INTERNATIONAL ACADEMY for QUALITY

Continual Process Improvement
Volumes 1, 2, and 3
Final Report
Designed Improvement Think Tank

GREGORY H. WATSON
LARS SÖRQVIST

2017

Final Report
Part 1: Organization
10 July 2017

International Academy for Quality

ENGINEERING THE PROCESS OF CONTINUAL IMPROVEMENT

Advancing Quality as Science: Improving Analytical Structure and Methods

Co-Editors: Gregory H. Watson and Lars Sörqvist

 1

1

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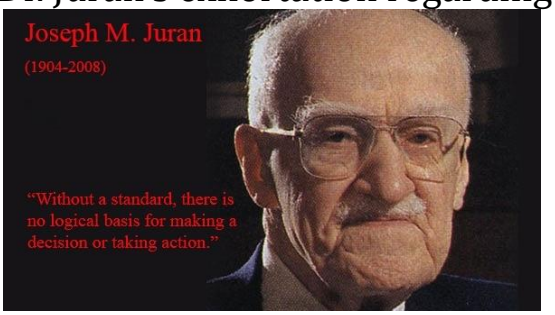
IMPROVING CONTINUAL IMPROVEMENT

 2

2

Dr. Juran's exhortation regarding Six Sigma:



- Joseph M. Juran challenge in May 2001: "Don't make the same mistakes with Six Sigma that ASQ made in development of Quality Engineering."
- Quality is not a brand entitlement; a brand's reputation must be diligently earned daily through coordinated, inclusive acts of all members of the organization and then validated by the external consumers regarding its marketplace deliverables.
- Without a standard … there can be no improvement!

 3

3

The Problem as Presented ….

EUROPEAN ORGANIZATION FOR QUALITY

- Request from EOQ in November 2014:

  Develop a formal certification program for Lean Six Sigma Green Belt, Black Belt and Master Black Belt qualifications under the EOQ Personnel Registration Unit program.

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The problem as perceived ….

- The initial problem was perceived as a lack of quality standard for Six Sigma which could be applied in the European community for professional development and certification of qualifications.
- At this time there was no European-wide accepted document that defined Lean Six Sigma or Six Sigma qualifications. Numerous consulting firms offered a wide variety of programs under the "banner" of a Six Sigma or Lean Six Sigma title, but there was little in the way of agreement among their training programs and approaches to qualification. Most of these were commercially motivated.

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The problem as understood ….

1. Proliferation of conflicting "standards and approaches" to the Six Sigma-related body of knowledge by America, Europe and China with new standards produced by ISO and a consortium of US-based consultants which result in differing positions on what these methods are and how to implement them.
2. The approaches recommended for deployment of Six Sigma are burdensome for SME application and major companies have customized these methods to fit their own needs which creates a concern for standard implementation among many resource-poor quality organizations in SME companies.
3. In addition to these Six Sigma-related methods several other methods compete for organizational improvement among a few "non-Six Sigma" based improvement methods: business process reengineering, activity-based costing, and also lean enterprise management.

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6

Preliminary investigation conducted ….

NATURE OF INQUIRY:

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- The first step was to conduct a survey and document the "state of the art" – approximately 284 Mbytes of files describing the related "body of knowledge."
- Benchmarking studies were conducted of the way to implement these methods by American and European companies and the approaches taken by all the major consulting companies and universities in teaching and presenting these Six Sigma-related methods.
- A detailed study of Japanese TQM methods was also undertaken for sake of comparison.

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The challenge accepted ….

PROJECT DESCRIPTION:

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- After an initial benchmarking analysis of European and globally-based Six Sigma initiatives it was determined that there was no accepted standard for Six Sigma or Lean Six Sigma.
- In addition conflict with improvement initiatives from IT, accounting and engineering was observed.
- IAQ Think Tank Mission: develop an inclusive, generic approach for continue improvement that operates in a cross-functional way for all organizations – especially SME's.

 8

8

IAQ Designed Improvement Think Tank:

IAQ CORE TEAM MEMBERS:

LAATUKESKUS
EXCELLENCE FINLAND

Program Manager:
Tani Järvinen, Companion, IAQ [Finland]

Think Tank Leaders:
Gregory H. Watson, Honorary Member, IAQ [Finland] – Chair
Lars Sörqvist, Academician, IAQ [Sweden] – Vice Chair

Team Members:

- Bjorn Andersen, Academician, IAQ [Norway]
- Pedro Saraiva, Academician, IAQ [Portugal]
- Paulo Sampaio, Academician, IAQ [Portugal]
- Jeroen De Mast, Associate Member, IAQ [Netherlands]
- Markku Nieminen, Associate Member, IAQ [Finland]
- Jiju Anthony, Past-Associate Member, IAQ [United Kingdom]

 9

9

PROPOSED SYSTEMS APPROACH: STRATEGY FOR DESIGNED IMPROVEMENT

 10

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How did we develop the "generic" mental models?

- Established a set of ground rules that would drive innovation in the approach:
  - No terminology for steps would be preserved from prior models
  - Correct problem areas perceived in prior models
  - Simple model with no more than seven steps
  - Each step must apply specific questions to advance knowledge
  - Methods and tools should be linked to the questions addressed
- Competence model must be based on a needs assessment that is done for a specific position description in an individual role.
- Models must be developed that integrate all aspects of the various approaches to structured problem solving or process improvement.

 11

11

Rules for developing a standard methodology:

- The recommended decision methodology must be backed by sound academic research, documented application in case study and be broadly applicable across industries.
- The number of steps should be limited but clearly convey both the sequence and meaning of the activities required to advance the improvement from concept to implementation.
- Each step should be named using terms that do not suggest any prior methodological options have been favored in structuring the consensus model.
- Textual descriptions of the logical step must identify intent in each step of the process without restricting or defining specific tools or competence that must be developed to accomplish this outcome.
- The methodologies for use in each step of the model should be linked to the questions to be addressed and the types of data available for analysis.
- Competence requirements for professional qualification must be based on a needs assessment in the application of the model using real-world case study to demonstrate the adequacy of the approach.

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The "generic" continual improvement mental model:

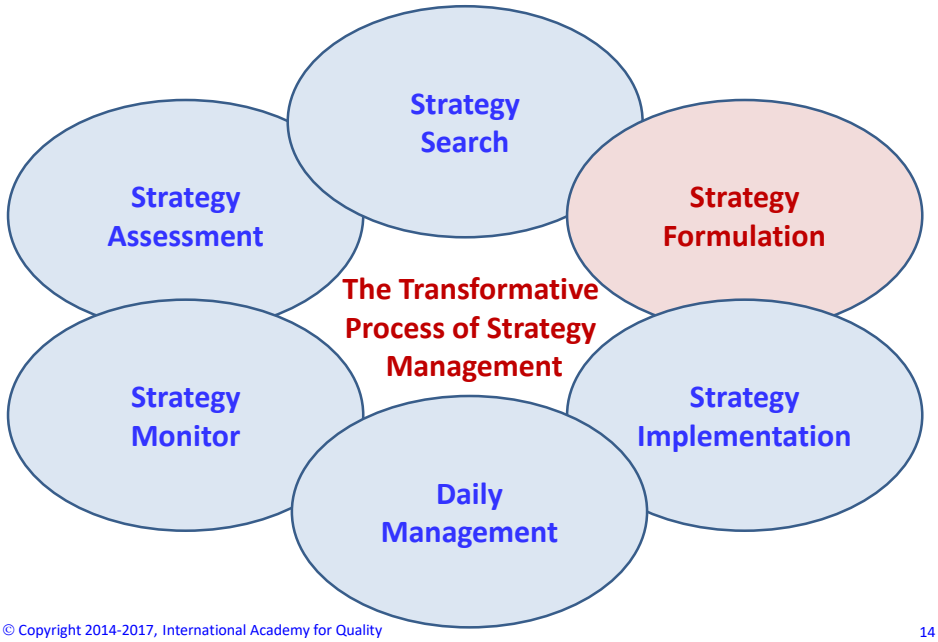
The proposed mental model addresses correction of some of the key deficiencies observed in other mental models for improvement:

- The front-end of the model must link to strategy formulation by the management team so it can be used to support a strategic change project initiated by management in response to strategic plans.
- The model's back-end must link to the daily management system to encourage implementation of change.
- The model must be flexible to permit within step change to respond to differing types of data and flexible lines of questioning.
- The model must integrate lessons learned from applying all decision methods and tools over the years and update legacy systems to be sure that the latest developments have been included as options in the model's application.
- Lessons learned from implementation of all prior mental models are to be consolidated and integrated in the architecture of the new structured improvement model.

 13

13

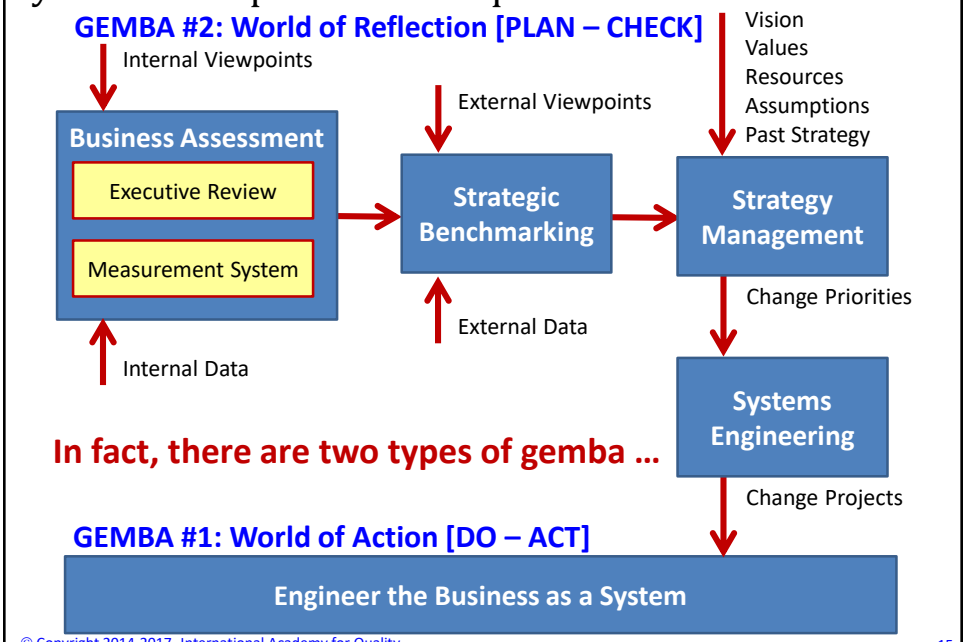
Strategic Management of Profound Knowledge:



 14

14

Systematic improvement requires collaborative work:



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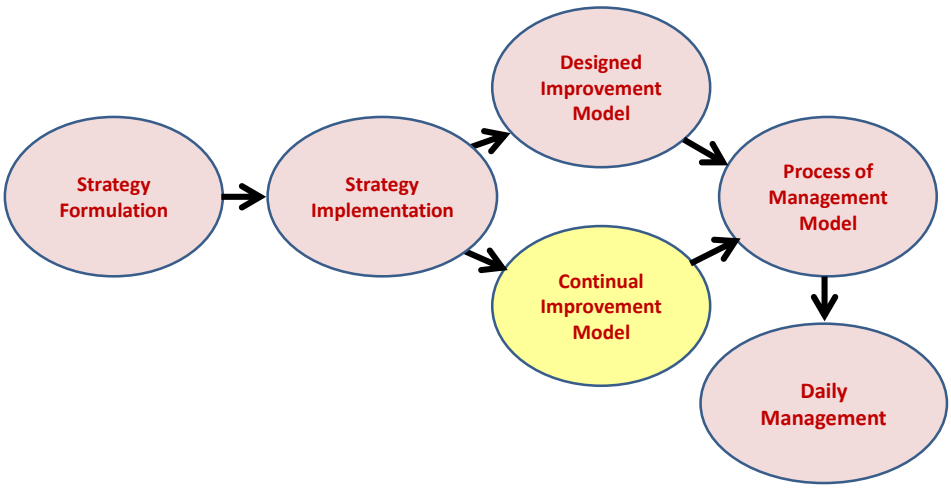
Converting strategic intent into actual results:

A thinking process to transform improvement strategies into existence and thereby generate value for society:

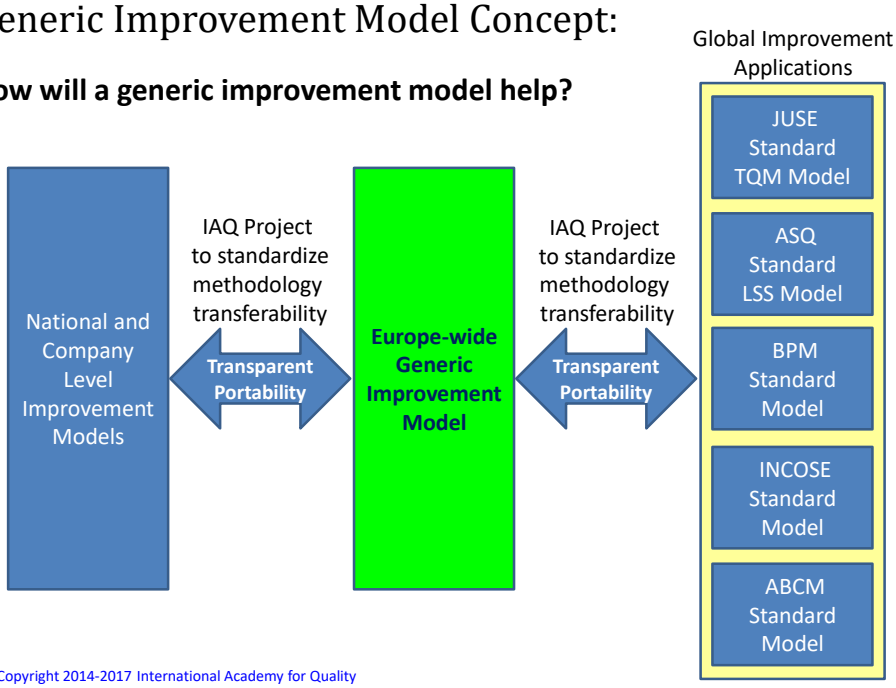


 16

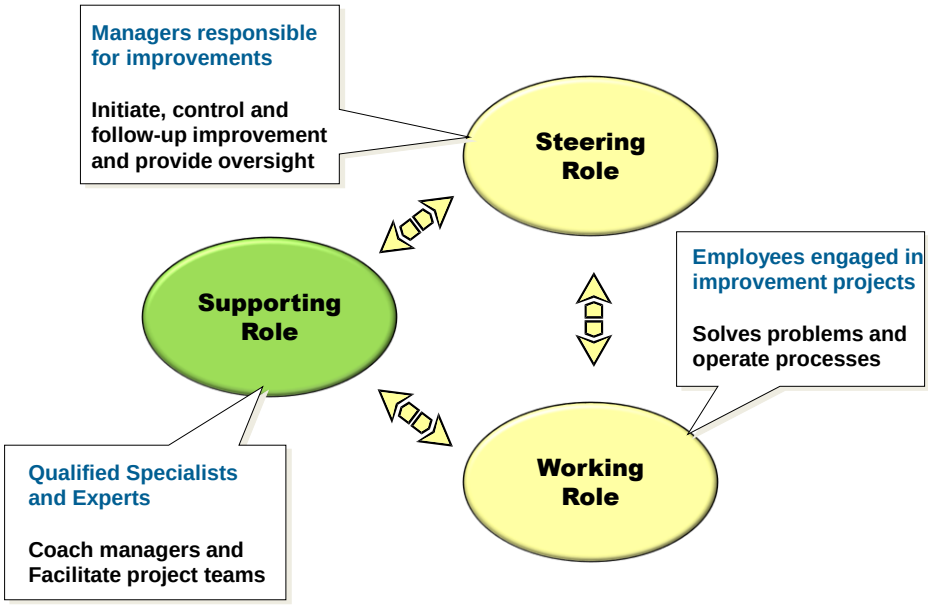
16

Generic Improvement Model Concept:

How will a generic improvement model help?



Role Infrastructure: Supporting roles are certifiable!



Role models for deployment of CIM by organizations:

How is CIM a UNIVERSAL improvement model that is useful for all levels and relevant to all types of improvement challenges?

CIM is a scalable: Analysis of different approaches to Continual Improvement shows that they all follow a similar type of three-tiered organizational structure:

- Employee Role: **Process Doer**/Worker – Operating/Executing – solves problems and take action for local improvement

  Emphasis is on "EMPLOYEESHIP" or being a good worker.
- Supporting/ Investigating Role: **Process Facilitator** – Steering – support managers and teams in effecting improvements

  CERTIFIABLE: Green Belt, Black Belt, Master Black Belt [COMPARATIVE]
- Decision Role: **Process Owner**/Manager – initiate, control and follow-up improvement work – sponsor for cross-functional or organizational issues and concerns.

  Emphasis is on "LEADERSHIP" or being a good executive

 19

19

Comparability of improvement roles & responsibilities:

- Skills and competence in supporting roles of the teams conducting an improvement project may be specified at three levels which are capable of using in a meaningful certification scheme.
- Competence models and certification schemes are applicable to the three levels of roles and responsibilities for managing improvement team activities:

Competence	Toyota	Lean	Six Sigma	BPM	JUSE		CIM Roles
Level 1 Doer	Supervisor	Bronze Coordinator	Green Belt	Worker	QC Circle Facilitator		Facilitator
Level 2 Facilitator	Engineer	Silver Leader	Black Belt	Analyst	Quality Engineer		Analyst
Level 3 Owner	Designer	Gold Expert	Master Black Belt	Consultant	Sr. Quality Engineer		Expert

 20

20

CIM deployment role concepts:

The three levels of competence required to support the use of the CIM approach to improvement in an organization can be described as follows:

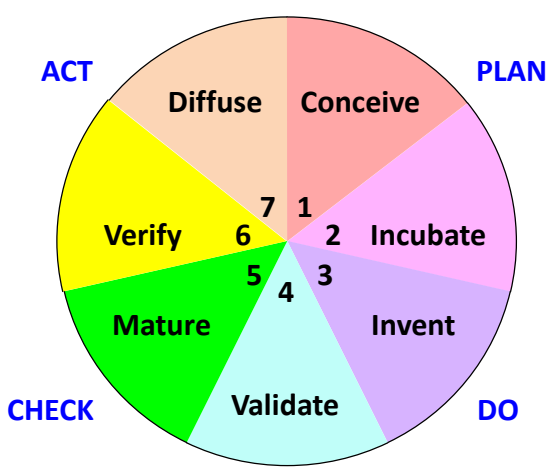
Skill Level	Team Role	Description of Activities and Responsibilities
Level 1	Facilitator	Equivalent to Lean Six Sigma Green Belt with the responsibility of facilitating workplace problems, conducting small experiments for improvement of work group performance and implementing lean solutions for improvement.
Level 2	Analyst	Equivalent to Lean Six Sigma Black Belt with the responsibility for conducting deeper analysis for improvement projects across the organization.
Level 3	Expert	Equivalent to Lean Six Sigma Master Black Belt who serves as the technical maestro for directing the improvement program.

 21

21

Designed Innovation Model (under consideration):

A thinking process to pull ideas into existence and generate value for society through improved ways of working:



 22

22

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PROPOSED STANDARD MODEL: LEAN PROCESS IMPROVEMENT

 23

23

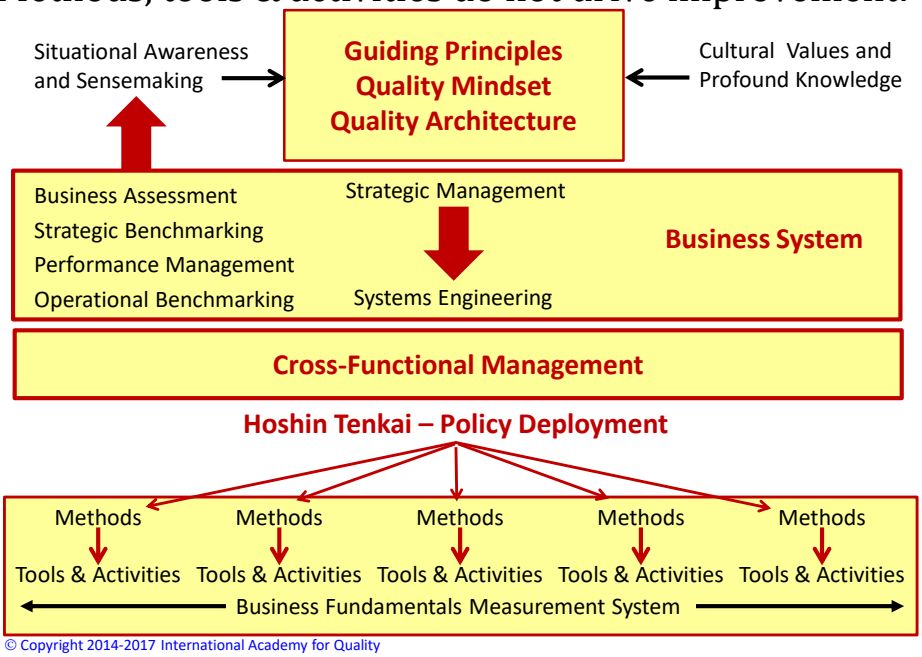
Initial problem: There is no mental model for lean!

- The Toyota Production System (TPS) has been conscientiously developed going back to 1896 by engineers at Toyota. This system has a management system for both cost and quality reduction that operate in parallel and use cycle time as a proxy measure for both of these improvement objectives.
- "Lean management" represents a modern interpretation of the Japanese approach to industrial improvement as interpreted by Western academics but it is not endorsed formally by the Toyota Company as representing its complete system of management.
- Examination of the documentation of lean reveals that it is just a collection of methods and tools without an integrating mental model that helps people apply it for systematic improvement.
- Lean management must be included in the systematic method for continual improvement. So the first step the Think Tank engaged in was categorization of lean methodology as a mental model.

