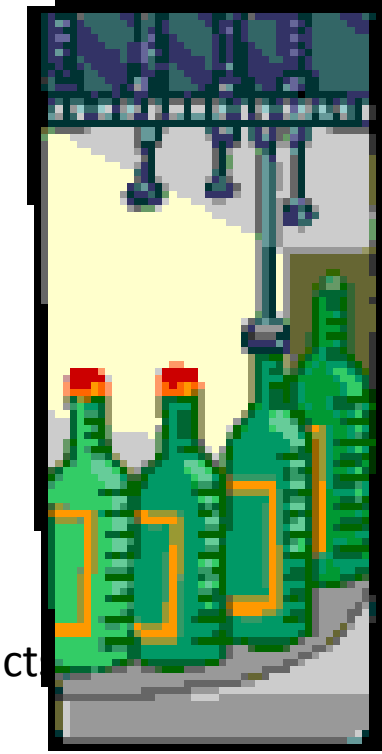
The DMADV Methodology and Tools



Lean (Toyota Production System)

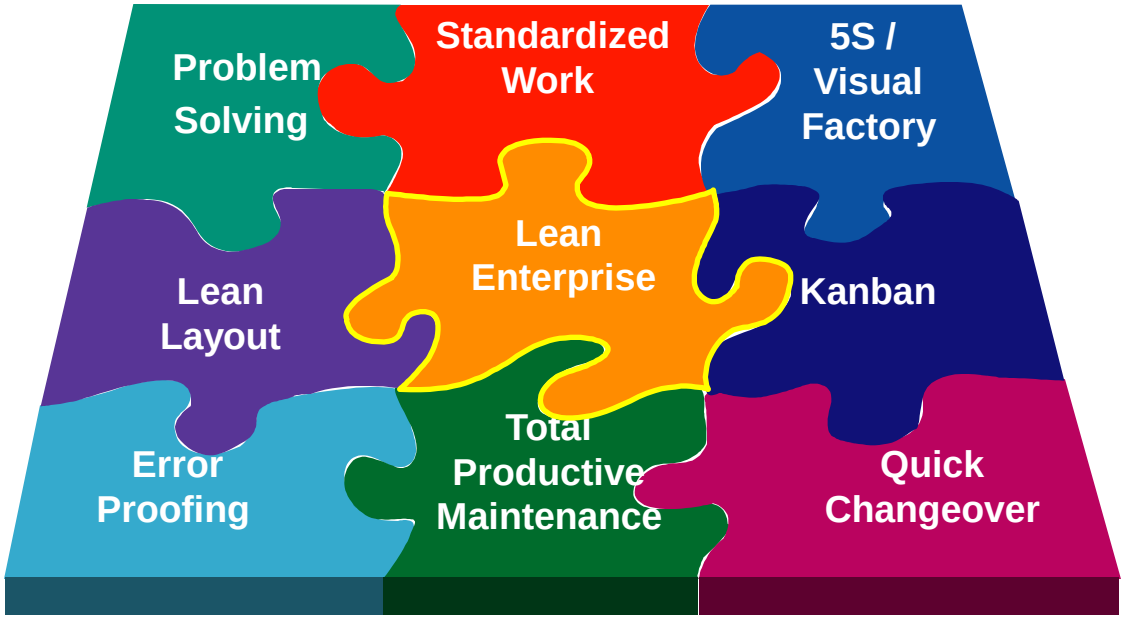
- Purpose: Reduce Waste
- Methodology:
  - Identify Customer Value
  - Draft Value Stream Map
  - Improve Stream
    - Remove Waste
    - Balance Workload
    - Flow the Process and Pull the Service/Product
- Effects:
  - Improved Delivery Time
  - Reduced Waste
  - Less Cost $$$

Lean Is . . . .

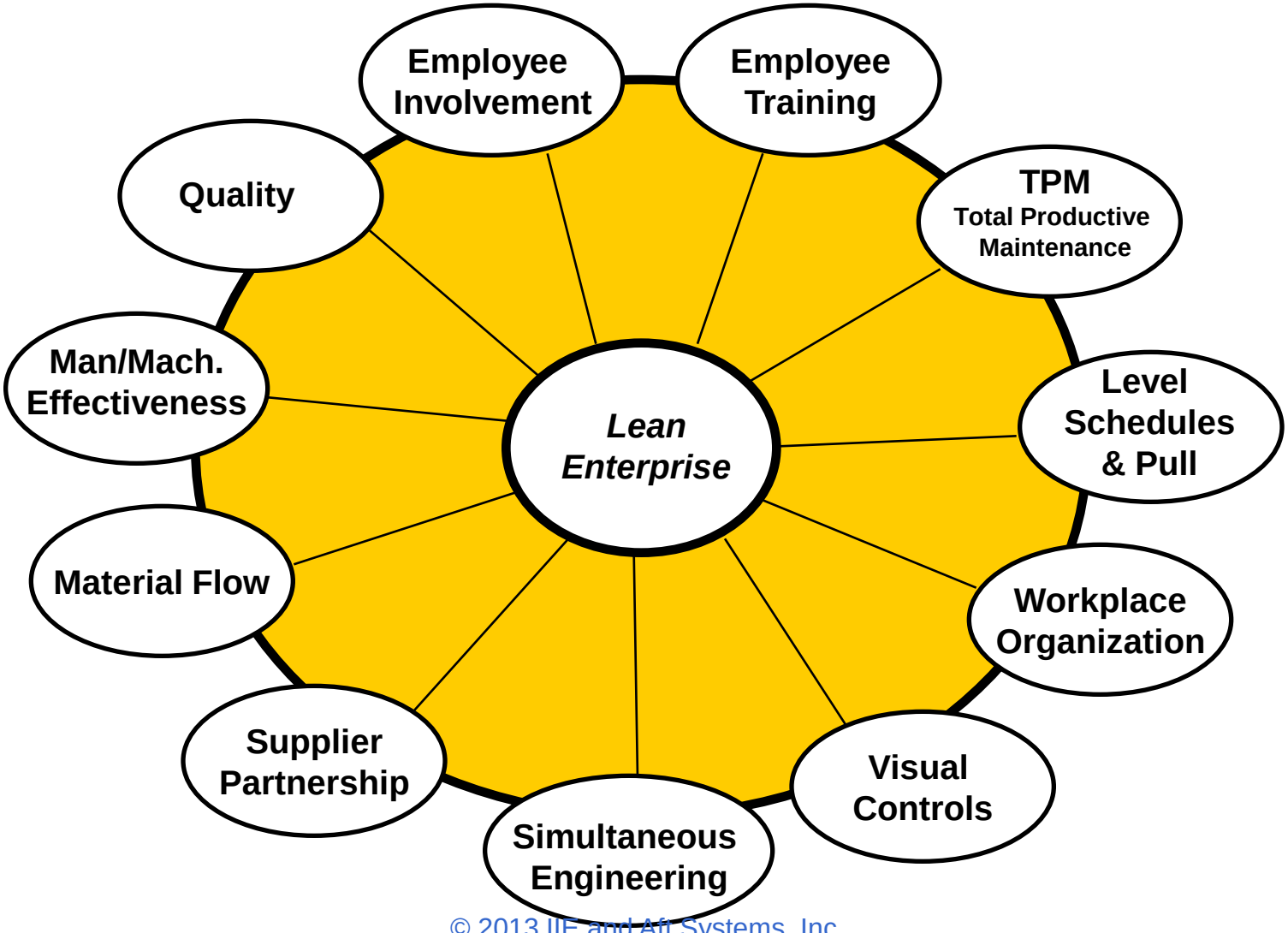


- According to . . .
  - Michael George
    - Lean is a process philosophy with three purposes
      - "To eliminate wasted time, effort, and material"
      - "To provide customers with make-to-order product
      - "To reduce cost while improving quality"
  - Henry Ford, 1926 (Ford Motor Company)
    - "One of the most noteworthy accomplishments in keeping the price of Ford products low is the gradual shortening of the production cycle. The longer an article is in the process of manufacture and the more it is moved about, the greater is the ultimate cost."