 24

24

Methods, tools & activities do not drive improvement:



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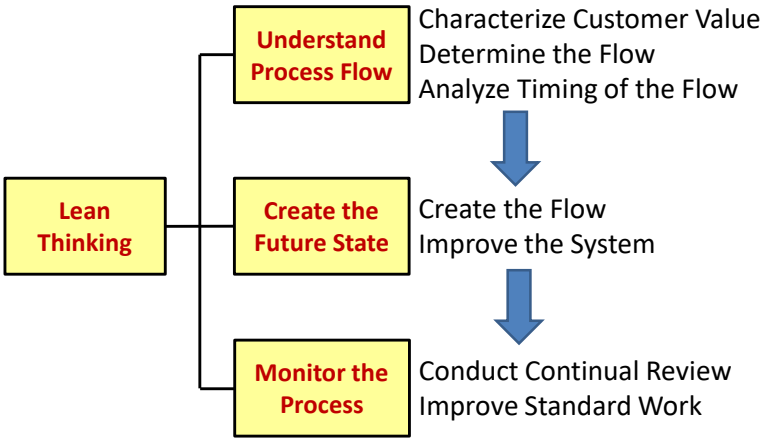
25

Lean Thinking Structure:

Issue: Lean Methods do not have a standard mental process model.
Team Action: Develop a mental model for application of lean thinking.



 26

26

Understanding Process Flow in Lean Management:

This initial step in the mental model of lean management is often the one that is missing or reduced in emphasis. This is the initial step of a 10-S process to understand current state performance.

Understand the Process Flow [Current State Analysis]		
Characterize Customer Value	**Determine the Flow**	**Analyze Timing of the Flow**
1-SIPOC Analysis	1-One-Piece Flow	1-Lean Process Measures
2-Customer Requirements Analysis	2-Seven Flows	2-Process Effectiveness Analysis
3-Muda-Mura-Muri	3-Spaghetti Map	3-Value Stream Map
4-Seven + Wastes	4-Six Losses	4-Rolled Throughput Yield
5-I-Chart of Process Results Analysis	5-Theory of Constraints	5-Analysis of Variance (ANOVA)
6-Takt Time	6-Five Why Analysis	6-Yamizumi Diagram
7-Fishbone Diagram/Mind Map	7-Five W's + 1 H Analysis	7-Inventory Buffer Analysis
8-Process Capability Analysis	8-Deployment Diagram	8-Process Bottleneck Analysis
9-Seven Zero's of Production	9-Gemba Walk / Hansei	9-Pareto Diagram
10-Makigami Diagram	10–Lean Process Audit	10-Radar Diagram

ISSUE: How have the organization assigned responsibility for quality to the participants in the work process flow? Has the process of *Hansei* been applied cross-functionally in the "Check" steps of PDCA and SDCA ?

 27

27

Implementing Lean Process Management Approach:

The lean "toolbox" of methods provides mechanisms by which to address waste. This is the visible part of lean operations and it is most often emphasized in lean improvement efforts.

Creating the Future State Process (Remedial Journey)	
Create the Flow	**Improve the System**
1-Increase Customer value	1-Standardize work (gensoku)
2-Eliminate waste	2-Establish housekeeping and improvement (10-S)
3-Design work to flow	3-Eliminate 3D's (dirty, dangerous and difficult)
4-Eliminate failures and mistakes	4- Mistake proof work process (Poka Yoke)
5-Create Continuous Flow (apply kanban)	5-Generate Alerting information (Visual Factory)
6- Balance work flow to takt time (heijunka)	6-Integrate man-machine tasks (Jidoka)
7-Implement Customer Demand Pull	7-Hanedashi, tebanare, and chaku-chaku production
8-Decrease lot size and use one-piece flow (Just-in-Time)	8-Plan for Every Part (PFEP) procurement process
9-Shorten changeover time (SMED)	9-Maternai handling (minomi, jundate, and junbiki)
10-Handle variation in demand	10-Workers Own Processes (Ji Kotei Kanketsu (JKK)
11-Take control over variation in the flow	11-Autonomous equipment maintenance by workers
12-Identify "one-best-way" for standard work (gensoku)	12-Total Productive Maintenance (TPM)
13-Innovate in flow (Reengineering principles)	13-Kaizen Teian employee suggestion system
14-Develop flow by using new technology (Information Technology and manufacturing technologies)	14-Waterspider supervisory function
	15-Systematic approach to CI teamwork
15-Kansei kougaku – engineer for the (human) senses	16-Kami Shibai – supervisor auditing work discipline

 28

28

Continual Process of Monitoring and Improving Flow:

The objective of management is to develop a self-regulating system of work that is self-motivated culturally to continually improve the quality of work by reducing waste, cycle time and cost.

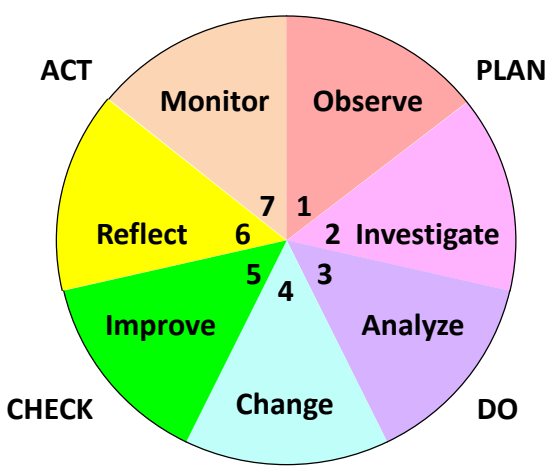
Monitoring the Process to Assure Conformance and Seek Improvements	
Continual Review	
1-Self-Inspection (Zero QC)	17-Jishu Kanri – Self-Mastery Management System
2-Problem Solving (SDCA)	18-Jishuken – Management-Driven Kaizen Projects
3-Process Kaizen (PDCA)	19-Catchball – interactive planning process
4-Cross Functional Teams (yokoten)	20-Nemawashi – informal target negotiation
5-Quality Circle Activities	21-Ringiseido – Shared decision process
6-Kaizen Improvement Projects	23-Tatakidai – Discussion of ideas across levels
7-A-3 Report for Daily Management System	24-Shoujinka – Flexible manpower assignment
8-Strategic Management by Policy (SMBP)	25-Shouryokuka – Labor-saving devices
9-Hoshin Kanri (Strategy Management System)	26-Menashinoshoujinka – Decrease staff to demand
10-Hoshin Tenkai (Policy Deployment)	27-Nagara – Doing more than one thing at a time
11-X-Matrix for Hoshin Tenkai	28-Shigoto – Increase value-adding work
12-Kaikaku Projects – Breakthrough Projects	29-Soikufu – Creative ideas from workers
13-Irei Projects - Strategic Imperative Priority Projects	
13-Hourensou - Frequent reporting to management	
14-Nichijo Kanri (Daily Management System)	
15-Hinshitsu Kanri (Quality System for Daily Management)	
16-Presidential Review	

 29

29

Lean Management Model (under consideration):

A working process to pull time out of the process through reduction of waste and improvement of quality in performance of standard work:



 30

30

CONTINUAL IMPROVEMENT MODEL: PILOT PROJECT

 31

31

Continuing Development Plans …. 2017

PROJECT PILOT PHASE:

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- Brief the EOQ and IAQ on Model status.
- Develop a Train-the-Trainer program.
- Develop Training materials for a three-tier competence model.
- Deliver Trainer Program for Pilot facilitators and organizations.
- Initiate pilot projects in Finland, Portugal, Sweden and Norway.
- Complete pilot projects and document the results.
- Review project results with ASQ and JUSE A-TQM Committee.
- Complete final project report.

 32

32

Project Plans for 2017 and Beyond:

PROJECT MILESTONES:

EUROPEAN ORGANIZATION FOR QUALITY

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LAATUKESKUS EXCELLENCE FINLAND

- Define the role models suitable for certification applications.
- Integrate CIM into the EOQ PRU certification scheme.
- Train national level instructor-facilitators.
- Prepare a textbook on Continual Improvement and academic papers about the CIM model and improved methods.
- Initiate two additional IAQ Think Tank projects on the topics of designed improvement for innovation and lean management.

 33

33

Book Idea: Continual Process Improvement

Foreword: The Imperative of Continual Improvement (Invited Executive)

Introduction – The Requirement for a Standardized Approach

Part 1: The Theory of Continual Process Improvement – history and list of methods developed over time – learnings – strengths & weaknesses

Part 2: The Continual Improvement Model – overview + seven chapters + assignment of standard methods and tools to each of the seven steps.

Part 3: Case Study Applications of CIM

Afterword: Quality Drives Global Trade (Invited Executive)

Authors and Acknowledgements

Index

 34

34

Book Idea: Collected Papers in Continual Improvement

Foreword: Gregory H. Watson, Think Tank Chairman

- Graphical Methods
- Lean/Process Methods
- Financial Methods
- Statistical Methods
- Management Methods
- Customer Methods
- Employee Methods

Specific topics and clustering of subjects to be determined .

Afterword: Lars Sörqvist, Think Tank Vice-Chairman

Authors and Acknowledgements: CIM Team biographies

Index:

 35

35

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Thank you for your attention!

 36

36

Final Report
Part 2: Background
10 July 2017

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ENGINEERING THE PROCESS OF CONTINUAL IMPROVEMENT

Advancing Quality as Science: Improving Analytical Structure and Methods

Co-Editors: Gregory H. Watson and Lars Sörqvist

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ABSTRACT: **Engineering the Process of Continual Improvement**

Advancing Quality as Science: Improving Analytical Structure and Methods

Quality problem-solving methods have evolved over the past five decades and have delivered two distinct approaches for the analysis of problems: the PDCA approach used in Japanese-style Total Quality Management and the DMAIC approach used in American-originated Six Sigma methods. However, other disciplines have also developed approaches for problem-solving: activity-based cost analysis by accounting; business process reengineering and business process management by information technology; and systems analytics by industrial and systems engineers. All of these approaches have similar methodologies as foundational techniques, but they arrange them in different order. In addition, there are really no standards within disciplines because many companies have customized or tailored these methods and companies that are large enough to influence their supplier base often dictate the quality methods employed in their supply chain to assure consistency within their own processes.

These observed trends create tension on the Small-to-Medium-sized Enterprises (SMEs) who populate the majority of Europe's supplier base who may have to adapt a generic quality management system to satisfy a variety of large customers and align their system to satisfy all external demands. Unfortunately, SMEs usually do not have excess resources and sufficient breadth in their quality function to customize quality systems so readily. This situation creates a significant need for a generic approach to the process of quality improvement that satisfies all major quality systems. The International Academy for Quality created a Think Tank to address this issue in 2014 at the request of the European Organization for Quality. Over the past two years this method has been under development and a generic model was approved for pilot use in June 2016. This model is currently under pilot testing in Norway, Sweden, Finland, Germany and Portugal.

This paper presents the historical development of the model, describes methods and techniques applied in each of its steps, and identifies methodology improvements recommended by the IAQ Think Tank.

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THE OBLIGATION TO IMPROVE IS IMPLICIT IN ORGANIZATIONAL PURPOSE

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What is a mental model? What is a framework?

Mental models provide the framework for how to transition the Bayesian Moment:

- **Mental Model**: A representation of how something works in the real world that helps to anticipate events or schedule a sequence of actions. Human reasoning operates using mental models to structure thinking pathways to order selected concept about how to pursue an activity or interpret external stimuli.

- **Framework**: A generic structure of interlinked activities that will support a particular approach for achieving an objective and may be modified or adjusted as required to adapt to circumstances by adding or deleting items.

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Integration of structured improvement and learning:

- Organizations learn by conducting structured reflection on the past experience to discover patterns and inquire about linkages among the factors that drive business performance.
- There are three levels of reflection required to capture learning for improvement:
  - Reflection at the work process level inquires about the way that work is accomplished and seeks to maintain control of standards or to improve performance (e.g., problem-solving and continual improvement).
  - Reflection by middle management about the patterns observed in the work seeks to identify methods, techniques, and tools to coordinate the manner that standardization and improvement influence business outcomes.
  - Reflection by senior management about assumptions and context of the external work environment aim to uncover opportunities to create the desired future state of the organization.

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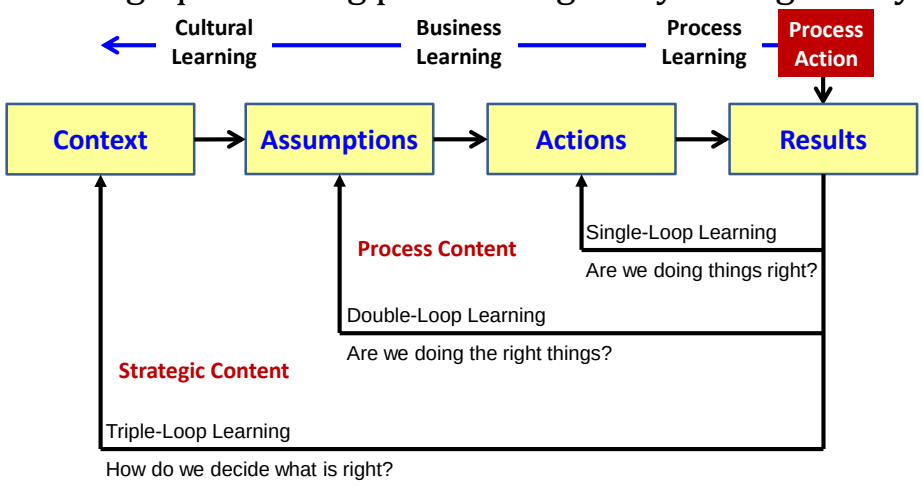
Learning: questioning process begins by seeing reality



Chris Argyris, ***Personality and Organization*** (New York: Harper Collins, 1957).
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Chris Argyris, ***Organization and Innovation*** (Homewood: Irwin, 1965).
Chris Argyris & Donald Schön, ***Theory in Practice: Increasing Professional Effectiveness*** (San Francisco: Jossey-Bass, 1974).

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Fundamentals of the scientific method:

- What is the scientific method?
- The scientific method conducts an inquiry by experimenting in a process for answering questions and exploring observations. All techniques used to investigate phenomena seek to acquire new knowledge by correcting, integrating, and expanding on the prior knowledge. To qualify as a scientific approach, an inquiry must be based on empirical (measurable) evidence that is subject to logical reasoning which generates knowledge.
- The logical process of the scientific method is an iterative and it usually begins with observations about the natural world which are formulated as a research hypothesis. Such conjectures predict an outcome that is testable or falsifiable – which means that it is possible to formulate an experiment that conflicts with predictions made using the hypothesis. The purpose of the experiment is to determine whether observations agree with or conflict with the postulated hypothesis.
- Objective science is replicable by external review and the data collected during a scientific inquiry is available for such analysis by other scientists who wish to replicate the original results.

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How does science create profound knowledge?

- Science notices what is different.
- Science collects data about the observations.
- Science perceives differences in data to detect patterns.
- Science formulates tentative hypotheses about relationships.
- Science explores the nature of relationship boundaries.
- Science develops research hypotheses for formal study.
- Science experiments to determine causality.
- Science develops theory to explain general behaviors.
- Science tests theory to assure broad applicability
- Science transforms sound theory into laws of nature.

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Definition of EDA–II:

What is the purpose of an analytical approach to learning about the performance of a process? Is the purpose just to develop an accurate and precise calculation of the potential of a process and accurately depict its performance or is the purpose to discover the hidden opportunities that will make the process work better?

What do we want to do? Calculate numbers with precision or discover where is there a difference and why does it exist? If this difference really matters and is truly salient, then what can be done to improve?

The purpose of Exploratory Data Analysis - II (EDA-II) is to rapidly investigate the performance of a process and determine quickly where improvement effort should be focused for further action.

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EDA–II begins by examining data about deliverables:

The measured deliverable output of a process is the starting point for an inquiry into where the process has developed losses or where waste has incapacitated its natural process capability.

Remember when you don't have good data, then you shouldn't use precise statistics. According to British astrophysicist Stephen W. Hawking: "The cost of bad data is the illusion of knowledge."

EDA-II inquiry begins with the output "Y" measure and conducts a backwards search to discover which rational sub-groups that have an impact on this performance measure are most closely related to the losses from the ideal state of performance. By a discovery of these sources of loss and variation, the investigator may discover the process interrelationships which must be fixed in order to improve the overall performance of the process. This search does not reveal root causes rather it unveils contributing factors which are related to the root cause.

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Setting expectations for your development:

Emphasis will be placed on application rather than education – Why?

- Education focuses on academic presentation of settled knowledge which is the domain of science. The world of science eliminates the noise to predict expected performance (i.e., regression to the mean rather than exploring variation). The education perspective tends to focus on formulae and proofs; however, this is "settled knowledge."
- Applications focus on the pragmatic presentation of methodologies for performance (e.g., "unsettled knowledge") which is the domain of engineering – this is the world of "dirty data in messy processes." The world of engineering analyzes noise to determine how to either eliminate or control it through real-time process management that is achieved through manipulating adaptive feedback loops at critical process control points.

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What are dirty data and messy processes?

- What is Dirty data?
  - Data that records counts of events and not quality of events
  - Data that is missing or unrecorded
  - Data that is mislabeled or misreported
  - Data that is overwhelmed by measurement error
  - Data that does not matter or is unrelated to performance
  - Etc.
- What are messy processes?
  - Processes that do not deliver the expectations of customers
  - Processes that cannot deliver their original design capability
  - Processes that are overcome with noise from false signals
  - Processes that have excessive losses, waste or inefficiency
  - Etc.

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EDA-II probes data to define process performance:

How should you explore issues and relationships among process data?

Exploratory Data Analysis (EDA) performs process inquiry using the philosophy for data analysis that employs a variety of graphical and statistical techniques to increase an observer's insight into meanings and discover performance issues that may be hidden in a set of data.

EDA seeks to:

- Uncover underlying structure in data distributions;
- Extract important variables from data sets;
- Detect patterns, outliers and anomalies in the data;
- Test underlying assumptions for data relationships;
- Develop data models that characterize results; and
- Determine appropriate boundary conditions for the performance of the key performance factors.

 13

13

What should be done in an Exploratory Data Analysis?

Objectives for an EDA:

- **Formulate questions** no matter if they sound naïve or stupid at the moment or not.
- Begin data analysis and think about what data is available and how the process works – develop a **simple logical explanation** about how the process works and how the data is related to the process in rational groupings.
- **Grab some data** and try to work Minitab analytical functions.
- **Interpret the data** – say out loud, what are you seeing, even if the conclusions are not useful to anyone.
- **Understand some key concepts**: special and common cause variation; specification and control limits; rational sub-groups; continuous and attribute data; and enumerative and analytical data studies.
- **Recognize the value of a team for interpreting process data.**

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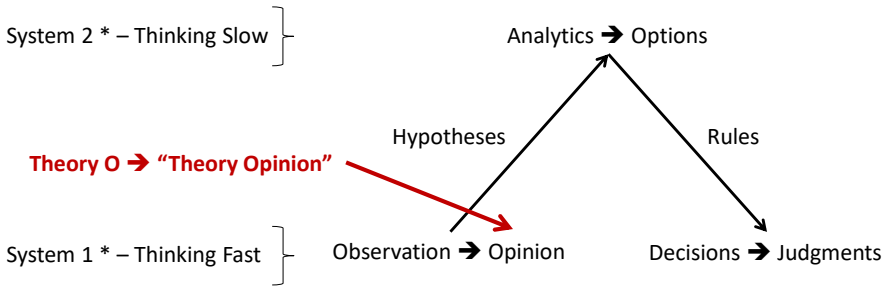
EDA–II formulates and evaluates research hypotheses:

Iterative Process for Formulation of Judgments from Observations:



This analytical process begins with "noticing" or "situational awareness" which formulates an observation, and then continues through a process of "sensemaking" which constructs alternatives and applies past knowledge to create profound knowledge that leads to sound judgments. The original hypotheses that are subject to analytical inquiry are opinions that need to be structured into a framework that makes sense and enables sound decisions.

* Daniel Kahneman (2011), **Thinking, Fast and Slow** (New York: Farrar, Straus, and Giroux).

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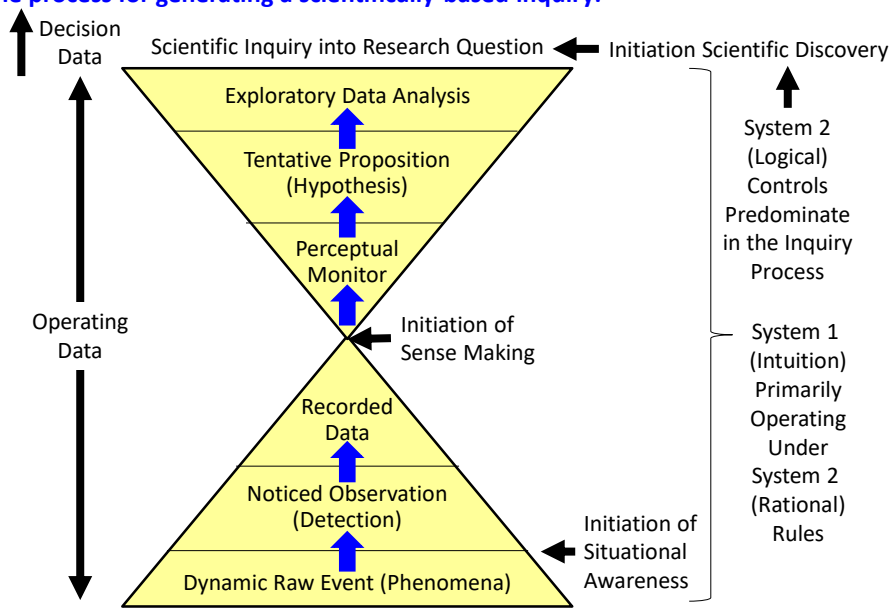
Transformation of an event into data and information:

The process for generating a scientifically-based inquiry:



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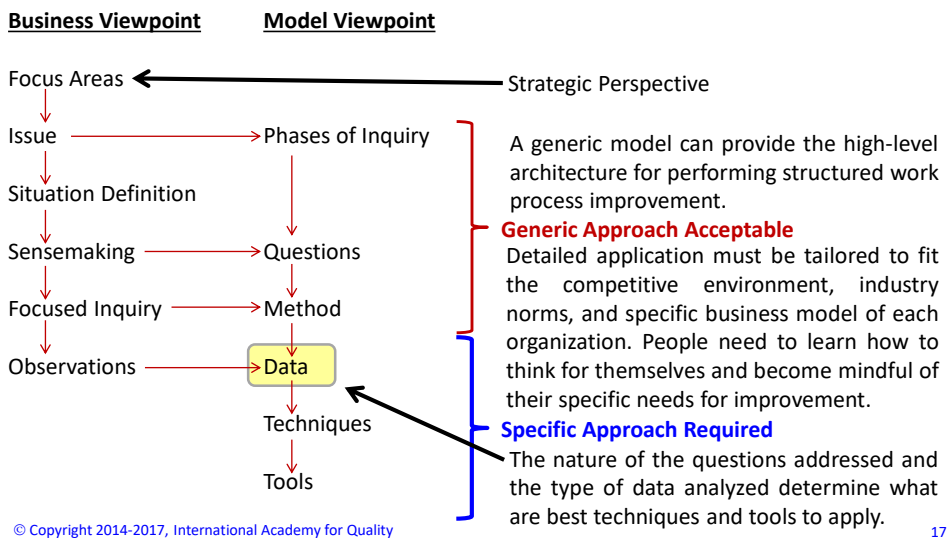
Hierarchy of analytical inquiry:

The business viewpoint focuses on the content of the organization's tasks in fulfillment of its mission and purpose while the mental model describes the approach used to analyze and develop strategic content based on data.



An "agile model" of structured continual improvement:

Agile improvement alternates cycles of improvement and consolidation in a pattern that seeks increased alignment with the actual needs of customers.

A standardization cycle provides the opportunity to consolidate and solicit customer feedback for reflection on the degree of alignment achieved to date.

The improvement cycle provides an opportunity to leap forward and achieve increased capability thru application of creativity to better deliver customer needs.

Cycles of improvement increase the inherent design capability of the work system and move its performance toward the currently available "ideal" level of performance as constrained by factors of: technological capability, organizational understanding of customer experience, human competence and capability, and the alignment in strategic and operational direction.

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HISTORY OF THE PROCESS OF IMPROVING

 19

19

Two quality mental models exist: PDCA and DMAIC

- The PDCA model has its roots in the development of modern quality systems in Japan during the 1950s. DMAIC has its roots in American resurgence of quality interest during the 1980s as industries fought to regain competitiveness lost to Japan. The competing system did not attempt to follow the Japanese approach but sought a uniquely American style to address the same issues using essentially the same tools as had been incorporated into the Japanese model.

- Also in the 1980s an approach to Activity-Based Costing (ABC) used the same PDCA base to define business process improvement from an accounting perspective while the Information Technology world used either Business Process Improvement (BPI) or, in the early 1990s, the methods of Business Process Reengineering (BPR) or Business Process Management (BPM) to implement IT-based process improvements. But these methods all had the PDCA logic as a core "thinking process" for addressing improvement.

 20

20

Historical origins – precursors to PDCA:

- Adam Smith, *The Wealth of Nations* (1776)
  Smith created divisions of labor and identified two components with planners (management) and doers (labor). This division of labor meant that each made their particular contribution to the economic well-being of society.

- Frederick W. Taylor, *Principles of Scientific Management* (1911)
  Taylor's book was translated into Japanese in 1912 where it was published under the title of "The Secrets of Eliminating Wasted Work" and it stimulated development of The Efficiency Society in Japan. Kaoru Ishikawa notes that Taylor contributed another version to the model: Plan-Do-See, where the "See" referred to the work of a new "inspector class" that was to use the scientific method to identify opportunities to improve.

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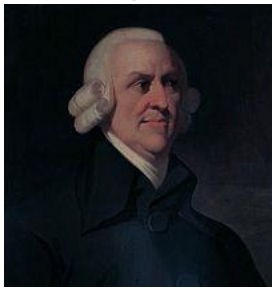
Dividing labor tasks between workers and managers:



Adam Smith (1723-1790)
The Wealth of Nations (1776)

PLAN vs. DO

Ideas introduced:

- Definition of man as "homo economicus"
- Market forces operate as an "invisible hand"
- Division of labor between management (planners) and labor (doers or workers)
- Identification of the inequity in the bargaining power of labor and management and economic conflict.

"The price of labor, it must be observed, cannot be ascertained very accurately anywhere, different prices being often paid at the same place and for the same sort of labor, not only according to the different abilities of the workmen, but according to the easiness or hardness of the masters. Where wages are not regulated by law, all that we can pretend to determine is what are the most usual; and experience seems to show that law can never regulate them properly, though it has often pretended to do so."

"A landlord, a farmer, a master manufacturer, a merchant, though they did not employ a single workman, could generally live a year or two upon the stocks which they have already acquired. Many workmen could not subsist a week, few could subsist a month, and scarce any a year without employment. In the long run the workman may be as necessary to his master as his master is to him; but the necessity is not so immediate."

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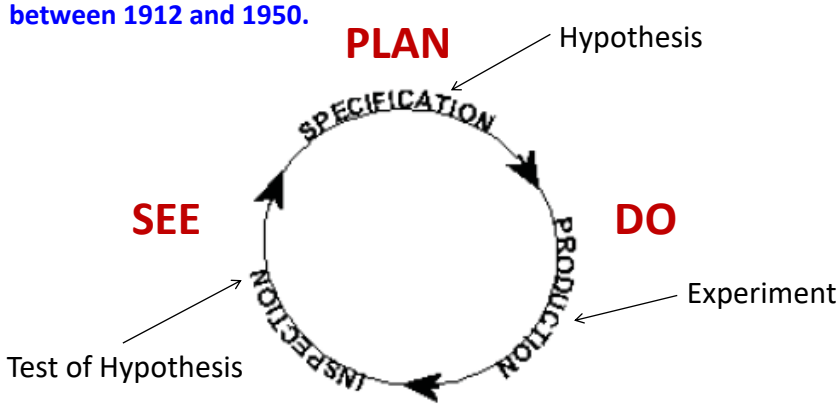
Walter A. Shewhart (1939) Cycle:

The Shewhart Cycle actually documents the thinking of Taylorism (Plan-Do-See) that was created by the Japanese Efficiency Society between 1912 and 1950.



Frederick W. Taylor and the "efficiency movement" which evolved into industrial engineering had added an "inspection function" to the management and worker dimensions in the division of labor.

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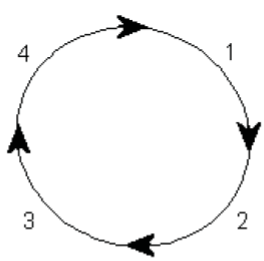
W. Edwards Deming (1950):



1. Design the product (with appropriate tests).
2. Make it; test it in the production line and in the laboratory.
3. Put it on the market.
4. Test it in service, through market research,
   find out what the user thinks of it,
   and why the non-user has not bought it.
5. *Re*-design the product, in the light of consumer reactions to quality and *price*.
   Continue around and around the cycle.

 24

24

Appreciation for the Japanese contribution ….

JUSE
Union of Japanese Scientists and Engineers

- Since 1948, JUSE (Union of Japanese Scientists and Engineers) has conducted a systematic development of quality as a science. It has continually built upon the prior advances to establish progress in learning about and understanding all aspects of the process for managing quality in organizations.
- This quality methodology has been practiced with a great deal of success throughout all Asia and globally.
- The Japanese quality way is a basis for all systematic approaches to managing for quality.

 25

25

PDCA originated in the JUSE QC Research Committee:

In 1948 JUSE established a Quality Control Research Group to determine how to introduce quality to Japan and Shigeru Mizuno appointed its chair.

In 1949 the name was changed to the QC Research Group. The QC Research Group developed the initial training programs offered within JUSE for quality education and also served as note-takers, translators, and expositors for the quality lectures of W. Edwards Deming and Joseph M. Juran. Following their interpretation of the words of Deming and Juran they structured the unique Japanese QC way initially called Total Quality Control (TQC) and then restyled as Company-wide Quality Control (CWQC) and later it was called TQM. The eight members of the QC Research Group were jointly awarded the Deming Prize for Individuals in 1952.

Shigeru Mizuno is credited with the simplification of the Shewhart Cycle and Deming Wheel into the PDCA Cycle, following the style of Frederick Taylor who described the process of control as "Plan – Do – See." Naming this PDCA Control Cycle the "Deming Cycle" was intended to honor the contribution of Deming who stimulated the thinking process for the team's development of this methodology. PDCA is the core for all Japanese continual improvement processes and is used cross all disciplinary functions in Japan.

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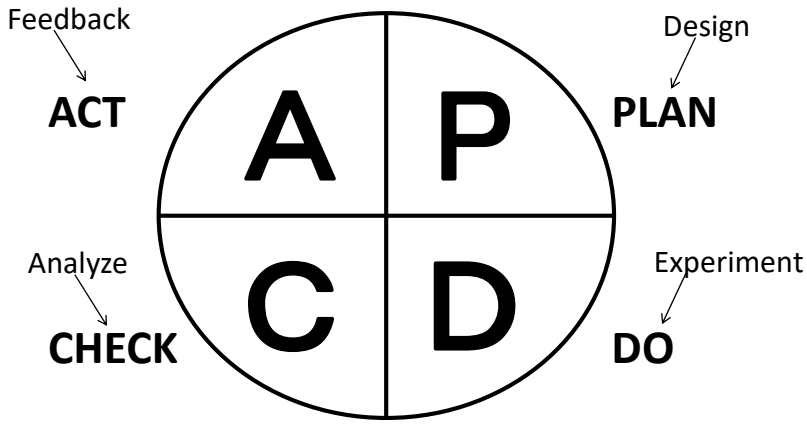
Union of Japanese Scientists and Engineers (1959):

The Control Cycle:



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PDCA Model Sub-Steps – 1:

- Kaoru Ishikawa: *What is Total Quality Control?* (1981)
  Defined the model as the Control Circle and sub-divided it:
  Plan: Determine goals and targets
  Plan: Determine methods of reaching goals
  Do: Engage in education and training
  Do: Implement work
  Check: Check the effects of implementation
  Act: Take appropriate action

- Shigeru Mizuno, *Company-wide Quality Control* (1984)
  PDCA is identified as "the control Circle with four steps:
  P: establishing a plan or standard for achieving your goal
  D: enacting the plan or doing
  C: measuring and analyzing the results, i.e., checking
  A: implementing the necessary reforms when the results are not as originally planned.

 28

28

PDCA Model Sub-Steps – 2:

- Katsuya Hosotani, *The QC Problem Solving Approach* (1992)
  Identified the PDCA Wheel as containing four elements of control: Plan (Quality Assurance), Do (Cost Control), Check (Production Control) and Act (Sales Management) amplified as follows:
  Plan: Prepare a plan
  Do: Implement the plan
  Check: Check the results
  Act: Take action based on the findings of step 3

- Hitoshi Kume, *Management by Quality* (1995, 2012)
  Defined the model as the PDCA Loop in the first edition of his book and he referred to it as a PDCA Cycle in the next edition, without any sub-divisions, but with more explanatory text to supplement the labels.

 29

29

QC Story Applications of PDCA:

- Hitoshi Kume (1985) – QC Problem-Solving Story
  1. Define the problem clearly (process diagram and Pareto analysis)
  2. Recognize the features of the problem (collect data, histogram, scatter diagram correlation and regression, control charts)
  3. Analyze to find the main causes (Fishbone, statistical inference and Analysis of Variance, Hypothesis testing)
  4. Act to eliminate the causes
  5. Check to assure the problem does not recur
  6. Standardize for a permanent solution
  7. Review the procedure and plan future work.
- Noriaki Kano (1997) – Task Achieving QC Story
  1. Policy understanding
  2. Task setting up
  3. Develop the methods to perform the task
  4. Successful scenario exploring
  5. Scenario implementing
  6. Effect confirming
  7. Daily operations transferring
  8. Future planning

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Hitoshi Kume (1985):

QC Story for Problem-Solving
Problem: Undesirable result from work

1. Define the Problem Clearly
   - Process Diagram
   - Pareto Analysis
2. Recognize the Features of the Problem
   - Collect Data
   - Histogram
   - Scatter Diagram, Correlation and Regression
   - Control Charts
3. Analyze to find the main causes
   - Fishbone Diagram
   - Statistical Inference and Analysis of Variance
   - Hypothesis Test
4. Act to Eliminate the Causes
5. Check to assure the problem does not recur
6. Standardize for a permanent solution
7. Review the procedure and plan future work

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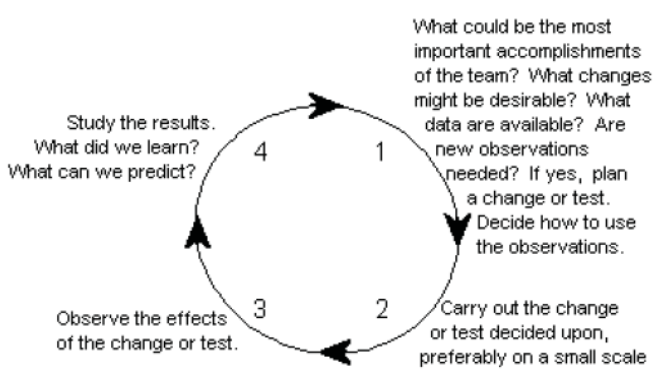
W. Edwards Deming (1986):



Step 5. Repeat Step 1, with knowledge accumulated.
Step 6. Repeat Step 2, and onward.

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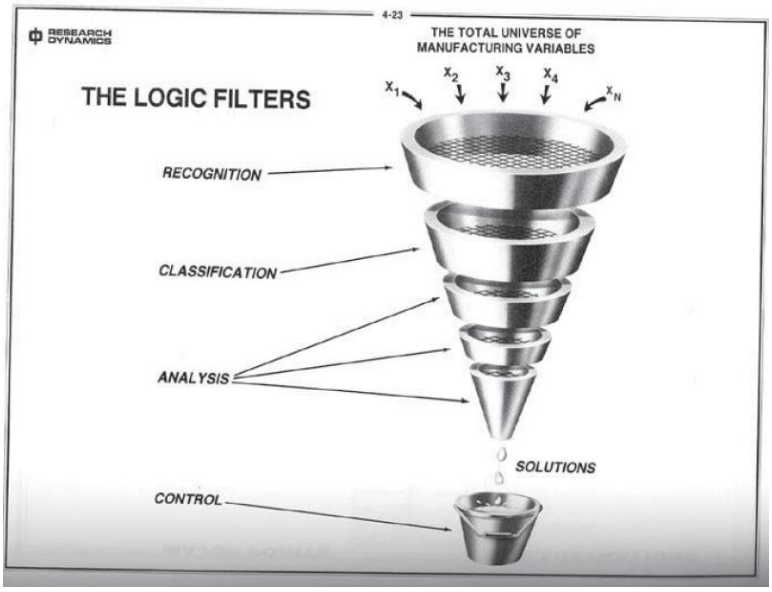
Mikel J. Harry: Logic Filters (1985) – 1



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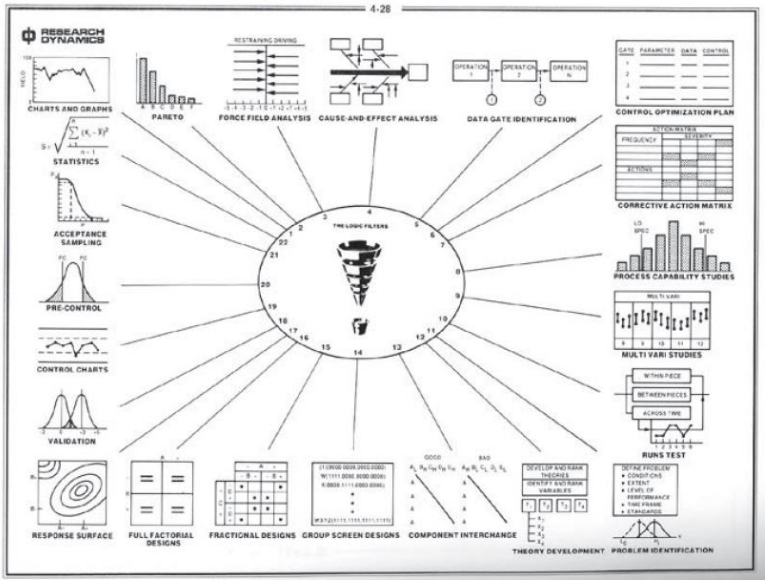
Mikel J. Harry: Logic Filters (1985) – 2



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DMAIC Origin – Motorola Six Sigma Research Institute:

- Dr. Mikel Harry's dissertation suggested logic filters: Recognition, Classification, Analysis, and Control but did not relate specific tools or methods to each step.
- The Motorola Six Sigma Research Institute developed its four phase process (Measure, Analyze, Improve and Control) based on the Japanese PDCA model and it had a more detailed twelve-step sequence of activities:
  1. Select Critical to Quality Characteristics
  2. Define Performance Standards
  3. Validate Measurement Systems
  4. Establish Product Capability
  5. Define Performance Objectives
  6. Modify Variation Sources
  7. Screen Potential Causes
  8. Discover Variable Relationships
  9. Establish Operating Tolerances
  10. Validate Measurement System
  11. Determine Process Capability
  12. Implement Process Controls
- General Electric added Define as a prelude step to MAIC as a management link.
- Mikel Harry added Recognize as a precursor step before Define and added the Standardize and Integrate steps to follow Control.

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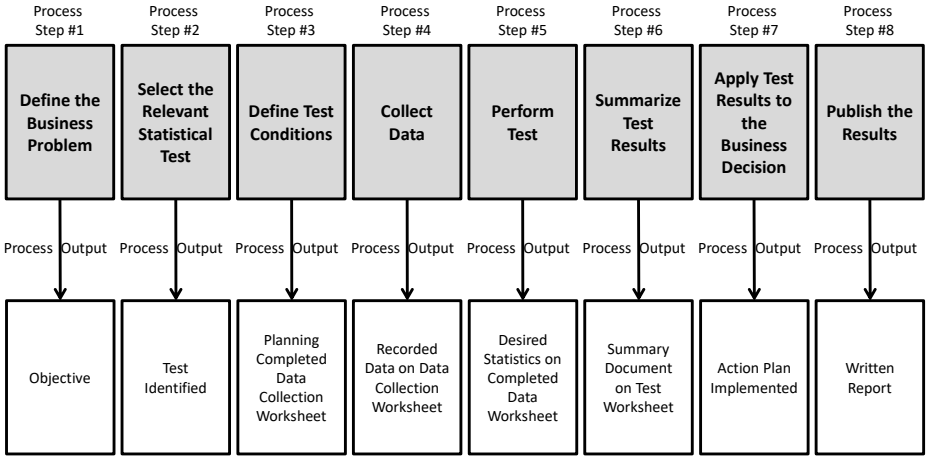
Compaq Computer (1991):

Data Driven Decision-Making Process



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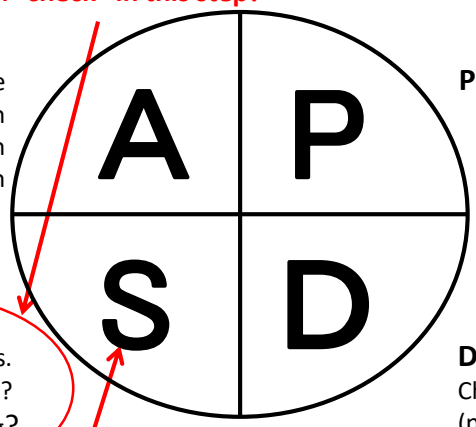
W. Edwards Deming (1992):

Why change from "check" in this step?

Act – Adopt the change, or abandon it, or run through the cycle again



Plan – A change or a test, aimed at improvement

Study the results. What did we learn? What went wrong?

Do – Carry out the Change or the test (preferably on a small scale)

But, this requires more than just study – check implies a comparison to a standard, history, or requirement. Thus, more than study is required.

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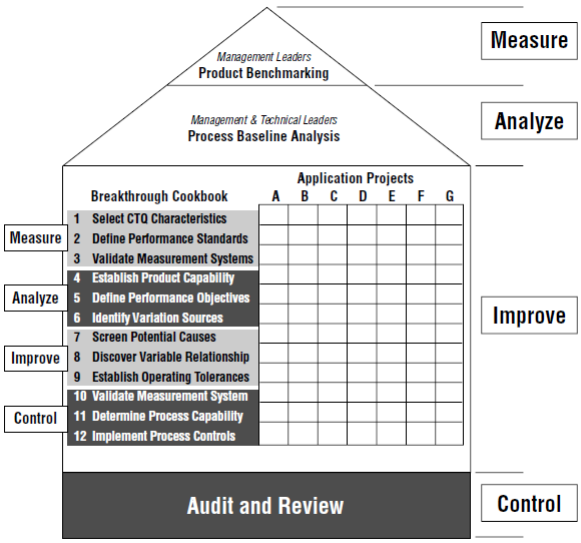
Six Sigma at Allied Signal (1993):



(Source: The Vision of Six Sigma: Supplier Breakthrough, First Edition)

 38

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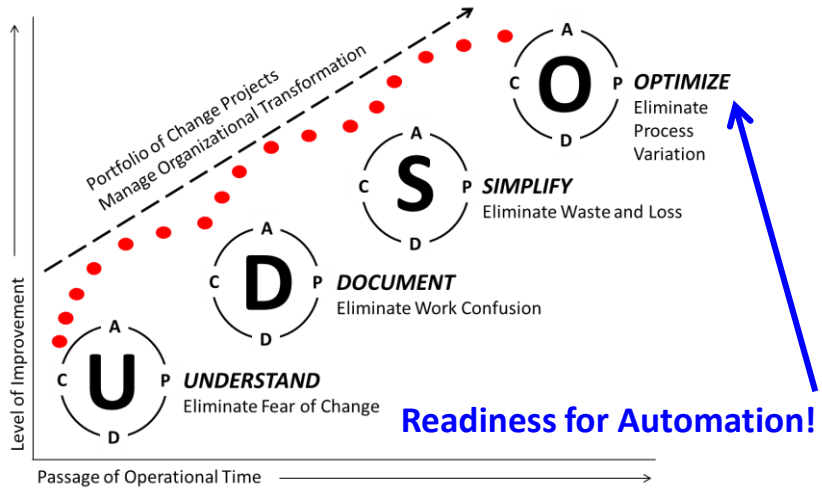
Business Systems Engineering Model (1994):

Capacity to Automate: approach to work that seeks to first understand, document the new standards, simplify for control, and finally to optimize the process variation before using automation to achieve predictable deliverables (UDSO) [**Robotics**]



Gregory H. Watson (1994), ***Business Systems Engineering*** (New York: Wiley), p. 98.