Lean Includes



Lean Enterprise Elements

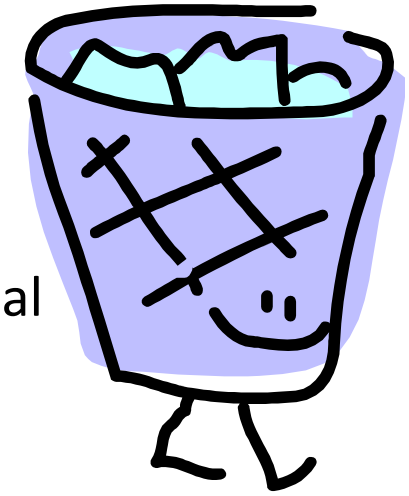


Elimination of Waste: Muda

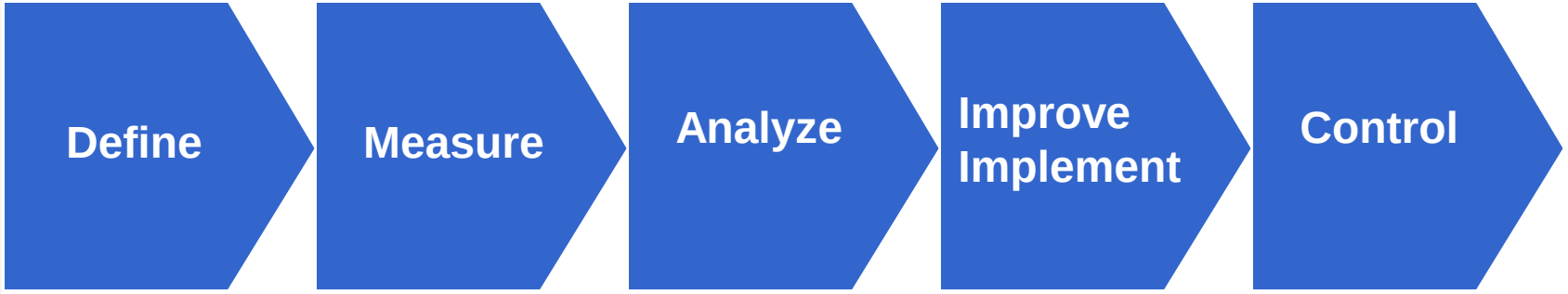
- A Japanese term for anything that is wasteful and doesn't add value.
- Waste reduction is an effective way to increase profitability.
- A process adds value by producing goods or providing a service.
- A process consumes resources.
- Waste occurs when more resources are consumed than are necessary to produce the goods or provide the service.

Muda

- The Seven Wastes
  - Overproduction
  - Inventory
  - Defects (Repair / Rejects / Rework / Correction)
  - Motion
  - Processing (Overprocessing)
  - Waiting
  - Transportation (Material Movement)
- Plus One More
  - Skill Abuse



Lean and Six Sigma Together



Define	Measure	Analyze	Improve Implement	Control
Benchmarking	Confidence	Affinity Diagram	DFSS	Control Charts
FMEA	MSA	Brainstorming	DOE	Control Plan
IPO Diagram	NGT	C&E Diagram	Kanban	Reaction Plan
Kano Model	Pairwise Ranking	F test, T test	Mistake Proofing	Run Charts
KB Management	Flow	Fault Tree Analysis	Standard Work	SOP
SIPOC	Capability	FMEA	Takt Time	
QFD	Time Value	Histogram	TOC	
VOC	VSM	Pareto	TPM	
Task Analysis	Waste Analysis	Regression	Work Cell Design	
VSM		Scatter	Visual Management	
		5 whys	5S	

Outside-In Thinking

Six Sigma requires us to look at our business from the **customer's perspective**, not ours. In other words, we must look at our processes from the outside-in. By understanding the transaction lifecycle from the customer's needs and processes, we can discover what they are seeing and feeling. With this knowledge, we can identify areas where we can add significant value or improvement from their perspective.

Data Based Decision Making

- Obtaining a return on your Six Sigma investment requires that you make use of the information you obtain.
- In successful Six Sigma organizations both strategic and operational decisions are guided by facts and data.
- EOE

Summary