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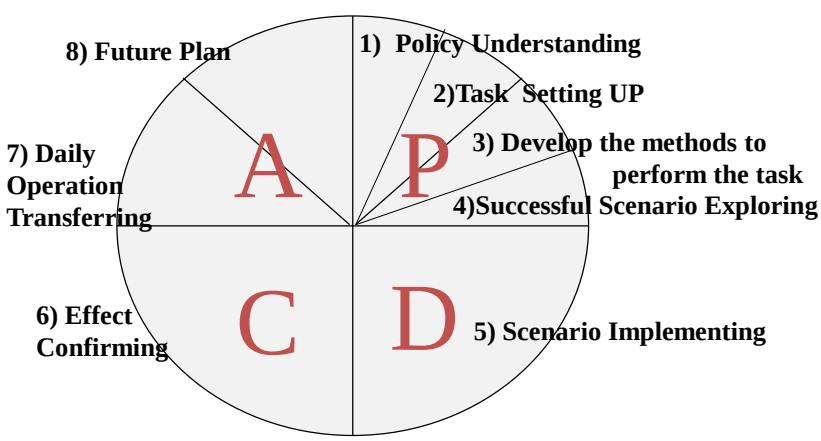
Noriaki Kano (1997):



Task Achieving QC Story and PDCA Cycle

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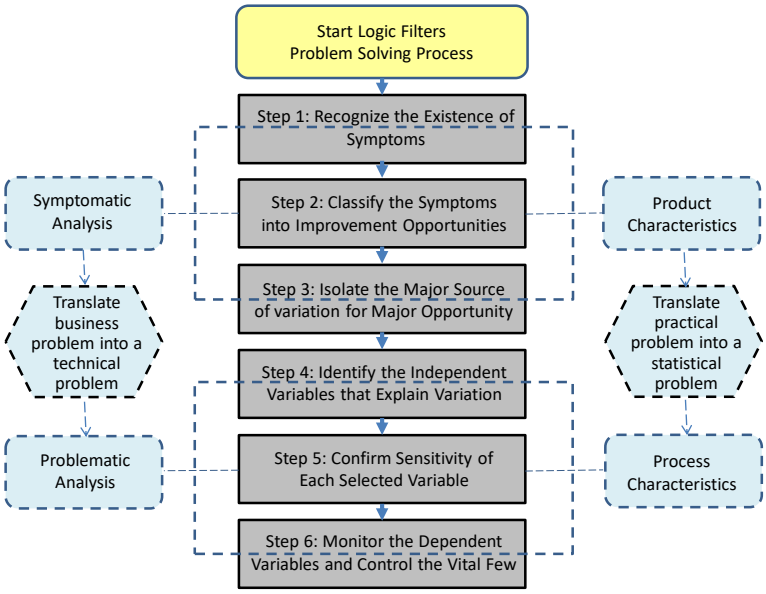
Mikel J. Harry: Logic Filters (1997) – 3



Mikel J. Harry (1997), The Vision of Six Sigma, 5th edition (Phoenix, AZ: Tri-Star Publishing).

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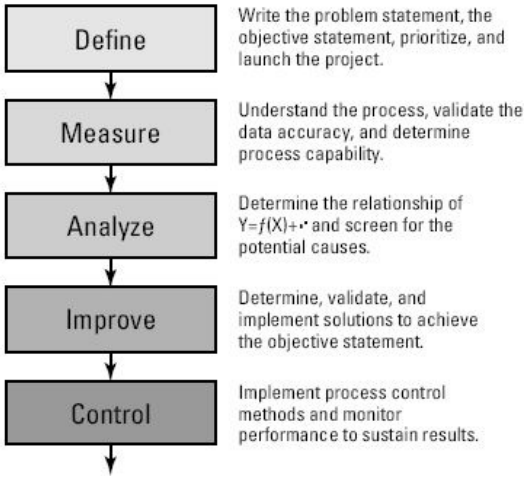
Six Sigma at General Electric (1997):



 42

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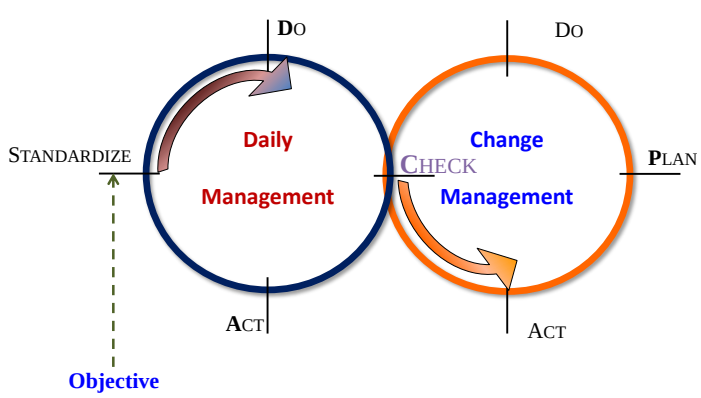
Mikel J. Harry, Quality Progress (2000):

The Breakthrough Strategy is an eight-step process that
Recognizes needs and requirements
Defines levels of entitlement
Measures actual performance
Analyzes capability and capacity gaps
Improves systems, operations and processes
Controls key inputs
Standardizes methods and procedures
Integrates improvements and knowledge

 43

43

JSQC Daily Management Standard (2003):



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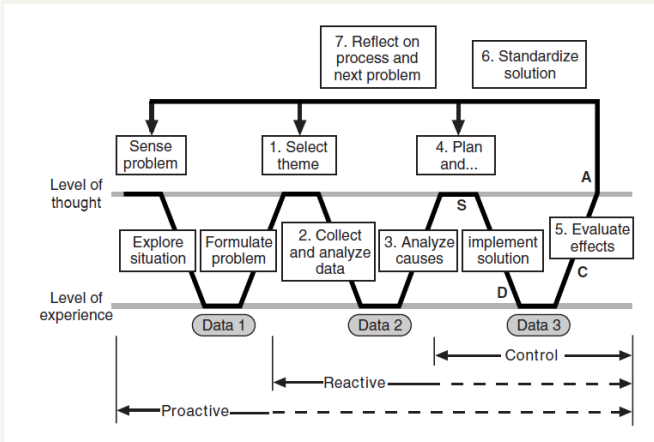
Shoji Shiba and David Walden (2006):



Breakthrough Management Process

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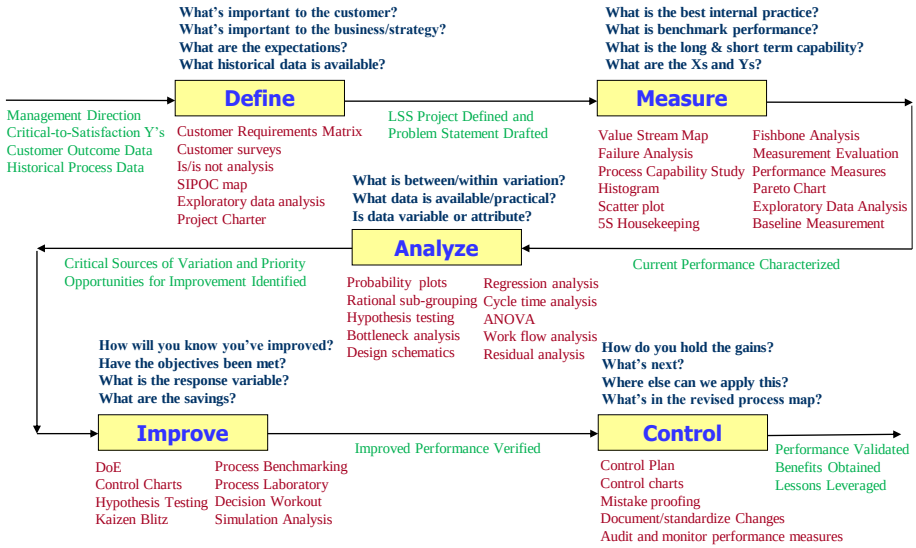
BEST Lean Six Sigma™ (2006):



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46

Performance Improvement Refines Daily Management:

- SDCA was developed in Japan and it has become the core mental model of JSQC standard (JSQC-Std 32-001 (E) – 2014 – Guidelines for Daily Management).
- PDCA evolved over the years and it has become the core mental model of the JSQC Policy Deployment Standard (JSQC Std 33-001 (E) 2017 – Guidelines for Policy Deployment).
- W. Edwards Deming proposed that a model for learning be used to describe transformation management – Plan-Do-Study-Act (PDSA). This model contributes the concept of study or learning to the prior Japanese models and this is illustrated in a model that integrates all three of these concepts.

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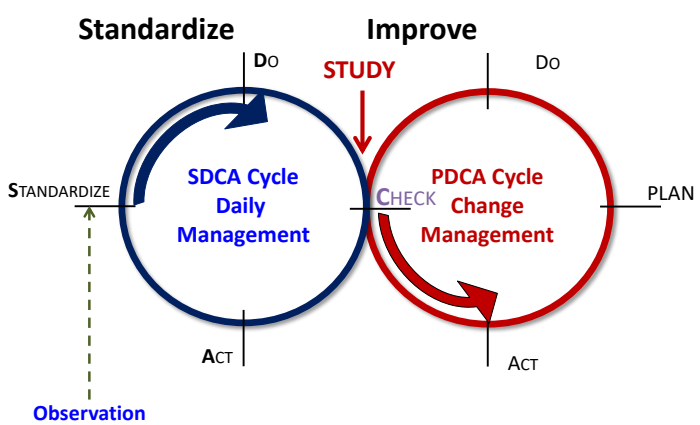
47

PDCA – Revisited and Integrated with PDSA – 2017:

Learning how to manage the mess begins by standardizing the process!

Standards are the basis for initiating system-wide improvements:



Management of quality in the routine activities is achieved using work standards.

* Standardize-Do-Check-Act (SDCA) / Plan-Do-Check-Act (PDCA) is a fundamental process mental model.

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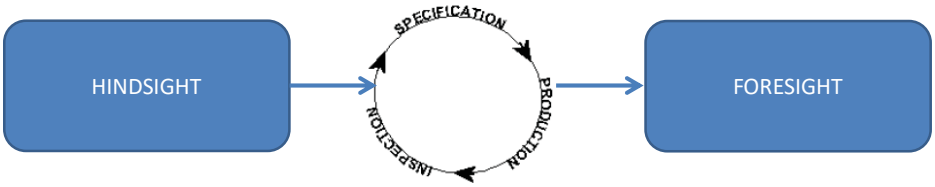
48

Control as a foundation for transformation:



INVESTIGATION **CONTROL AND TRANSFORMATION** **PREDICTION**

"Hindsight supplements foresight: a view backward often adds materially to a view forward."

~ Walter A. Shewhart (1939)

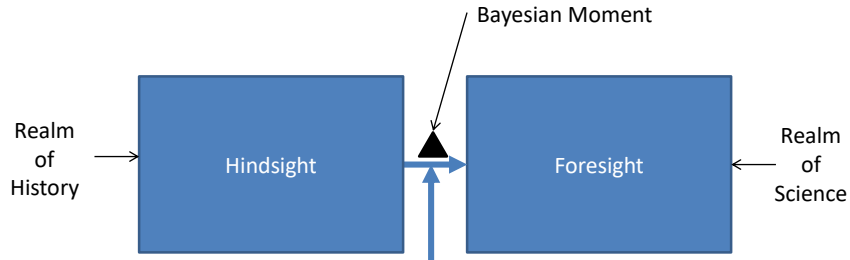
Statistical Method from the Viewpoint of Quality Control

[Editorial comment made by W. Edwards Deming.]

 49

49

The process flow of scientific inquiry:



DEFINITIONS

- **Hindsight**: how we use historical data to discover causal systems from past experience.
- **Foresight**: how we project what future potential is possible as a function of past experience and knowledge.
- **Insight**: how we perceive data of past experience and interpret its meaning in decision-making as an individual decision-maker.

- **Bayesian Moment**: a point in existential time when an observation is made of the phenomena, perceived and interpreted as an individual and represented through a mental model as an actual entity and decisions drawn based using a constrained level of knowledge, time or consciousness (as bounded reality).

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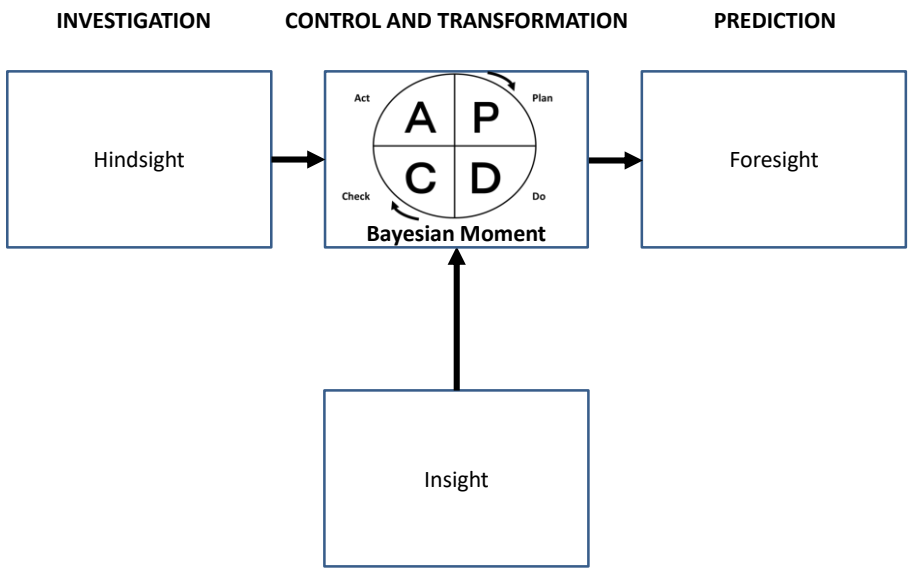
Relationship of PDCA to transformation mental model:



International Academy for Quality

CRITIQUE OF IMPROVEMENT MENTAL MODELS

What is wrong with the "popular" mental models?

None of the most popular were considered as adequate for application as a generic "structured improvement model" for various reasons:

- PDCA: While the Japanese PDCA model does describe the generic logic for structured improvement, it has not been universally recognized. It is most widely accepted in Asia and parts of Europe and America, but it is considered by many a "rival of DMAIC" and it does not clearly address its strategic linkage to change initiatives. It also has a problem in that many followers of Deming to not use the PDCA model but have followed Deming's suggestion and use PDSA, which creates confusion.
- DMAIC: The American Lean Six Sigma (LSS) approach uses DMAIC; but it is also weak on strategy linkage as well as transition to operations. It is not as widely accepted and there is no accepted model for its use as ASQ and ISO have distinctly different details in their models.
- Lean: The movement promotes individual tools and has not developed a coherent mental model for application for structured improvement.

 53

53

Concern in traditional European approaches to quality:

- The European approach to development of management systems for quality control and improvement has been mired in a commitment to standardization that stagnated innovation in designing new methods and capabilities for a long-time.
- ISO9000 has demonstrated a long-term incremental increase in what is basically bureaucratic administration of the quality function for the long-term; however, it does not specify content or methodologies to be employed to achieve the quality outcomes or increase efficiency.
- The European Quality Award provides a model that is essentially the same as the American Malcolm Baldrige National Quality Award in its requirements; however, it also is silent on best practice content that makes a difference in business performance and only demonstrates what to do in one-off case studies that describe the processes that were significant in the 'winning' organizations, without the benefit of sound theoretical or academic basis for these actions – thus these practices become anecdotally-defined, not scientifically based.

 54

54

Issue: No "standard model" for quality improvement

- To remain a viable business operation all organizations must develop a program for continual improvement of the quality of their work so they may meet market pressures of lower prices and higher value.
- However, there are many routes to satisfy the need to have continual improvement and there are many alternative ways to approach this:

Function	Quality	Quality	Technology	Technology	Accounting
Method	Japanese TQM PDCA	Lean Six Sigma DMAIC	Business Process Reengineering	Business Process Management	Activity Based Cost Management

- In addition, each major company develops their own unique way to apply these methods and emphasizes different approaches to satisfy their own particular business management needs and biases.

PROBLEM: Why must a Small-to-Medium Enterprise (SME) create chaos as they attempt to create a singular process satisfies all customers needs if the basic need is the same – continual improvement of processes to deliver productivity in a consistently efficient manner.

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Problems identified – SME's lack standard guidance:

- The LSS Define-Measure-Analyze-Improve-Control (DMAIC) model excludes the steps that assure strategic alignment and execution of the improvements which often may result in a disjoint collection of projects that are not fully implemented.
- Lean improvement methods are a disjoint collection of methods and tools that have no integrating mental model to guide in their sequential application as an assistance for workers to streamline activities, reduce waste and standardize tasks around best practice.
- ISO TC69 SC7 approach to DMAIC standardization does not align with the methods that have been long proposed for certification by the American Society for Quality, specifies "mandatory" techniques which are not aligned with all European national implementations of DMAIC, and are not agreed on a global basis as DMAIC has been largely advanced by consultants who do not have any collective way to respond as they have no standing in the formal review process.
- There is little agreement among the European providers of DMAIC training about the manner in which it is implemented.

 56

56

Problems identified – SME's lack standard guidance:

- The TQM Plan-Do-Check-Act (PDCA) model excludes performance monitoring to assure on-going effectiveness of change and applies unclear logic for transition to the daily management process in the Standardize-Do-Check-Act (SDCA) model.
- TQM applies the PDCA and SDCA models within the contexts of the quality improvement story and task-achieving story for structuring improvement activity. Lean methods and quality methods overlap in application and statistical methods are embedded in the training activities, so it is not clear how these methods operate systemically without intensive coaching in the methods which is not practical for the SME organization.
- ABC methods concentrate on transaction costs and identifying cost drivers, but do not use a holistic approach to process improvement, ignoring the use of statistical methods for process analysis and lean methods for process streamlining.

 57

57

Problems identified – SME's lack standard guidance:

- BPM methods focus on ill-defined process maps so the flow of work among process steps is unclear, statistical methods are not used for the characterization of work flows and lean principles are not used for reducing waste in routine work. Therefore, the recommended improvements have a bias to information technology solutions.
- BPR methods are project focused, rather than process focused, and have the same set of issues as the BPM approach.
- The EFQM Business Excellence Model defines a structured approach for conducting management self-assessments of organizational performance management, but it does not identify specific practices, only highlighting "opportunities for improvement" without defining what improvements would be best for implementation.
- ISO9000 defines a structure within which to document the quality management system of an organization and it indicates a need for continual improvement but the standard does not address or specify any particular approach or methodology which is considered as a best practice.

 58

58

Specific problems in the ISO Six Sigma documents:

- Requirements are described without any reference to industry or type of problem that is being pursued (design or improvement or lean).
- DMAIC process does not follow the logical sequence of questions that must be addressed in a Lean Six Sigma improvement project (starting with initial condition, process description, determination of potential failure mechanisms in the process, definition of the measurement system description and validation of its integrity, analysis of sources of variation, and determination of causal linkages.)
- Presents tools as mandatory for steps when alternative methods are also possible (e.g., Fishbone diagram and mind-mapping).
- Overly mechanistic viewpoint of the process which is suitable more for physical processes than service processes and lack of capability to extend the methodology to a wide variety of types of problems.
- Inclusion of methods that "cloud up" the coherent application of the methodology (e.g., the "8D" model used for communication with suppliers) and many tools that appear to have been "thrown into the toolbox" without rationale as to their use.
- The instructions do not have a clear set of behavioral learning objectives.

 59

59

To complicate matters just a little bit more …

- Major multi-national companies have defined their own ways for conducting continual improvement and request that their suppliers follow this methodology.
- Applications of continual improvement differ from industry to industry (e.g., automotive, medical, aerospace, etc.)
- Strong "spheres of influence" of both ASQ and JUSE have led to accepting their approaches to quality improvement in key regional areas; however, lack of explicit alignment between their methods and across industry leaves the SME without any real guidance as to how to implement a single system that will satisfy all demands.

FINALLY:

- The SME is probably the **least qualified** participant in a supply chain to have expertise necessary to manage this strongly complicated requirement to develop a local quality system.

 60

60

Lessons learned about structured problem solving:

Over the years we have learned many lessons about how to conduct a structured problem solving:

- Develop an overall graphical representation of the problem space.
- Identify rational sub-groups for analysis of the problem in both the process and measurement dimensions.
- Examine aggregate performance patterns or trends observable in the output indicator and then separately by the meaningful rational sub-groups (e.g., geographical, market, product-based, etc.) to identify concentration areas to focus the inquiry.
- Examine historical trends by rational sub-group and distinguish the frequency of occurrence of issues by categories of potential problem.
- Examine performance times across the process flow to determine if bottlenecks or imbalance occurs.
- Distinguish differences in performance conditions and operations by comparing the best and worst to determine how the processes were operating differently.
- Build hypotheses for inquiry and testing of theories about influence.
- Test the hypotheses by manipulating the processes as experiments.

 61

61

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Thank you for your attention!

 62

62

Final Report
Part 3: Continual Improvement Model
10 July 2017

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ENGINEERING THE PROCESS OF CONTINUAL IMPROVEMENT

Advancing Quality as Science: Improving Analytical Structure and Methods

Co-Editors: Gregory H. Watson and Lars Sörqvist

 1

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Approach to Continual Improvement: Summary – 1

- Improvement is only possible if the people in an organization become mindful about issues that are hindering performance capability. When the organization builds an improvement culture, then the gateway is opened to develop the potential for continual improvement thorough responsible management.
- Continual improvement is impossible if there is no awareness of the situation that is happening: the conjoined discovery acts of sensing, noticing, observing, recording, and interpreting can be enjoined for conducting anallysis of the current state of performance.
- It is essential to understand the current state of performance before determining what improvement is necessary; otherwise, you are just guessing about what needs to be done (or brainstorming as it is most typically described).
- Continual improvement requires reflection on the situation that is discovered in the current state and this implies a comparison to a desired state for the outcome. If the desired state has been defined according to the best practices and standardized for performance, then there is a sound basis for making improvement. Thus, it is preferable that work standards be established prior to initiating a broad program of improvement.

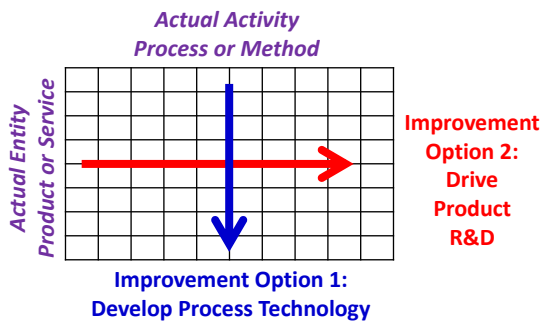
The nature of human organization:

Organizations are systems that are designed to fulfill a purpose through a coordinated use of human and infrastructure resources through a sequence of its actual work activities, or the method and processes that are designed to produce the actual entity of a service or a product that fulfills the business purpose of the organization to the satisfaction of its core stakeholders. Improvements are made to address either human or systemic dimensions.

Business System Design:

A business system will operate by designing and delivering deliverables across the systems that create them. The "actual entity" is focused on the outcome content while the "actual activity" is focused on the means by which the outcome is prepared. If an organization needs to improve its results, then it can be accomplished in two ways depending on the nature of the business challenge it faces.

Matrix Organizational Structure:



"Deliverable content to customers is created by accumulation of value in the process flow across the functional activities which contribute the competence and methods that design work to create results."

~ Gregory H. Watson

Approach to Continual Improvement: Summary – 2

- To really know that an improvement has occurred, it is essential that a sound basis for performance be defined in a stable measurement.
- Performance measurement systems must accomplish two objectives: they should track progress of the process throughput to assure work is accomplished efficiently (e.g., cycle time, quality level of activities, and transaction cost) and that results meet expectations of the recipients of the deliverable outcome and investors in the process infrastructure.
- Once a standard has been established and its performance measures with targets set, then the act of discovery can commence to manage the process of continual improvement as a learning experience to seek to initially learn about three factors:
  - **Observation**: An act of noticing a situation or circumstance that influences performance of an organization (a function of sensemaking and situational awareness).
  - **Issue**: An observation of a real or actual condition in a work activity that requires improvement based on observation or analytics.
  - **Risk**: An observation of a potential work condition, activity or deliverable that requires corrective and/or preventive action in the future in order to assure achievement of the purpose of an organization or its processes.

 5

5

Approach to Continual Improvement: Summary – 3

- The Continual Improvement Model (CIM) is a mental model that can be used to structure the project management approach to improving the standard work in an organization. CIM can be used to manage the hoshin kanri type of improvement project that has been identified and selected by management to investigate as a potential "game-changer" in its pursuit for higher levels of organizational performance that will aid it in accomplishing its business purpose over a sustained period of time. CIM blends the methods and techniques of many disciplines in a sequence of seven project management steps that transition noticing a performance issue into corrective action that becomes embedded into the standard work of an organization. Steps in the CIM approach are:
  1. Characterize
  2. Investigate
  3. Explore
  4. Solve
  5. Evaluate
  6. Implement
  7. Monitor

  An engineered approach to developing and sustaining a competitive level of business performance capability is essential to achieve long-term commercial success in any organization. This approach needs to operate end-to-end and it must develop profound knowledge to perform successfully. Such management systems must be designed to achieve strategic organizational intent; be executed flawlessly so that no losses occur in the organizational development process; and be monitored aggressively so that information is not lost which may be essential for steering the organizational performance and achieving stability in outcomes and consistent improvement.
- The result of the execution of the CIM approach should be an improvement in the standard work performance of the organization.

 6

6

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CONTINUAL IMPROVEMENT MODEL: INTRODUCTION

 7

7

Results Obtained … Continual Improvement Model:

- The model is a seven-step project management process that pulls data through a series of questions and operates at three levels of competence in conducting an inquiry:
  - (1) Maintaining and improving standard work (***process doers*** who operate at a so-called "yellow-belt" level);
  - (2) Solving more complex problems and integrating all the flows across work processes (***process facilitators*** who operate at a so-called "green-belt" level); and
  - (3) Increasing work performance capability by designing improved cross-process work flows (***process designers*** who operate at a so-called "black-belt" level).
- This model uses core measures of work processes: quality of throughput, consistency, safety, economy of operations, and worker motivation. It also applies team-based methods as supervised by a trained facilitator who leads the effort.

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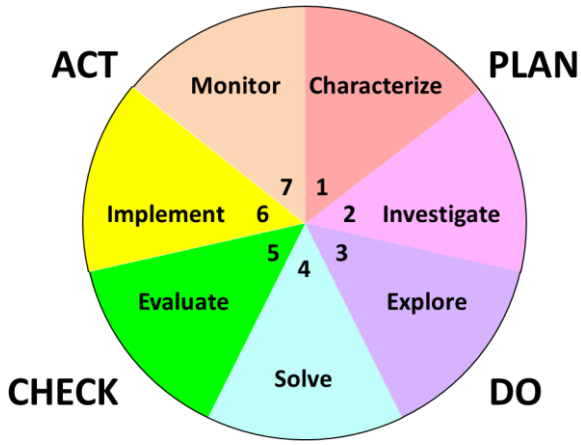
Continual Improvement Model:

A thinking process to pull observations into data that shows causality and improves the way that people work:



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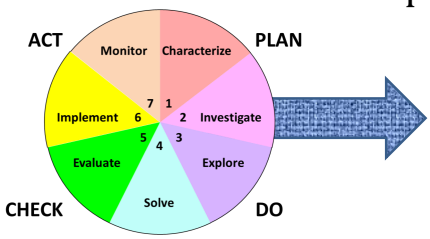
Structured Continual Improvement Model:



The questions addressed, tools and methods used and the outcomes of the work are all similar to a blend of the Standardize-Do-Check-Act (SDCA) and Plan-Do-Check-Act (PDCA) method Japanese TQM (Total Quality Management) applies and it parallels the Lean Six Sigma extended process of Recognize, Define, Measure, Analyze, Improve, Control, Standardize, and Integrate (DMAIC+).

QUESTION:

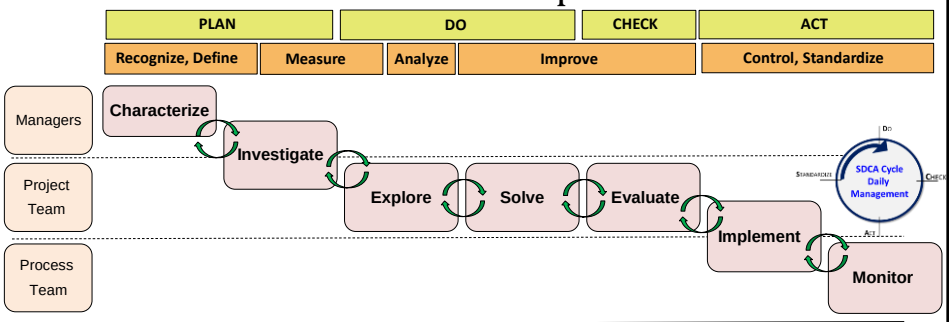
What common elements do all continual improvement models contain that may be integrated into a generic model that satisfies the needs of all functional disciplines?

- **Characterize**: Identify an opportunity then define, specify and scope the project.
- **Investigate**: Evaluate facts to find boundary constraints that limit an opportunity.
- **Explore**: Identify the essential nature of the opportunity to improve.
- **Solve**: Determine alternatives for improving outcome performance.
- **Evaluate**: Demonstrate the efficacy of the proposed solution(s).
- **Implement**: Develop plans for implementation and benefit capture.
- **Monitor**: Monitor the process to ensure sustained, consistent performance.

 10

10

Visualization of the Continual Improvement Model:



Questions	**What** is the issue/concern and strategic alignment?	**What** is "as is" state of current situation?	**Which** factors will most likely affect the overall performance?	**Which** factors really affect the performance and how much influence do they have (causality)?	**How** effective and robust is the set of proposed solutions?	**How** will a transition to the improved process be done and how will it be maintained?	**How** well does the process continue to operate doing its routine tasks?
Activities	Define, specify and scope the opportunity to improve • Strategy alignment • Initial issue investigation • Project management	Evaluate facts to find boundary constraints • Graphical process presentation • Exploratory data analysis • Quantify capability and potential	Identify the essential nature of the opportunity to improve • Process analysis • Data analysis • Work analysis	Determine alternatives for improving outcome performance • Demo testing • Experimentation • Lab process analysis • Benchmarking	Demonstrate the efficacy of the proposed solution and confirm the results • Confirmation experiments • Improvement demonstration	Develop plan to assure that change will be implemented • Control plans • Training • Physical changes • Benefit capture plan	Stabilize process, replicate and extend group work for process improvement • Routine daily management • Continual improvement

 11

11

Systematic Risk and Failure Opportunity Analysis

Risk and Potential Failure Analysis	**Risk Specification** • Physical or digital process location • Potential Failure • Mechanism of the Failure
	Potential Failure Assessment • Expectation of Failure Effect • Severity of Failure Effect • Probability of Failure
	Impact of the Potential Failure • Customer Impact • Brand Reputation Impact • Financial Impact
	Managerial Judgment • Recommended Management Action
Action Plan for Risk Management	**Preventive Actions** • Immediate actions for remediation • Plan for prevention and level of achievement expected
	Contingent Actions • Trigger for contingent actions • Contingent actions anticipated
	Assignment for Action • Responsible Process Owner • Responsible Worker

 12

12

Deploying the Continual Improvement Model:

Characterize	Investigate	Explore	Solve	Evaluate	Implement	Monitor
1.Describe the issue to be addressed 2.Specify the issue as a business concern 3.Localize the occurrence in time and place 4.Establish customer impact of the issue 5.Determine expectations and consequences 6.Identify managers responsible for action 7.Provide resources to address the issue 8.Convene the project team	1.Characterize customer value 2.Develop a descriptive narrative 3.Decompose the narrative into its issues 4.Define the current state of performance 5.Determine the ideal state of performance 6.Determine practical limitations of the project 7.Define the issue statement to be addressed 8.Limit the internal scope of the inquiry 9.Develop a study plan for the investigation 10.Develop a plan for execution of the project	1.Create graphical descriptions of the process 2.Determine the necessary facts and data 3.Evaluate integrity of the available information 4.Build an information collection plan 5.Evaluate information collection effectiveness 6.Develop an analytical model of the process 7.Quantify cost of waste, losses and inefficiency 8.Document the performance baseline 9.Discover relative influence of process factors	1.Distinguish between system and individual controllable improvement issues 2.Identify appropriate solution approach 3.Evaluate possible solutions and results 4.Evaluate expected outcomes and benefits 5.Perform sensitivity, risk analysis and identify implications of intended change consequences 6.Assess unintended consequences of change 7.Define how to implement and control solutions	1. Find the best optimal solution 2. Create solution robustness 3. Assure measurement system integrity 4. Estimate expected benefits and results 5. Clarify implementation responsibilities 6. Identify third-party benefit assessor	1.Align project with cross-functional change management process 2.Build and follow implementation plan 3.Upgrade skills and competence in the system 4.Deploy the standardized solution plan 5.Evaluate implementation of solution 6.Extract and leverage lessons learned 7.Identify further improvement projects 8.Prepare, communicate, and record the final project report	1.Perform daily work of the process 2.Evaluate process performance regularly 3.Examine possible deviations and side effects 4.Scale up from pilot to full solution adoption 5.Conduct continual improvement reviews 6.Report actual performance results and benefits achieved 7.Communicate results and lessons learned 8.Celebrate success of the project

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CONTINUAL IMPROVEMENT MODEL CHARACTERIZE STEP

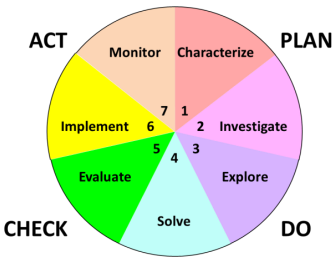
1. Characterize

Objective:

- **Characterize**: Describe issue, scope and opportunity to improve.

Questions:

- What is the issue or concern?
- What are the symptoms?
- How big is the potential impact?
- Where is the situation occurring?
- How does it affect our customers?
- Who should take responsibility?



New analytical and process elements included in this phase:

- Strategic Alignment of Improvement Projects
- Measurement System Alignment
- Situational Awareness and Sensemaking
- Lean Thinking – Characterize Customer Value
- Behavioral Analytics (Strategic – Kahneman's System 1 and System 2)
- Exploratory Data Analysis (Results Measures)

 15

15

Continual Improvement Model: Characterize

1. Describe the issue to be addressed
2. Specify the issue as a business concern
3. Localize the occurrence in time and place
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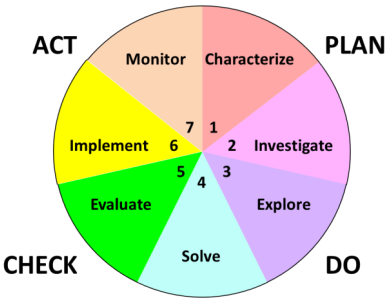
5. Determine expectations and consequences
6. Identify managers responsible for action
7. Provide resources to address the issue
8. Convene the project team



DMAIC: Recognize-Define

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

 16

16

1. Characterize

1. **Describe the issue to be addressed**
2. Specify the issue as a business concern
3. Localize the occurrence in time and place
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6. Identify managers responsible for action
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8. Convene the project team

1.1 Statement of Symptoms

Operational Definition: The presenting apparent cause that creates awareness that there is an issue to be addressed.

Items to Address:

- What is our vision of the future and what could prevent it from becoming a reality?
- What business assumptions are embedded in our legacy ways of thinking that constrain future opportunities?
- What happened? What has gone right in our results that could become an even more powerful force in the future?
- Have made visible and understandable the current set of situations or issues that should cause business concern?
- What tangible and intangible results demonstrate that an opportunity for improvement exists?
- How can the functional organization components be used to facilitate improvement of the end-to-end process?

Examples of Symptoms:

- Managerial sense of "discomfort" with their situation
- Customer experience concern conditions are detected
- Business growth opportunities that are unaddressed
- Perceived risk in future state of the environment
- Spending more than required for an investment
- Unusual waste, loss or inefficiency in daily operations.
- Revenue shortfall from prediction
- Customer complaints or product returns
- Market rumors or suspicions

 17

17

1. Characterize

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1.2 Business Implication

Operational Definition: An observation that has been noted as an irregularity in the business and which has a potential impact on future opportunities for performance.

Items to Address:

- How do these perceived irregular circumstances noted in the business environment challenge our standard ways of working?
- Has this problem been addressed or solved by another organization either internally or externally?
- What inventive ways could we address this observed set of circumstances to focus future performance opportunities?

Examples of Implications:

- Unexpected overachievement of sales forecast.
- Loss of a "critical-to-success" customer or market.
- Disruptive technology or competence introduced that will revolutionize the business area.
- Shift in revenue base causing a readdressing of criteria for cost-effectiveness in performance.
- Radical shift in customer value propositions.
- Demand increases performance requirements without the necessary budgetary support.
- Competitor with new products launched prior to our own readiness to "go to market" with comparable products.

 18

18

1. Characterize

1. Describe the issue to be addressed
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1.3 Issue Location

Operational Definition: Identification of the characteristics in the set of symptoms that point to a specific location of the source of concern or which define boundaries of an episode that has been observed.

Items to Address:

- When did it happen? What was the history of occurrence of the originally observed event? What was the sequence in the observations? Was there a repeating pattern of effects that were noted?
- Where did it happen? What was the specific geographic location, process application, organizational component and human element involved?

Examples of Location:

- Geographic specific issue or episode
- Application area issue or episode
- Organizational-specific issue or episode
- Process, product, or service-specific issue or episode
- Time-specific or seasonal issue or episode

 19

19

1. Characterize

1. Describe the issue to be addressed
2. Specify the issue as a business concern
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6. Identify managers responsible for action
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8. Convene the project team

1.4 Customer Effect

Operational Definition: The observed symptoms inhibit the ability of specific customers of a product (either tangible or intangible), process or service deliverable from achieving the intended objective.

Items to Address:

- Which customers have what performance expectations?
- Which expectations are most important to be achieved by the deliverable?
- What needs and expectations do customers have relative to these deliverable characteristics (both explicit as well as implicit or latent expectations)?
- What unanticipated consequences have our customers experienced as a result of using these deliverables?

Examples of Effects:

- Customers are unable to use the deliverable as intended in its original design.
- Customers were unable to achieve the performance from this deliverable as anticipated based on its expected performance capability.
- While customers can use the deliverable and it also works as advertised, the performance capability is unable to meet the current needs for performance.

 20

20

1. Characterize

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8. Convene the project team

1.5 Performance Expectation

Operational Definition: The level of performance or rate of change in outcomes that are achieved through the operation of the product, process or service. The increase in stability of a process through reduced risk, enhanced legal compliance, or improved regulatory control. Increased satisfaction of the employees and customers with the organization's procedures and processes.

Items to Address:

- What are the essential requirements of deliverables which customers rank as "musts" for demanded performance?
- What needs and expectations of targeted customers are essential to meet comparative requirements of the final deliverable?
- What latent desires, hopes, or wishes of either actual or potential customers create unique attractive ingredients to interest them in product, process or service deliverables?
- What risks does the organization face as consequences of not properly addressing the performance expectations of the customers?

Examples of Expectations:

- Financial and process performance of the organization.
- interactions between an organization's people, processes, and procedures build trust with and create value for both customers and employees.

 21

21

1. Characterize

1. Describe the issue to be addressed
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6. **Identify managers responsible for action**
7. Provide resources to address the issue
8. Convene the project team

1.6 Responsible Manager

Operational Definition: The managerial role that has been assigned to an individual for routine operation of particular work area including both control and improvement aspects and sponsoring specific improvement projects.

Items to Address:

- Which executives should serve on a cross-functional team for steering the progress of this project?
- Who should serve as the responsible executive to sponsor the improvement project? Who should serve as business-oriented leader, project manager or process owner who is actively engaged to assure expectations are achieved and adverse consequences are avoided?
- How is this project aligned with strategic change actions in the organization's improvement plans? How do executive sponsors of strategic change initiatives incorporate these opportunities for improvement into an ongoing integrated plans of action? How is the project prioritized for team participation and resources relative to other efforts?

Examples of Responsibility:

- Ownership of budgetary controls related to the focus area.
- Possession of decision rights relative to managing change.
- Ability of invest in competence and people development.
- Responsibility for reporting information and performance.

 22

22

1.Characterize

1.Describe the issue to be addressed
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1.7 Resources Required

Operational Definition: Consideration of the importance and availability of the various resources required to conduct the entire improvement project including the fiscal, managerial , facility and also the human competence concerns necessary to assure success.

Items to Address:

- What specific skills and levels of competence are required to do work that is capable to successfully complete the improvement project?
- What organizational resources are necessary to remove any structural barriers to progress (e.g., financial, data, or access requirements)?
- Will these resources be readily available to the team so the improvement investigation is not delayed by excessive bureaucracy!

Examples of Resources:

- Time for project improvement activities.
- Access to data for analyzing performance and evaluating process throughput productivity, quality and costs.
- Access to the targeted improvement process for observing, testing and conducting experiments.
- Investments in necessary improvement equipment that will facilitate the analysis process.
- Assignment of essential individuals with relevant capability and competence to participate on the team.

 23

23

1. Characterize

1.Describe the issue to be addressed
2.Specify the issue as a business concern
3.Localize the occurrence in time and place
4.Establish customer impact of the issue
5.Determine expectations and consequences
6.Identify managers responsible for action
7.Provide resources to address the issue
8.Convene the project team

1.8 Team Members

Operational Definition: Individuals assigned to collaborate on an improvement project as either core team members or ad hoc members participating as needed or in the role that provides managerial oversight for the improvement effort.

Items to Address:

- Which technical specialists, problem-solving specialists, financial specialists, and data specialists are required to participate in the team to address the improvement project properly?
- Which specific individuals will make the most significant contributions in these team roles?
- How can these diverse individuals be formed into an effective team with specified roles and responsibilities?

Examples of Team Members:

- Executive sponsor
- Cross-functional steering committee
- Process owner
- Improvement facilitator
- Improvement specialist
- Improvement expert
- Process doers (workers)
- Technology specialists
- Financial analyst

 24

24

Issue Registration Form	
Issue Identification and Description:	Issue Location • Physical or digital process location • Sub-process or algorithmic identification
	Issue Description
	Effect of the issue and Operational Importance
	Reporting Information • Reporting Individual and Date of Observation • Process Conditions at Time of Report
Action Plan for Issue Resolution	Action Priority: • Estimate of Type and Magnitude of Potential Benefit • Estimated Time for Corrective Action
	Scope, Boundary Conditions, Constraints
	Assigned to Responsible Manager

 25

25

Characterize Template	
Statement of Performance Symptoms • What happened? • When did it happen? • Who was there? • When did it happen? • Why did it happen? • How did it happen?	Issue Location • Where did it happen? • Who is the responsible manager?
	Business Implication
Performance Expectation	Customer Effect
Process Owner / Responsible Manager	Benefit to Capture
Project Manager / Champion	Team Leader / Project Facilitator
Improvement Approach • Where did it happen? • Who is the responsible manager?	Resources Required
Team Members, Contact Information, Individual Roles, and Project Responsibility	

 26

26

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CONTINUAL IMPROVEMENT MODEL: INVESTIGATE STEP

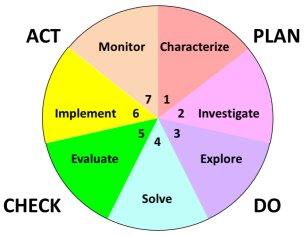
2. Investigate

Objective:

- **Investigate**: Evaluate facts to find boundary constraints that limit an opportunity.

Questions:

- What is the situation?
- How well is the process doing?
- How well could it be doing?
- Can the process detect problems?
- How can the process fail?
- What is the process loss function?
- Does the history show any trend?
- Where should the project focus?



New analytical and process elements included in this phase:

- Behavioral Analytics (Operational Applications)
- Graphical Process Analysis and Mind Mapping
- Business Risk Analysis (Externalities)
- Lean Thinking – Determine the Flow
- Business Excellence Assessment
- Strategic Benchmarking

Continual Improvement Model: Investigate

1. Characterize customer value
2. Develop a descriptive narrative
3. Decompose the narrative into its issues
4. Define the current state of performance
5. Determine the ideal state of performance
6. Determine practical limitations of the project
7. Define the issue statement to be addressed
8. Limit the internal scope of the inquiry
9. Develop a study plan for the investigation
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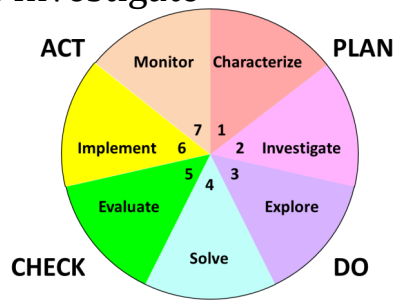

DMAIC: Define-Measure

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

2. Investigate

1. **Characterize customer value**
2. Develop a descriptive narrative
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2.1 Valuation Analysis

Operational Definition: The description of how a process will deliver value-adding deliverables to customers while at the same time eliminating waste, loss and inefficiency.

Items to Address:

- Does the organization understand the true nature of its customer requirements for performance so it is possible to conduct an objective comparison to external data?
- Does the organization understand the true nature of its external environment (i.e., customers and markets, leading process organizations, and industry-wide trends) that will help focus and direct its internal improvement effort?
- Is management's understanding of the symptoms sufficient to indicate that there is sufficient benefit to be pursued in conducting an improvement project focused on this specific activity?
- Does the organization have sufficient information to give the project team to focus on customer needs that will be able to resolve the problem correctly?

Examples of Valuation Analysis:

- Voice of the customer/customer requirements analysis
- Kano Model
- Process productivity and effectiveness analysis
- Process waste map (e.g. high-level value stream map) and efficiency analysis.
- Financial impact and economic analysis.

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2.2 High-Level Process

Operational Definition: The initial description that defines how the context of a problem or issue evolves as an end-to-end (from the understanding of the customer requirements to the satisfaction of those requirements at the customer after completion of the process) set of circumstances which creates the discrepant set of conditions that need to be improved.

Items to Address:

- Does the project team have sufficient understanding of its process to address the problem?
- Are all engaged parts of the organization represented in the project team so a holistic perspective of the entire process and its situation can be studied?
- How does this proposed effort relate to the ongoing set of strategic change initiatives that the organization is now conducting or planned to address in the near future?

Examples of High-Level Process:

- SIPOC Map (with or without Rolled Throughput Yield)
- Business Process Map/Customer Process Map
- Organizational Context Diagram
- Narrative Problem Description

 31

31

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2.3 Define Functions in the Process

Operational Definition: The decomposition of the work of the organization covered by the end-to-end process into its functional components (e.g., functional mapping to show the various groups who participate in assuring end-to-end flow of the process activity).

Items to Address:

- What functional activities contribute to the performance that has been noted as being irregular?
- In what way do these functions contribute to the process outcomes and do they constrain in some way the process performance?
- Which factors that have been identified are controllable and which are noise factors relative to management's ability to control the process outcomes? Which factors are system-level issues, controllable by management, as compared to factors controllable by operators as human factor issues?

Examples of Functions in the Process:

- Functions are competence groups that support process performance outcomes.
- Using the Fishbone Diagram to show functional linkages that are necessary to understand the process narrative situation.
- Other methods: Mind Map, Tree Diagram, Deployment Diagram, Interrelationship Diagram, Activity Diagram.

 32

32

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2.4 Actual Capability Analysis

Operational Definition: Actual process capability defines the relationship between the full range of natural variation observed in a process as designed and delivered, compared to performance limits specified for its deliverable results or outcomes.

Items to Address:

- What is the true nature of the customer requirements as specified by customers using performance boundaries?
- How relevant are these specification to the actual needs of customers for outcome results?
- What performance boundaries are implied for a process in its natural design state (e.g., financial targets, service level agreements, or a set of standard conditions)?
- What is the level of process stability over time? What is the baseline performance of the process Y-measure as has been observed?

Examples of Actual Capability Analysis:

- Requirements analysis and specification management.
- Standard process performance (average results for cost standards, contractual guarantees or operating targets).
- Analysis of "best day/worst day" conditions.
- Process capability analysis (biased for mean) (Cpk)
- Process capability analysis (biased for target) (Cpm)
- Process performance results baseline for productivity and profitability of the process.

 33

33

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2.5 Desired Capability Analysis

Operational Definition: This performance indicator explains the design capability of a process to inherently perform to a specified level of performance. It equates to an ideal level of process performance such as the "nameplate" output of a machine or the ability of a process to produce specified results under controlled laboratory conditions. As a rough, heuristic approximation for this index the "best day of performance" may be used to indicate an expected value for capability.

Items to Address:

- What are the customer-required performance limits for their critical-to-satisfaction performance indicators?
- At what point in this performance spectrum will your key customers no longer accept performance degradation?
- How much performance "safeguard band" is required to assure that customer degradation is highly improbable?
- What decisions are possible for improvement as the level of observed Cpk approaches the design limits of Cp?

Examples of Desired Capability Analysis:

- Process capability index (Cp) .
- Observed "best day" of output for a given process.

 34

34

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2.6 Constraints and Risk Analysis

Operational Definition: This addresses business risk that is generated by either pursuing or not pursing the project. It is the opportunity to miss the organization's goals through a constraint or risk which inhibits desired performance results or missing managerial performance targets.

Items to Address:

- What risk is implied for the organization in consideration of the items to be addressed in the problem as defined?
- What constraints inhibit achievement of desired results or performance outcomes?
- What external risk circumstances could influence

Examples of Constraints and Risk Analysis:

- Risk management process.
- Force field analysis.
- Evaporating cloud diagram.
- Failure opportunity analysis.
- Systems event tree analysis (software failure).
- Risk analysis matrix.

 35

35

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2.7 Problem Statement

Operational Definition: Problems are specified by the difference between the current and desired state of affairs of an issue and it does not include any expectations or implications about solutions or levels of the improvement that may be achievable. The description of an issue to be addressed which includes a performance measure, desired direction of improvement (increase, control or reduce), and the location at which the issue is observed and it is possible to make decisions that could regulate the throughput to achieve a state of control.

Items to Address:

- How can the problem be operationally defined in terms that are meaningful to the process operators?
- What is the performance measure of successful outcome for the process? How does this measure indicate a level of goodness for the results and lack of control in overall performance?
- What is the desired performance improvement based on the observed condition (increase, reduce or maintain)?
- At what point in the process is the performance measure taken and where can this function be controlled in a way that regulates process outcomes?

Examples of Problem Statements:

- Outcomes of a process query using the 5W + 1 H.
- Outcomes from defining SMART objective.

 36

36

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2.8 Project Boundary Scoping

Operational Definition: Boundary conditions define the limits of concern for investigation of a problem state. Boundaries may be set by organizational structure, geographical limits, or temporal distinctions. Boundaries must be clearly set so that they identify natural differences between the performance descriptors for the rational sub-groups from the highest level of abstraction in the process design to the most detailed level of process work. The problem's decomposition into rational sub-groups should provide a pathway for conducting future inquiries into process performance.

Items to Address:

- What is included for consideration in a problem and where is the boundary between concerns that are excluded from pursuit by the team?
- What should be the "stopping rule" for decomposition of the problem statement or extension of the problem scope?

Examples of Project Boundary Scope:

- Customers or markets included or excluded from study.
- Geographical regions included or excluded from study.
- Organizational units included or excluded from study.
- Products or services included or excluded from study.
- Process or process phases included or excluded from study.
- Production equipment included or excluded from study.
- Time periods included or excluded from study.

 37

37

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2.9 Draft the Investigation Plan

Operational Definition: The study plan describes how the team will pursue its inquiry and identifies the data elements for focus, location for collection of data, storage parameters about the data, and also may include such concerns as the sampling plan for size and frequency of data collection. The study plan should also identify the sequence of questions to be addressed and suggested analytical methods for conduct of the inquiry. This plan originally focuses on the "Y" metric performance at the "meta-level" of process performance to inquire about the overall outcome results.

Items to Address:

- What are the constraints to performance measurement and access to operational data?
- How well do we detect overall operational performance as changes in observable process indicators?
- What should be measured? How should it be measured? What are the recommended sampling method, sample size, sampling frequency, time of the observation? Who should measure? How should the data be documented graphically and interpreted? What is the risk inherent in the data collection process?
- How is this observed in the historical process of interest?

Examples of Investigation Plan:

- Data collection plan for process outcome data.
- Performance baseline for process performance.

 38

38

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2.10 Project Management Plan and Charter

Operational Definition: The project plan or charter is a management document that governs the execution of the project.

Items to Address:

- What is the problem statement and overall performance measure for the project? What are the boundary conditions of the project?
- How are schedule, resources and risk to be considered in the project planning?
- What will be the project governance structure for: senior leadership sponsorship, steering committee advice, lead for project management, and other stakeholders with a shared interest in the project? How will reporting and the project follow-up for execution be managed?
- Who are the people involved in the project and what are their roles and commitment of time? Who else could be effected during the project's progress? How will they be included in the project team? What are the expectations for their engagement? How will communications with them be conducted?
- How will project lessons learned be preserved, shared, and applied for future improvements?

Examples of Project Management Plan and Charter:

- Suggested template for a project charter.

 39

39

Investigate Template - 1

Business Case for Change:

- What is the business objective to be achieved?
- Are realistic alternatives presented for consideration?
- Are comprehensive risks and benefits presented for all alternative decisions?
- Are the sources of data used in the comparative analysis credible and represent broad perspectives about relative opportunities?
- How does the case challenge the critical assumptions of the organization's baseline business model?

Qualitative Assessment

- How is this project *aligned with our strategy*?
- Why is this *specific* project important?
- Why is it important to do this project *now*?
- How does this project effect the *results, goals and success* of our business?
- How would this project affect our *competitive position*?

Quantitative Assessment

- What is the magnitude of the *loss, waste and inefficiency that are* observed across the end-to-end process?
- What is the total *end-to-end cost* of the process?
- How much more has been invested in the infrastructure than is required for meeting performance objectives if the process operates at maximum efficiency and effectiveness.

Human Returns on the Project

- What are the internal employee-related implications that are related to the issue performance?
- What are the potential customer-related effects of this project?
- What are the important shareholder-related effects of this project?

Benefit Scheduled to Capture

- What financial benefits are expected to be achieved in terms of increased revenue, reduced assets, improvement in working capital, or reduction in transaction costs?
- What legal, regulatory or ethical improvements may be made to improve the public responsibility of the organization?
- What employee hassles can be reduced to improve quality of working life?

Problem Architecture

- Incorporate the context diagram of the business (e.g., using a comprehensive SIPOC map) with the value stream for the deliverable performance measures tracking across the major steps in the business processes.

Performance Baseline

- Incorporate the Exploratory Data Analysis summary for the Business outcome "Y" performance measures of success showing both the historical performance and the current capability with a synopsis of performance issues.

 40

40

Investigate Template - 2

Issue Definition and Process Challenge

- Problem description – what symptoms have been observed in the work process.
- Problem Statement – what is the output measure that needs to be improved?
- What is the measure of the output and the desired direction of improvement (improve, reduce or control) and the boundary conditions where the problem occurs.
- What are the consequences of the issue with respect to financial performance and the impact on customers (also, which groups of customers are most affected)?
- Provide a SIPOC map to define the context of the problem with a value-stream map for the KPI Y-metric.
- Provide a Fishbone diagram to identify the rational subgroups in the process that are worth analyzing.

Current State Analysis

- What is the current state of the issue from the customer perspective?
- Define for the process deliverable indicators and for the process activity; indicators.
- The process key process Y measure (KPI) should be defined using a four-up chart that consists of an I-Chart (with stages), process capability analysis, Pareto diagram of incidents of process failure and a one-way ANOVA illustrating flow across sub processes.

Desired Future State and Risks or Barriers to Achievement

- Define the achievable target performance that is desired state of improvement after the identified issue is resolved.
- What is the benefit to be captured through the improvement?
- What are the risks to be addressed and mitigated or safeguarded in this approach?
- Define the predictable performance improvement to be addressed (R-squared change)
- Illustrate the "should be" process definition to be developed.

Plan of Action and Milestones

- Define the project elements to be addressed with actions and targets set

 41

41

Project Plan of Action and Milestones (POA&M):

Date of Report

Improvement Project Tasks and Structure

Task / Phase	Year/Quarter	Year/Quarter	Year/Quarter	Year/Quarter	Year/Quarter
CHARACTERIZE					
Sub-Tasks as specified					
INVESTIGATE					
Sub-Tasks as specified					
EXPLORE					
Sub-Tasks as specified					
SOLVE					
Sub-Tasks as specified					
EVALLUATE					
Sub-Tasks as specified					
IMPLEMENT					
Sub-Tasks as specified					
MONITOR					
Sub-Tasks as specified					

Task
Phase end

On schedule

Delayed

Not started

 42

42

International Academy for Quality

CONTINUAL IMPROVEMENT MODEL: EXPLORE STEP

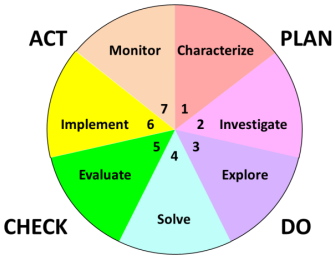
3. Explore

Objective:

- **Explore**: Identify the essential nature of the opportunity to improve.

Questions:

- Is anyone doing this work better?
- What are the potential causes?
- What is the cost of poor quality?
- How can the work be simplified?
- Which factors affect variation?
- Where is productive time lost?
- Where is cost wasted?
- How much variation is explained?
- What are potential root causes?
- Are there any 'missing' variables?

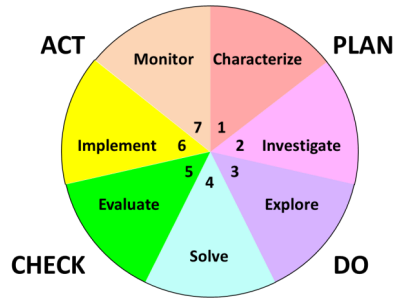


New analytical and process elements included in this phase:

- Responsibility and Risk Analysis (Internalities)
- Behavioral Analytics (System 2 Rules Development)
- Lean Process Analysis – Analyze the Flow
- Exploratory Data Analysis (Process Measures)
- Best Sub-sets Regression
- Partial Least Squares Regression

Continual Improvement Model: Explore

1. Create graphical descriptions of the process
2. Determine the necessary facts and data
3. Evaluate integrity of the available information
4. Build an information collection plan
5. Evaluate information collection effectiveness
6. Develop an analytical model of the process
7. Quantify cost of waste, losses and inefficiency
8. Document the performance baseline
9. Discover relative influence of process factors



DMAIC: Measure-Analyze

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

 45

45

3. Explore
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3.1 Create Graphical Description of the Process

Operational Definition: Graphical description is used as a means to describe how the process works from a variety of perspectives: functional viewpoint, sequential process step viewpoint, measurement hierarchical structure, failure/risk perspective, value stream description, coordination of work viewpoint and detailed thought map.

Items to Address:

- Functional perspective is shown as a characteristic quality description.
- Sequential process step is delivered using flow charts that describe the flow of process events.
- Measurement hierarchy is show with a tree diagram that decomposes higher order metrics to work level measures (quality, cost and time).
- Potential failure analysis is summarized using a matrix of risks and actions.

Examples of Graphical Representation:

- Fishbone Diagram or Mind Map.
- Deployment Diagram or Thought Map.
- Tree Diagram or Value Stream,
- Potential Problem Analysis, Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA) and Event Tree Diagram (ETD).

 46

46

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3.2 Determine Necessary Facts and Data

Operational Definition: Facts and data begin with the identification of factors that are critical-to-satisfaction (CTS) results/output measures of the process deliverables (Key Process Output Variables (KPOV or "Y" measures) and then decomposed using a measurement tree to breakdown CTS level metrics into critical-to-quality (CTQ) measures that define process measures or X measures in categories such as quality, cost and time). Through detailed process analysis sources of waste, loss and inefficiency can be identified for subsequent improvement.

Items to Address:

- Determine measures of flow that link process outcomes to process inputs and process monitoring indicators.
- Performance should be traceable for cycle time factors, cost elements, quality characteristics and satisfaction or motivation as well as safety of employees.
- Actual process performance as well as theoretical process performance should be calculated a visible loss function.
- An analytical model of process performance should be linked to the graphical model of the physical process using the value stream map.

Examples of Necessary Facts and Data:

- Rolled throughput yield, transaction cost, A Δ T (Actual to Theoretical Cycle Time), etc.

 47

47

3. Explore

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3.3 Evaluate Integrity of the Available Information

Operational Definition: Determination of the quality of data management and analysis for the Y-measure (e.g., results indicators) including the meaning of terms, rational sub-groups for dividing information by sub-category and measurement analysis to determine quality of the data for detecting process change.

Items to Address:

- Meaning of measurements and methods for calculating.
- Sampling plan (sample size and sampling frequency).
- Rational sub-groups.
- Measurement error and noise.
- Analyze data structures and determine procedures for selecting data for system-level throughput analysis (Y's).
- IT data collection systems and determination of proper samples for calculation of baseline performance (for the Y-Measure).

Examples of Information Integrity Methods:

- Operational Definitions
- Measurement Tree
- Attribute Agreement Analysis
- Gage R&R for the Y-measure
- Gage Run Chart for the Y-measure
- Individuals Control Charts
- Process capability studies.

 48

48

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3.4 Build an Information Collection Plan

Operational Definition: Identify data collection points (e.g., check points and control points); data items to collect and store; sampling plan (sample size and sampling frequency; data storage location; and data access mechanisms.

Items to Address:

- What are the measurement devices, data collection forms and scales of performance measurement that should be used for the item to be measured?
- What data is captured at specific process locations and is it possible to implement corrective action feedback loops at these locations (e.g., converting check points to control points)?
- How will data integrity be guaranteed for observations of the process performance in the future?
- Who will manage the measurement system to assure that it maintains its performance capability?

Examples of Information Collection Plan:

- Control points: check points with feedback loops based on quality decision algorithms.
- Definition of the scales of measurement and selection of the measurement device for capturing and recording the observations.
- Measurement specification: documentation of all factors relevant to maintaining sound data collection methods.

 49

49

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3.5 Evaluate Information Collection Effectiveness

Operational Definition: Examination of historical data to see how well the information describes real-world performance data which has been the basis for prior management of the system (analysis of Y-performance over time).

Items to Address:

- Develop enumerative and analytical viewpoints about the process performance.
- Determine the process effectiveness relative to customer requirements.
- Determine most frequently occurring reasons for failure of the measurement system.
- Identify where in the process the measurement system indicates that problems occur most frequently/
- Identify the process steps where waste is most prevalent.

Examples of Information Control Effectiveness:

- Methods of Exploratory Data Analysis Including:
  - Individuals Control Chart
  - Process Capability Study
  - Pareto Chart
  - One-Way ANOVA
  - Yamazumi Diagram

 50

50

3. Explore

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3.6 Develop an Analytical Model of the Process

Operational Definition: Demonstrate the linkage between the graphical representation of the physical model and the numerical representation of the data model.

Items to Address:

- Identify the X-measures that create the results measures as Key Process Input Variables (KPIV).
- Determine the predictive power of X-measures to learn of variation in process performance that changes the output results.
- Link physical steps in the process to the measurements at control points which permit management observation as well as exercise of preventive and corrective action.

Examples of Analytical Model Components:

- Measurement decomposition diagram (e.g., Fishbone diagram or tree diagram)
- Process thought map for flow of measurements across the activity steps.
- Value stream added to either a deployment diagram (for human-intensive processes) or a thought map (for flow of engineering processes).
- Decision specification for all process points requiring managerial judgment.
- Responsibility Matrix for decisions (RACI Matrix)

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3.7 Quantify Cost of Waste, Losses and Inefficiency

Operational Definition: Define appropriate process wastes and losses that may be encountered and inefficiencies in the flow of work across the process with cost estimates for these factors.

Items to Address:

- Analysis of one-piece flow for efficiency, bottlenecks and systemic constraints.
- Examination of process potential for sub-optimization.
- Identification of the waste factors in the process (e.g., muri, mura, and muda).
- Specification of waste by type (categories of process loss and waste that are applicable to the target process).
- Estimation of transaction cost and financial loss that has occurred due to process waste, loss and inefficiency.

Examples of Measurement Quantification:

- Takt time (rate of incoming orders).
- Process activity cost.
- Cost of poor quality.
- Rolled Throughput Yield.
- Value stream cycle time losses.
- Process turnaround time (end-to-end cycle time).
- Defect rate by category of defective item.

3. Explore

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8. **Document the performance baseline**
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3.8 Document the Performance Baseline

Operational Definition: Specify the critical X-measures to be evaluated and evaluate the historical performance level for these X-measurements.

Items to Address:

- Operationally define measurement and defects that are applicable to the measurement observations.
- Conduct risk analysis to determine the effect of improper measurement on process performance outcomes.
- Define the measurement system and support procedures.
- Describe what can go wrong in the measurement system.
- Identify sources of measurement system noise.
- Determine measurement check and control points.
- Define measurement devices and scales of measurement.
- Quantify sample size and frequency to be used.
- Define appropriate measurement range for acceptable levels of performance (e.g., tolerance band).
- Determine process capability for each X-factor.
- Determine measurement responsibility and training that is required for operators to measure process data..

Examples of Performance Baseline:

- Process Performance Matrix for Y-Measure
- Process Performance Matrix for X-Measures
- Matrix cross-plot of Y to X Measures

 53

53

3. Explore

1. Create graphical descriptions of the process
2. Determine the necessary facts and data
3. Evaluate integrity of the available information
4. Build an information collection plan
5. Evaluate information collection effectiveness
6. Develop an analytical model of the process
7. Quantify cost of waste, losses and inefficiency
8. Document the performance baseline
9. **Discover relative influence of process factors**

3.9 Discover Relative Influence of Process Factors

Operational Definition: Determination of how the process performance factors influence a business case for change of the operational process and identify performance drivers in the process activities (e.g., cost drivers, quality drivers and time-wasters).

Items to Address:

- Determine the operational case for change (driven by an improvement in process efficiency) and the financial case for change (driven by cost reduction and improvement for productive output for top-line growth) which combine to form the business case.

Examples of Influential Process Factors:

- Business case analysis of problem status in terms of the effect on working capital reduction (cash flow measure), inventory reduction (balance sheet) and the contribution margin for individual products as a function of volume and throughput (profit and loss factor).

 54

54

Exploratory Data Analysis Template for Y-Deliverable Performance Metric

Understanding the patterns embedded in the distribution of the data:

- Enumerative perspective to understand overall performance expectations, identify risk level and to estimate the performance expectations in general (process capability study). Shape of the distribution is characteristic of the natural nature of the process variation (e.g., time series queueing data follows an Erlang distribution).
- Analytic perspective provides insight into observable patterns that illustrate trends, shifts, oscillations as well as excessive variation and unexpected stability (Individuals control chart with tests for pattern variation across the stages of natural sub-groups for timing of performance).

Understanding performance relative to established expectations:

- Understanding performance relative to performance boundaries agreed as specifications , requirements, or as service level agreements for performance expectations (expressed as a capability analysis). Difference between individual observations indicates the stability of the process in the short –term compared to overall results.
- Actual process performance (Cpk which represents the performance of a process at its level of its standard cost) can be compared to ideal process performance (Cp) to determine the degree of improvement that is possible by managing current resources. When Cp and Cpk converge then investment in additional system resources is required to increase further performance gains.

Incidents of issues as a function of rational sub-groups within actual activity and entity:

- Rational sub-groups representing types of losses, defects, and inefficiencies may be displayed on a Pareto Chart as relative frequency of occurrence (other displays may be as cost contribution to loss or as contribution to the observed process variation (using the R-squared statistic apportioned to individual causal actions). [This chart assumes that all conditions are independent which may not always be the case].

Observing flow experience across processes and production of waste, loss and inefficiency:

- Analyzing the time sequence of process steps and movements using Analysis of Variance (ANOVA) permits the identification of bottlenecks and flow disturbances that signal waste, loss, and inefficiency. These sub-process elements illustrate the best and worst process contributors to variation and determine where to investigate for identifying specific opportunities for improvement.

 55

55

CIM Progress Report:

Progress & Status

Tasks and Sub-Steps in the Project Phase

Task	Date	Status

Milestone — Due Date — Status

Achievements & Actual work

Current State and Planned Activity

Achieved
- Describe accomplishments of the project and the performance of the team according to the initial POA&M

Scheduled
- Summary observations for the phase of project
- Present next steps to be taken in the project

Constraints, Concerns, Risks

Issues and concerns
- Identify any barriers , constraints, concerns, and hindrances that need to be overcome for progress to occur

Risks and challenges
- Add text here

Overall Status
Traffic Light Reasoning

Time — Add text here
Result
Risk

	Characterize	Investigate	Explore	Solve	Evaluate	Implement	Monitor	Benefit Summary
	Target Date	Target Date	Target Date	Target Date	Target Date	Target Date	Target Date	
PLAN	Year/Month							
ACTUAL								

June 29, 2019

 56

56

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CONTINUAL IMPROVEMENT MODEL: SOLVE STEP

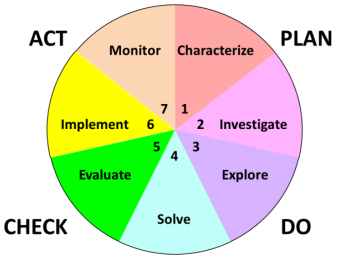
4. Solve

Objective:

- **Solve**: Determine alternatives for improving outcome performance.

Questions:

- Which factors affect performance?
- What factors manage variation?
- What factors shift the average?
- What factors reduce operating cost?
- What is their operating envelope?
- What happens outside this range?
- How are these factors controlled?
- How can the process be controlled?
- How easily can it be implemented?

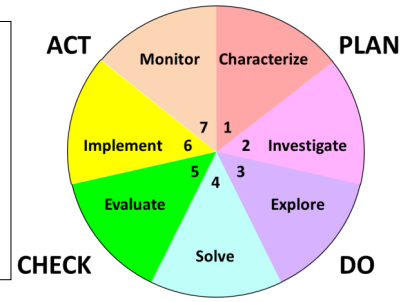


New analytical and process elements included in this phase:

- Lean Thinking – Create the Flow
- Graphical Process Analysis and Mind Mapping
- Operational Process Benchmarking
- Corrective Action / Preventive Action (CAPA)
- Process Laboratory
- Time Series Analysis
- Sequential Design of Experiments (DOE)

Continual Improvement Model: Solve

1. **Distinguish between system and individual controllable improvement issues**
2. **Identify appropriate solution approach**
3. **Evaluate possible solutions and results**
4. **Evaluate expected outcomes and benefits**
5. **Perform sensitivity, risk analysis and identify implications of intended change consequences**
6. **Assess unintended consequences of change**
7. **Define how to implement and control solutions**



DMAIC: Improve

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

4. Solve

1.Distinguish between system and individual controllable improvement issues
2.Identify appropriate solution approach
3.Evaluate possible solutions and results
4.Evaluate expected outcomes and benefits
5.Choose the best solution
6.Perform sensitivity, risk analysis and identify implications of intended change consequences
7.Assess unintended consequences of change
8.Define how to implement and control solutions

4.1 Distinguish Between System and Individual Controllable Improvement Issues

Operational Definition: Separate process control factors into categories that relate to systems and people and define mechanisms for improving each of these factors: what are the methodologies to be applied to develop an operable solution state?

Items to Address:

- Which factors are due to mechanical systems?
- Which factors are due to information systems?
- Which factors are due to organizational systems?
- Which factors are due to decision systems?
- Which factors are due to human performance systems?
- Which factors are management controllable?
- What can be done to address improvement in each of the above categories?

Examples of Controllable Improvement Issues:

- Decision rights
- Information access
- Financial resources
- Skill-based training
- Competence development
- Standard work instructions
- Job performance aids for mistake proofing/safeguarding
- Measurement and recording equipment

4. Solve
1.Distinguish between system and individual controllable improvement issues **2.Identify appropriate solution approach** 3.Evaluate possible solutions and results 4.Evaluate expected outcomes and benefits 5.Choose the best solution 6.Perform sensitivity, risk analysis and identify implications of intended change consequences 7.Assess unintended consequences of change 8.Define how to implement and control solutions

4.2 Identify Appropriate Solution Approach

Operational Definition: What can be done to generate the appropriate solution state for the issue being addressed?

Items to Address:

- How to learn from other organizations?
- How to learn from employee suggestions?
- How to learn from process analytics?
- How to learn by experimentation?
- How to learn by pilot testing or process laboratory?
- How to learn by process intervention (action learning)?
- How to apply innovative problem-solving methods?

Examples of Appropriate Solution Approach:

- Creative dialog for idea generation
- Benchmarking and best practice analysis
- Decision workout
- Kaizen Blitz
- Demonstration Testing
- Statistically designed experiments and Taguchi Methods
- Theory of Inventive Problem Solving

4. Solve
1.Distinguish between system and individual controllable improvement issues 2.Identify appropriate solution approach **3.Evaluate possible solutions and results** 4.Evaluate expected outcomes and benefits 5.Choose the best solution 6.Perform sensitivity, risk analysis and identify implications of intended change consequences 7.Assess unintended consequences of change 8.Define how to implement and control solutions

4.3 Evaluate Possible Solutions and Results

Operational Definition: Analyze performance outcomes of experimental conditions to determine the sufficiency of the proposed solution state.

Items to Address:

- How to demonstrate that the new state is actually better than the old state of performance?
- How to demonstrate that the root cause of degradation in the process performance has been identified?

Examples of Possible Solution Results:

- Experimentation and Testing
- A vs. B Pareto Plots
- Two-Sample t-Test
- One-way ANOVA
- DOE and Taguchi Methods

4. Solve
1.Distinguish between system and individual controllable improvement issues 2.Identify appropriate solution approach 3.Evaluate possible solutions and results **4.Evaluate expected outcomes and benefits** 5.Choose the best solution 6.Perform sensitivity, risk analysis and identify implications of intended change consequences 7.Assess unintended consequences of change 8.Define how to implement and control solutions

4.4 Evaluate Expected Outcomes and Benefits

Operational Definition: Distinguish between the observed or predicted and expected conditions from the experimental outcome.

Items to Address:

- Has the observed change exceeded your expectation for the theoretical process improvement?
- Conduct a Chi-Squared test of performance to determine the magnitude of improvement from the prior state of the process performance.
- Is the observed change large enough to satisfy a decision that it could not have been achieved by pure chance as a result of the change?

Examples of Expected Outcomes and Benefits:

- Shift in the mean value of process performance.
- Reduction in the cycle time for a critical value of process performance.

 63

63

4. Solve
1.Distinguish between system and individual controllable improvement issues 2.Identify appropriate solution approach 3.Evaluate possible solutions and results 4.Evaluate expected outcomes and benefits **5.Choose the best solution** 6.Perform sensitivity, risk analysis and identify implications of intended change consequences 7.Assess unintended consequences of change 8.Define how to implement and control solutions

4.5 Choose the Best Solution

Operational Definition: Determine the criteria for solution choice and evaluate alternatives for improvement based on their relative performance against this criterion.

Items to Address:

- What systems approach is required for a comprehensive performance improvement result?
- What is the prioritization sequence in which the various solution components should be implemented?
- Which factors require capital investment and which of the potential solutions require the least effort to implement?
- Which factors require cultural change in order for them to be effectively implemented?
- What are the payback periods and magnitude of financial return generated by alternative solutions? Calculate the return on solution for each potential solution proposed.

Examples of "Best" Solution States:

- Decision matrix of solutions vs. decision factor results .
- Pugh Concept Selection matrix.

 64

64

4. Solve

1.Distinguish between system and individual controllable improvement issues
2.Identify appropriate solution approach
3.Evaluate possible solutions and results
4.Evaluate expected outcomes and benefits
5.Choose the best solution
6.Perform sensitivity, risk analysis and identify implications of intended change consequences
7.Assess unintended consequences of change
8.Define how to implement and control solutions

4.6 Perform Sensitivity Studies and Risk Analysis; Identify the Implementations of Intended Change Consequences

Operational Definition: Determine the sensitivity and risk of shifts in the technical process solutions. Determine if the proposed solution is vulnerable to external factors that yield desirable performance.

Items to Address:

- What is the desired state to be achieved from making this recommended change?
- What is the intended befit to be derived?
- What is the range of results that may be expected from the solution?
- What are the set of implications to be considered for the solution?
- What can be done to accelerate the effects of the process outcomes that represent desirable states?
- What can be done to create a bridge that will encourage achievement of this outcome?

Examples of Sensitivity and Risk Issues:

- Sensitivity and risk analysis of factors that can magnify the expected benefits from the desired change state.
- Implications of technology improvements on downsizing.
- Opportunities for new products or services as a result of changes in production capability.
- Opportunities for shifting product-related services to a self-service model by engaging customers directly.

 65

65

4. Solve

1.Distinguish between system and individual controllable improvement issues
2.Identify appropriate solution approach
3.Evaluate possible solutions and results
4.Evaluate expected outcomes and benefits
5.Choose the best solution
6.Perform sensitivity, risk analysis and identify implications of intended change consequences
7.Assess unintended consequences of change
8.Define how to implement and control solutions

4.7 Assess Unintended Consequences of Change

Operational Definition: The effects of a process change that are not intended and have a negative influence on product or service outcomes as an unintended consequence of the change.

Items to Address:

- What external technical factors create a negative process outcome in the implementation?
- What are the technical mechanisms that create risk in the improvement and what preventive actions are available in the technical implementation to counteract this type of undesired problem?
- What can be done to create a barrier that inhibits these effects of unwanted or negatively influencing unintended consequences?

Examples of Unintended Consequences:

- Sensitivity and risk analysis for consideration of technical factors that degrade expected outcomes.
- Redundancy in design to crate a more robust solution.
- Use of automatic sensor systems to detect change states, diagnose the situation, and apply corrective actions that redirect the process state to a desirable condition.

 66

66

4. Solve
1.Distinguish between system and individual controllable improvement issues 2.Identify appropriate solution approach 3.Evaluate possible solutions and results 4.Evaluate expected outcomes and benefits 5.Choose the best solution 6.Perform sensitivity, risk analysis and identify implications of intended change consequences 7.Assess unintended consequences of change **8.Define how to implement and control solutions**

4.8 Define How to Implement and Control Solutions

Operational Definition: Determine the characteristics of the technical solution that are required to achieve performance results that deliver controllable outcomes.

Items to Address:

- What are the system level, parameter level and tolerance level factors that can influence the controllable outcome of performance?
- What system-level components of the technical solution should be deigned so they deliver the expected outcome for the desired state?
- What are the critical parameters in the technical design and what level of performance should be specified so the outcome can deliver performance within the desired range of process capability?
- What control mechanisms should be included within the design to mistake-proof the technology and assure that an unintended consequence does not adversely affect the tolerance for performance in the process results?

Examples of Implementation and Control Mechanisms:

- Future state thought map and value stream for expected outcomes of the change.

 67

67

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CONTINUAL IMPROVEMENT MODEL: EVALUATE STEP

 68

68

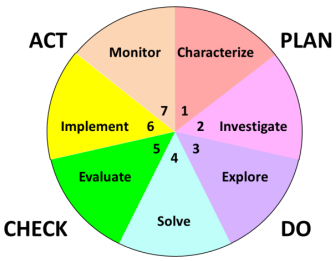
5. Evaluate

Objective:

- **Evaluate**: Demonstrate the efficacy of the proposed solution.

Questions:

- How to optimize factor settings?
- Is the solution sufficiently robust?
- Do indicators need to change?
- Are measurement methods valid?
- What financial benefit will result?
- How to capture the benefits?
- Who is responsible for action?



New analytical and process elements included in this phase:

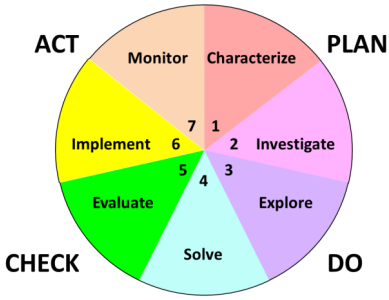
- Taguchi Confirmatory Analysis
- Lean Thinking – Improve the System
- Decision Workout
- Kaizen Blitz
- Lean Accounting
- Target Cost Analysis

 69

69

Evaluate:

1. **Find the best solution**
2. **Create solution robustness**
3. **Assure measurement system integrity**
4. **Estimate expected benefits and results**
5. **Clarify implementation responsibilities**
6. **Identify third-party benefit assessor**



DMAIC: Improve

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

 70

70

5. Evaluate

1. **Create solution robustness**
2. Analyze solution robustness
3. Assure measurement system integrity
4. Estimate expected benefits and results
5. Clarify implementation responsibilities
6. Identify third-party benefit assessor

5.1 Create Solution Robustness

Operational Definition: Robustness is the ability to perform in the face of external noise and continue operating in an effective manner. Adaptive systems learn from failure and then seek to avoid such circumstances in the future.

Items to Address:

- What are the systems performance tolerance limits which when exceeded dissatisfy customers in the solution state?
- What are the critical system performance assumptions that must be "protected" by design of the system?
- How will a proposed system solution respond to external variation or noise originating from outside the system?
- What adaptive learning can occur by monitoring outcome performance of the system and providing feedback loops for learning and correcting process behavior?
- How can human error be avoided through cross-training and skill deepening of the workforce?
- How can mistake-proofing and technical safeguards be used to protect the system from inadvertent errors?

Examples of Solution Robustness:

- Design for reliability, robustness and redundancy for the critical system components.
- Taguchi experiments to test effects of external noise.
- Ability to cope with external environmental variation.
- Feedback loops to identify and inform prior activities of process performance shortfalls.

 71

71

5. Evaluate

1. Create solution robustness
2. **Analyze solution robustness**
3. Assure measurement system integrity
4. Estimate expected benefits and results
5. Clarify implementation responsibilities
6. Identify third-party benefit assessor

5.2 Analyze Solution Robustness

Operational Definition: Tests of the "corner case" or "worst case" in the operating envelope to determine how a process solution performs or degrade performance beyond the limit.

Items to Address:

- What is the expected performance envelope?
- What are the inherent risks that could prevent a process from delivering this expected performance?
- Under what conditions can this performance envelope be violated and the system will continue to operate in a way that does not degrade fully desired process outcomes?
- What actions are possible for a process worker to take in order to manage the process differently as the process behavior is approaching its performance limits (e.g., what are the action limits and what actions can be taken)?
- Can process measures be taken at "control points" that allow the process to assess its own state of control and to adapt its own settings and to automatically correct its outcome and remain in a state of control?
- What safeguards can be put in place to assure continued performance within the desired operating band?

Examples of Solution Robustness:

- Testing product performance in a process will assure the ability to predictably produce its quality characteristics.
- Implementing system feedback loops and measurements allowing humans to manage throughput more efficiently.

 72

72

5. Evaluate

1. Create solution robustness
2. Analyze solution robustness
3. **Assure measurement system integrity**
4. Estimate expected benefits and results
5. Clarify implementation responsibilities
6. Identify third-party benefit assessor

5.3 Analyze Measurement System Integrity

Operational Definition: Performance measurement systems must be demonstrated to be able to detect changes in the process results or performance conditions that will cause a significant shift in the desired outcomes. Measurements must have "integrity" or be reliable statements of the actual conditions of performance.

Items to Address:

- What is the operational definition of the measure itself?
- How should the measurement be observed and what are the appropriate scale and units of measurement?
- Is the measurement process reliable (e.g., repeatable and reproducible)?
- Will the measurement system change over time or will it have any implicit bias?
- What is the ability of measurement systems to detect a change in the object being measured?
- What is the ability of a human to observe and interpret a change in the object being measured using the device?

Examples of Measurement System Integrity:

- Measurement specifications including failure modes.
- Attribute Agreement Analysis.
- Gage R&R Studies.
- Gage Linearity Studies.
- Performance Baseline.

 73

73

5. Evaluate

1. Create solution robustness
2. Analyze solution robustness
3. Assure measurement system integrity
4. **Estimate expected benefits and results**
5. Clarify implementation responsibilities
6. Identify third-party benefit assessor

5.4 Estimate Expected Benefits and Results

Operational Definition: Improvement benefits will include benefits to customers, owners, and employees: financial, operational, and satisfaction with outcomes.

Items to Address:

- Where do process activities create financial, operational, or human losses, waste or inefficiencies?
- What process outcomes degrade the satisfaction of either employees or customers and could stimulate conditions of disloyalty?
- How do waste, loss and inefficiency reduce profitability in process performance outcomes by creating excessive cost in transactions?
- Where can improvements be generated within processes that will reduce quality losses to society or organizations and what actions can be taken that will preserve outcome quality at the lowest total cost to society?

Examples of Expected Benefits and Results:

- Cost-benefits or Return-on-Investment of improvements.
- Financial benefits or outcomes for profitability.
- Satisfaction benefits to customers and employees (both short-term relationships and long-term loyalty).
- Process benefits like reduction in set-up time, cycle time, waste, loss and other inefficiencies).
- Reducing nuisance for employees in conditions of labor.
- Reducing costs throughout the entire supply chain.

 74

74

5. Evaluate

1. Create solution robustness
2. Analyze solution robustness
3. Assure measurement system integrity
4. Estimate expected benefits and results
5. **Clarify implementation responsibilities**
6. Identify third-party benefit assessor

5.5 Clarify Implementation Responsibilities

Operational Definition: The individual responsible for the effective, efficient and economical performance of a process is the process owner. Therefore process owners must take action to remediate performance problems and assure the continuity of operations at the desired level of performance.

Items to Address:

- What are the roles and responsibilities of the individuals involved in the process for conducting routine operations and assuring predictably on-target results?
- Who need to be consulted or informed about any change to the operating processes or the products and services it produces?
- What authority will be delegated in a Plan of Action and Milestones (POA&M) for both financial expenditures and decision rights to regulate decisions raised during a daily management system improvement activity?

Examples of Implementation Responsibilities:

- Drafting or revising work documentation.
- Engineering changes to production processes.
- Deciding on the performance measurements to be used and limits for making operational decisions.
- Delegating rights for making operational decisions about the conduct of the daily work.
- Approving the control documents that define and govern performance of work.

 75

75

5. Evaluate

1. Create solution robustness
2. Analyze solution robustness
3. Assure measurement system integrity
4. Estimate expected benefits and results
5. Clarify implementation responsibilities
6. **Identify third-party benefit assessor**

5.6 Identify Third-Party Benefit Assessor

Operational Definition: Independent assessment of process performance improvement can be performed by an internal or external assessor. A third-party is any person or group that is external to the improvement team that is invited to take a role in assessment of the improvement project or its outcome. This evaluation provides a "second set of eyes" and a different perspective that enables new ideas to be generated or new interpretations to be obtained.

Items to Address:

- How will senior management review the improvement projects to assure alignment with the strategic direction of the organization?
- When will the financial function review the proposed set of improvements to assure that financial benefits will be obtained and that resources are properly applied?
- When does benchmarking with external organizations (in the organization or outside the organization) make sense for generating new ideas or constructive critique?
- When should a third-party "quality auditor" be invited to review the process?

Examples of Third-Party Benefit Assessors:

- Business Excellence Assessment.
- Financial audits.
- ISO9000 auditors and quality-related internal audits.
- Business partner benchmarking reviews.

 76

76

Solution Description and Recommendation Template

Point Paper of Recommendations:

Point paper summarizes the issue and its recommended resolution along with the supporting logic. It defines the principal, presents the facts regarding this issue, summarizes the most salient points, draws a conclusion and then makes a decision recommendation. Construction of a Point Paper includes the following items and can follow the "**PEARS**" acronym in format:

- Issue statement that defines the initial circumstances and implications
- Factual presentation which presents the most salient points discovered
- Conclusion drawn from the analysis
- Recommendation [note that options are presented only if choices are roughly equivalent]

Point (or Problem):

- This element presents an operational definition of the issue or problem and describes the action required (e.g., increase, reduce or control) the performance of a specific product, service, or process factor at a particular location or position.

Explanation (or Experience):

- This element describes the experience that has been observed in history, identifies the best and worst case performance, and then partitions the problem into components or rational sub-groups that exhibit similar internal behavior (e.g.., common cause variation) and between which a critical distinction in performance may be observed (e.g., special cause variation).

Analysis (or Assessment):

- This element of the presentation presents the concluding arguments about the sources of variation and observations about how it is possible to manage the performance by adjusting process factors, human factors, or physical aspects in products or services to achieve the desired performance outcome.

Recommendation (or Report):

- This element of the presentation presents the recommendations that are supported by the analysis for management decisions.

Success (or State Desired):

- This element defines the expected outcome, result or end state that is anticipated to be achieved by the recommendation along with the time estimate to achieve this performance.

 77

77

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CONTINUAL IMPROVEMENT MODEL: IMPLEMENT STEP

 78

78

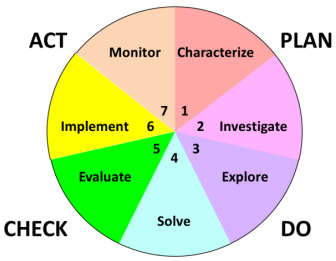
6. Implement

Objective:

- **Implement**: Develop plans for implementation and benefit capture.

Questions:

- What will be standard work?
- Which factors must be managed?
- What is their tolerance range?
- How will the process be maintained?
- What training will operators need?
- How will work errors be prevented?
- What is the action plan?
- How to leverage this knowledge?
- How to capture the benefits?

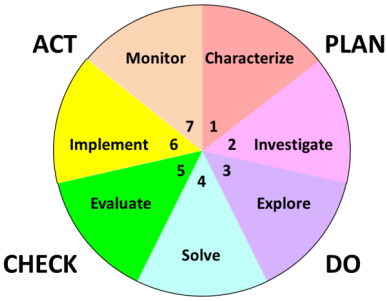


New analytical and process elements included in this phase:

- Hoshin Tenkai / X-Matrix
- Lean Process Control
- Implementation Plan
- QC Story
- 4-Up Chart
- Benefit Capture Plan

Continual Improvement Model: Implement

1. **Align project with cross-functional change management process**
2. **Build and follow implementation plan**
3. **Upgrade skills and competence in the system**
4. **Deploy the standardized solution plan**
5. **Evaluate implementation of solution**
6. **Extract and leverage lessons learned**
7. **Identify further improvement projects**
8. **Prepare, communicate, and record the final project report**



DMAIC: Control-Standardize

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

6. Implement

1.Align project with cross-functional change management process
2.Build and follow implementation plan
3.Upgrade skills and competence in the system
4.Deploy the standardized solution plan
5.Evaluate implementation of solution
6.Extract and leverage lessons learned
7.Identify further improvement projects
8.Prepare, communicate, and record the final project report

***6.1* Align project with cross-functional change**

Operational Definition: Coordinate and manage change to assure that solutions will work in real life when effected by people in different functions and across cultural boundaries.

Items to Address:

- Define the change required for the organization.
- Determine need for change from a human perspective.
- Develop a vision of the future state.
- Define the zone of indifference for win-win change where all individuals can be persuaded to participate in making the change a success.
- Identify success factors and risks for the workers
- Identify sponsors and stakeholders.
- Assess the cultural impact of proposed change and the organization's readiness for such change.
- Assess communication needs to assure that employees are engaged and willingly support and encourage desired changes.

Examples of managing change:

- Change definition and vision
- SWOT-analysis
- Force Field analysis
- Stake holder analysis
- Sponsorship and Stakeholder strategy
- Communication strategy and plan

 81

81

6. Implement

1.Align project with cross-functional change management process
2.Build and follow implementation plan
3.Upgrade skills and competence in the system
4.Deploy the standardized solution plan
5.Evaluate implementation of solution
6.Extract and leverage lessons learned
7.Identify further improvement projects
8.Prepare, communicate, and record the final project report

***6.2* Build and follow implementation plan**

Operational Definition: A plan that defines how successful implementation should be executed and details the specific components or change projects to be executed along with assigned responsibilities, performance targets, scheduled milestones and resources allocated.

Items to Address:

- Identify the POA&M to implement the proposed solution.
- Determine the time schedule to achieve key milestones.
- Estimate the budget required for investment in achieving the change and the cost impact on operational budgets.
- Assign responsibility for managing the change effort and identify key team members who should be involved in the transformation effort.
- Conduct a comprehensive risk analysis for implementing the POA&M.
- Conduct follow up progress reviews of implementation to steer the projects to successful performance.

Examples of Implementation Plans:

- Hoshin Plan (overall transformation plan)
- Hoshin Tenkai X-Matrix (cross-functional project plan)
- Japanese TQM QC Story (project-level review)
- Benefit capture plan (cross-functional action review)

 82

82

6. Implement
1.Align project with cross-functional change management process 2.Build and follow implementation plan **3.Upgrade skills and competence in the system** 4.Deploy the standardized solution plan 5.Evaluate implementation of solution 6.Extract and leverage lessons learned 7.Identify further improvement projects 8.Prepare, communicate, and record the final project report

***6.3* Upgrade skills and competence in the system**

Operational Definition: Create development plan to define how skills and competence should be upgraded to support successful implementation of project-specific changes

Items to Address:

- Define job skill requirements for task completion
- Conduct assessment to define individual training needs
- Correlation learning requirements with training activities
- Design program of required training for learning to occur
- Create development plan for individual learners
- Execute development plan and review individual progress
- Evaluate learning activities to assure that objectives have been met and knowledge is transfer to actionable ability to perform.
- Assess training outcomes by impact on-the-job to verify that "business benefits" have been obtained.

Examples of learning and training:

- Training material developed using adult learning theory
- Training of trainers in content and training methods
- Training courses at the levels appropriate for awareness, application and managerial oversight
- Seminars in special topics requiring greater depth
- Workshops in practical applications
- E-learning for repetitive tasks not requiring coaching

6. Implement
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6.4 Deploy the standardized solution plan

Operational Definition: Take action to execute an approved implementation plan and standardize the solution across all processes that are applicable or relevant. Leverage the results to related process areas. Transition to daily management.

Items to Address:

- Process owners take action to implement the POA&M in their own areas of assigned responsibility and work with the cross-functional managers of groups who share in the delivery of desired process performance results.
- Process facilitators mentor process owners in execution of the implementation plan and guide teams establishing daily management systems capable of routine operation of the required work within tolerance boundaries of the final customer's performance expectation.
- Project champions and business leaders review the plan implementation to assure desired results are achieved.

Examples of the Solution Deployment:

- Continual process improvement and following a standard process of management for implementation of the plan.
- Implement the training plan and evaluate the individual qualifications of workers in the updated skillsets.
- Revise standard operating procedures, work instructions, and in-process tests to align with the revised activities.
- Evaluate measurement system capability to report upon process revision quality, productivity and cost.

6. Implement

1.Align project with cross-functional change management process
2.Build and follow implementation plan
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***6.5* Evaluate implementation of solution**

Operational Definition: Observe improvement transition to the daily management system and evaluate if the solution implementation has been a success.

Items to Address:

- Follow up improvement POA&M activities to assure that planned activities have been completed.
- Review schedule of performance to assure that project goals and task milestones are managed on schedule.
- Evaluate resource expenditures (financial and human) to maintain control of the "burn rate" of investment.
- Assess early results of implementation to demonstrate observed performance complies with expectations and adjust plans to assure successful results.

Examples of Management Reviews:

- Project business and technical reviews to assure focus is maintained on the outcome performance and methods for conducting the project and applying technologies.
- Gate and milestone reviews for key project management projects and programs to assess progress and compliance risk (or maturity development that minimizes risk).
- Monthly and quarterly management reviews of business performance of operational measures and improvement projects.

 85

85

6. Implement

1.Align project with cross-functional change management process
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***6.6* Extract and leverage lessons learned**

Operational Definition: Review obtained results and extend lessons learned to all applicable areas and functions.

Items to Address:

- Lessons Learned: Discoveries in the application of new or revised methods that demonstrate a clear performance gain over "legacy" ways of working or "traditional" work outcomes.
- Leverage: Transfer lessons learned to other processes or activities that have similar requirements for improving performance.

Examples of Lessons Learned:

- New methods, technologies, techniques, procedures, or tools that facilitate improvement in performance results.
- Learning about how to improve the system of improving as well as the application of specific improvements.

Examples of Leverage:

- Benchmarking across organizations for seeking how to gain improvement for similar process operations.
- Review of improvement projects to seek opportunities to replicate lessons learned in other operational areas.
- The ability to replicate a lessons learned to another area of the organization (either internally within an operating unit or externally across organizations) based on learning that has occurred during an improvement project or by a benchmarking study.

 86

86

6. Implement

1.Align project with cross-functional change management process
2.Build and follow implementation plan
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8.Prepare, communicate, and record the final project report

***6.7* Identify further improvement projects**

Operational Definition: Update the organization's project improvement portfolio with future project subjects that are of importance to do.

Items to Address:

- How well has the originating problem statement been addressed by the set of implementation solutions?
- Have you reviewed the project "parking lot" to determine if there are "unaddressed improvement opportunities" in the current project?
- What improvements should be addressed to reduce the sources of waste, loss or inefficiency that are noted in the current project but not addressed?
- What improvements should be addressed that reduce the variation in process outcomes but were not addressed in the current project?
- Which processes will become performance limited in this are and potentially require capital investment for further gains?
- How could process automation or information technology aid in further performance gains?

Examples of Follow-on Improvement Projects:

- Information technology and process automation or other engineering or IT-based improvement projects.
- Lean Six Sigma or Quality Circle projects to be initiated.

 87

87

6. Implement

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6.8 Prepare, communicate and record the final project report

Operational Definition: The final report provides a detailed description of the full project life cycle from initial problem description through the discoveries at each project step in the team's activity to conclusions and recommendations, including the results of implementation as well as all further recommended improvement projects.

Items to Address:

- How did the progress transition from its initial statement of the problem to implementation of a pilot solution?
- What are the messages about this project that should be communicated and who is the target audience?
- What lessons were learned about ways to apply the set of improvement methods and related tools and techniques?
- What further improvement projects have been visualized as a result of this improvement project?
- What are the relative priorities of these further projects?
- How will this work be preserved for future application?

Examples of Final Project Reports:

- Newsletter or other announcement of project results.
- Updated project portfolio for future project selection.
- Technical performance report or engineering report.
- Lean Six Sigma or other final project report.
- Update report archive for final improvement reports.
- Realization review (independent financial validation of the impact of change).

 88

88

Implement Planning Template

Date:	Process Owner:	Period:	Page: _X_ of _Y_
Current State Analysis:			

Improvement Goal:		Objectives: •	Status:

PLAN OF ACTION AND MILESTONES

No.	Planned Improvement [Team Leader, Organization]:	Desired Outcome and Completion Milestone:	Status:
1			
2			
3			
4			

 89

89

Control Planning Template

Critical Parameter Identification:

Process	Activity	Task	Critical to Satisfaction		Quality Characteristic	Specification Requirement		
			KPIV	KPOV		LSL	Target	USL

A control defines the specific data requirements for the performance measures of process output where results may be predicted and flows controlled to regulate the process throughput. It identifies desired output characteristics of a process, the measurements that define it, and activities needed to sustain it.

Measurement System Specification:

Measurement Method	Measurement Capability	Sample Size	Sampling Frequency	Who Measures	Where Recorded	Last Calibrated

Determines the adequacy and the integrity of measurement systems and procedures for sampling the data, storing records, as well as maintaining the measurement system.

Response Characterization:

Action Limit	Decision Rule	Countermeasures	SOP Reference

Presents guidelines to self-regulate process performance within the desirable limits, recommended actions to maintain control in the event of a process disturbance as well as the reference where further information about managing process performance may be viewed.

 90

90

Benefit Capture Planning Template

Purpose:

- To monitor execution of planned project improvements and verify the benefits received by making these improvements.

Information Content:

1. Identification of improvement opportunity
2. Responsibility accepted by a line manager/supervisor
3. Monitored Performance Measure
4. Baseline Measure
5. Achievable Performance Target
6. Expected Achievement Date
7. Expected Financial Benefit
8. Achieved Completion Date
9. Percentage of Task Completion
10. Financial Benefit Achieved
11. Additional Improvement Available
12. Determine Additional Actions

Procedure:

- Conduct the analysis as an auditor would perform an independent financial assessment.
- Review the individual action items and "go and see" how change occurred (may request process owner/facilitator to accompany).
- Identify findings that have been "cemented" into the organization's infrastructure and can achieve "annuity" status or benefits to perpetuate rather than benefits which do not become realized in final actions that eliminate the costs, waste or inefficiency over the long term (e.g., reduction in wasted time with no impact on process organization, overtime costs, or headcount).
- Benefits must be traceable from the recommendations in the final report to the accounting in the ledgers of the formal records of the organization – both operational and financial.
- Leveraging opportunities for deriving additional benefit from related improvements must be identified and the cognizant process owners notified of the potential benefits to be captured by incorporating the lessons learned.

 91

91

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CONTINUAL IMPROVEMENT MODEL: MONITOR STEP

 92

92

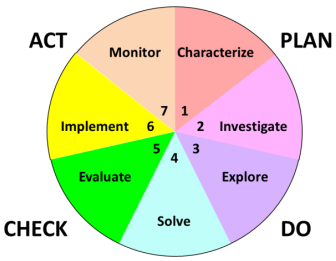
7. Monitor

Objective:

- **Monitor**: Monitor the process to ensure sustained, consistent performance.

Questions:

- How is the process operating?
- Where is standard work not right?
- Does the team work consistently?
- Where is waste occurring?
- What can be improved?
- What conditions are not safe?
- How does it affect our customers?
- What people should address it?



New analytical and process elements included in this phase:

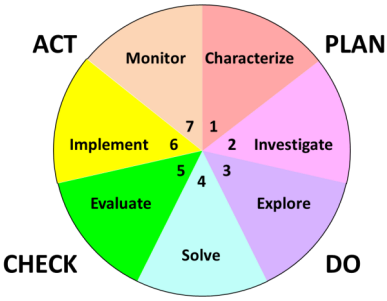
- Daily Management System (Nichijo Kanri)
- QC Story, A-3 Report and Radar Diagram
- Performance Monitor System (4-Up Chart)
- Lean Thinking – Conduct Continual Review
- Lean Thinking – Improve Standard Work
- Lean Thinking – Presidential Review

 93

93

Continual Improvement Model: Monitor

1. **Perform daily work of the process**
2. **Evaluate process performance regularly**
3. **Examine possible deviations and side effects**
4. **Scale up from pilot to full solution adoption**
5. **Conduct continual improvement reviews**
6. **Report actual performance results and project benefits achieved**
7. **Communicate results and lessons learned**
8. **Celebrate success of the project**



DMAIC: No Equivalent Step

		Methods for Use in Applications [SME Emphasis]			
	Levels/Belts	Production	Service	Healthcare	Education
Matrix of Applicable Tools and Methods	3 - Black				
	2 - Green				
	1 - Yellow				

Pilot Phase Results

 94

94

7. Monitor

1. **Perform daily work of the process**
2. Evaluate process performance regularly
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7. Communicate results and lessons learned
8. Celebrate success of the project

7.1 Perform daily work of the process

Operational Definition: Standard work represents routine activities and tasks are conducted on a daily basis to reduce risk so process outcomes are delivered with regularity and repeatability in a predictable manner. Standard work is most often documented in standard operating procedures as well as in work instructions and linked to the quality system.

Items to Address:

- What work procedures define the best possible way of working needed to deliver process outcomes to meet a documented customer objective?
- What are the skills and competence levels required of the process workers to accomplish these tasks?
- How should standard work be measured so that it may be monitored to assure conformance to task requirements?
- How can standard work be documented in a useful way so that it is suitable for workers and its flow as a system is assured with maximum efficiency and minimum risk so all of its activities operate in harmony?

Examples of Standard Work:

- Written procedures and work instructions.
- Check lists and standard forms.
- Prescribed pathways for material movement.
- Embedded software tutorials for on-the-job training
- On-line job aids as reminders for workers.
- Diagnostic software.

 95

95

7. Monitor

1. Perform daily work of the process
2. **Evaluate process performance regularly**
3. Examine possible deviations and side effects
4. Scale up from pilot to full solution adoption
5. Conduct continual improvement reviews
6. Report actual performance results and benefits achieved
7. Communicate results and lessons learned
8. Celebrate success of the project

7.2 Evaluate process performance regularly

Operational Definition: In each improvement process there is always a "check" step to assure that risk will be managed, objectives of the effort will be fulfilled, and progress toward this goal will advance consistently.

Items to Address:

- What is the performance measure that will be used as the mechanism to monitoring risk level and progress?
- How adequate is the measurement system to assure that the observations represent factual data and are as free of noise or spurious effects as possible?
- Does the organization follow procedures it documented as standard work and is the system effective in achieving its goals through this system?
- How to assure that human aspects of the process operate properly and contribute to the performance goals?
- How well does the "check" activity correspond to the set of targeted objectives for the process?

Examples of Process Outcomes:

- Deliverables to specified performance targets.
- Deliverables achieved within specified time limits.
- Deliverables completed with required quality levels.
- Employees satisfied with the quality of their working life.
- Customer satisfied with their experience with outcomes.
- New processes/procedures developed as a result of the learning from this "check" step.

 96

96

7. Monitor

1. Perform daily work of the process
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6. Report actual performance results and benefits achieved
7. Communicate results and lessons learned
8. Celebrate success of the project

7.3 Examine possible deviations and side effects

Operational Definition: Special Cause Variation occurs as a process deviates from its natural state of statistical control as a result of some internal or external cause. When all of the special causes are eliminated then a process will work at its natural level of performance which, when it is operating in control then only "common cause variation" remains.

Items to Address:

- What are reasons for variation in process performance?
- What are the boundaries of performance within which a process can operate predictively?
- What are the root causes which create the outcome of a special cause of variation?
- What techniques can be used to monitor the process performance to identify situations in which these special causes of variation occur?
- What corrective actions can be taken to eliminate all of the undesirable side effects of special cause variation?
- What preventive actions can be taken that solve the root cause of the problem rather than just the symptoms?

Examples of Examining Special Cause Variation:

- Special causes of variation arise from changes in the core process features such as technology, personnel, or work procedures.
- Methods to detect and analyze special cause variation include control charts and process capabilities studies.

 97

97

7. Monitor

1. Perform daily work of the process
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3. Examine possible deviations and side effects
4. **Scale up from pilot to full solution adoption**
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6. Report actual performance results and benefits achieved
7. Communicate results and lessons learned
8. Celebrate success of the project

7.4 Scale up from pilot to full solution adoption

Operational Definition: Full scale production occurs when a pilot demonstration of process improvements or the results of experimentation are incorporated into routine procedures and local managers transition or change the work methods to revise standard work activities accordingly.

Items to Address:

- What type of integration should be conducted to adapt an improvement into the operational work processes?
- Have implementation risks as the result of any unintended consequences been fully assessed?
- Have worker been adequately trained in the new working procedures and mechanisms for performance checking?
- Have software, system and documentation changes been completed to support the daily management system in an effective manner?
- Has the revised standard work been integrated into all of the applicable areas within the organization?
- Has a leveraged improvement in performance from this adoption been realized across the organization?

Examples of Full Scale Production:

- Integrating system change across the entire supply chain.
- Transitioning all related equipment, operations, and work activities to the new way of working and evaluated to the standard operating procedures.
- Transforming equipment to updated technology levels.

 98

98

7. Monitor

1. Perform daily work of the process
2. Evaluate process performance regularly
3. Examine possible deviations and side effects
4. Scale up from pilot to full solution adoption
5. **Conduct continual improvement reviews**
6. Report actual performance results and benefits achieved
7. Communicate results and lessons learned
8. Celebrate success of the project

7.5 Conduct continual improvement reviews

Operational Definition: A Quality Management System will incorporate an audit function that provides for third-party or independent review of process performance, deliverable performance as well as the actions that pay attention to the obligation for continual improvement of all elements in the operating system. The objective of such review is to assure continuing reduction in areas of risk and focus of managers on the necessity of vigilance for increasing performance in all aspects of the conduct of routine work.

Items to Address:

- Where are the opportunities for improvement among the items addressed by the audit or review?
- What is the POA&M for improving by conducting both the corrective and preventive action in a timely manner?
- When should a review of action item compliance be made by the third-party assessor and senior management?
- Have improvements been incorporated into the standard work procedures and processes?

Examples of Integrated Quality System:

- First party assessment is done by workers in the system; second party assessment is conducted by local manager or supervisor of the work, and third party assessment is done by an internal or external independent assessor.

 99

99

7. Monitor

1. Perform daily work of the process
2. Evaluate process performance regularly
3. Examine possible deviations and side effects
4. Scale up from pilot to full solution adoption
5. Conduct continual improvement reviews
6. **Report actual performance results and benefits achieved**
7. Communicate results and lessons learned
8. Celebrate success of the project

7.6 Report actual performance results and benefits achieved

Operational Definition: Performance results in a process will encompass four major areas: financial results, process results, employee results and customer results. All four of these areas must be managed synergistically to achieve a level of sustained success in comparison to an organization's direct competitors or best practice global organizations. Contribution of individual projects to organizational success must meet or exceed the intentional goals or targets that it seeks to address.

Items to Address:

- What is the financial benefit contributed by improvement to the organization's overall results (e.g., increase in profit, working capital or return on investment)?
- What is the improvement of the process compared to its designed level of capability?
- What is the improvement in the collective attitude of the workers regarding the quality of life found in daily work?
- How do customers perceive their specific experience with outcomes of performance and how does this build a long-standing relationship that generates their confidence in the organization's ability to deliver future performance?

Examples of Project Reports:

- QC Story and/or A-3 Report.

 100

100

7. Monitor

1. Perform daily work of the process
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3. Examine possible deviations and side effects
4. Scale up from pilot to full solution adoption
5. Conduct continual improvement reviews
6. Report actual performance results and benefits achieved
7. **Communicate results and lessons learned**
8. Celebrate success of the project

7.7 Communicate results and lessons learned

Operational Definition: Communication of the in-tact work process team efforts for continual process improvement of the daily management system should be promoted to the entire organization as a mechanism to encourage others to take similar proactive steps in reducing inefficiency, loss and waste in all routine operations.

Items to Address:

- What improvements that have been made by the team are worthy of wide-spread publication?
- What is the appropriate audience for publishing this set of improvement lessons learned?
- What communications channels for disseminating this news are best for assuring leverage of the effort?
- What recognition of teams and individuals is worthy of a wide-spread promotion?

Examples of communications:

- Team activity eliminating customer concerns, complaints or taking corrective actions.
- Completion of a process team-based rapid action change activity that is within the scope of control, resources, decision-making rights and expertise of the work team to effect a change that results in performance improvement.
- Recognition of individuals or teams for suggesting some improvements that are beneficial to the organization.

 101

101

7. Monitor

1. Perform daily work of the process
2. Evaluate process performance regularly
3. Examine possible deviations and side effects
4. Scale up from pilot to full solution adoption
5. Conduct continual improvement reviews
6. Report actual performance results and benefits achieved
7. Communicate results and lessons learned
8. **Celebrate success of the project**

7.8 Celebrate success of the project

Operational Definition: Recognition of improvement action must be timely, relevant and appropriate to reinforce the benefits from making such improvements.

Items to Address:

- What improvements are worthy of celebration?
- What form should celebration take so that it is reinforcing of the benefits obtained from the improvement?
- How can a celebration lead to the replication of the role model for performance improvement as demonstrated by a team or an individual?

Examples of Celebration Events:

- Executives making a personal “thank-you” appearance.
- Team social event (e.g., pizza party, etc.).
- Internal awards and/or rewards according to the system of the organization.
- Small recognition gifts (e.g., t-shirt, coffee cup, etc.).
- Publications in internal media or local newspapers.

 102

102

Monitor Success Story Template for Sharing Good Practices

Background:

- History of the problem
- Context within which the problem occurs
- Symptoms of the problem
- Conditions that limit achievement of ideal performance
- Individuals participating in the problem condition
- Best and worst performance observable for the process performance outcome

Issue Current Condition:

- Problem Definition
- Process Diagram
- Pareto Analysis

Problem Characteristics:

- Historical Data Analysis of Trends
- Distribution Analysis/Capability Study
- Analysis of Variance

Analysis of causal system:

- Fishbone Diagram/Tree Diagram/Mind Map
- Analysis of Variance
- Regression Analysis

Actions to Eliminate Causes:

- Emergency Containment Activities
- Corrective Action Activities
- Preventive Action Activities

Assessment of Potential for Recurrence:

- Individual Control Chart
- Process Capability Study
- Risk and Potential Failure Analysis

Standardization of Solution:

- Control Items and Check Items
- Measurement Specification
- Standard Work Instructions

Follow-up of Implementation and Future Activities:

- Activities that remain to be completed
- Further improvement projects planned

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Thank you for your attention!