Structured Improvement for the 21st Century: A New Model from Europe

Bjorn Andersen, IAQ Academician, Norway,
Lars Sorqvist, IAQ Academician, Sweden,
Pedro Saraiva, IAQ Associated Academician, Portugal and
Gregory Watson, IAQ Honorary Member, USA/Finland

Abstract

Purpose and Organization:

This project began with a desire by the Board of Directors of the European Organization for Quality (EOQ) to standardize training in Lean Six Sigma methods throughout Europe. But, it quickly realized that the need was much broader. In 2014 the International Academy for Quality (IAQ) established a Think Tank to define a generic "Systematic Improvement" methodology to satisfy the EOQ's requirement. Laatukeskus Excellence Finland was appointed by EOQ to manage this project and coordinate its application within Europe.

The project team has been requested to develop a generic model and engage a broader global quality community to reach consensus for a final model and to develop a data base of case studies that demonstrate how to apply the method.

World Quality Forum
Budapest, Hungary
27 October 2015

Structured Improvement for the 21st Century:
A New Model from Europe

Bjorn Andersen, Pedro Saraiva, Lars Sörqvist, and Gregory H. Watson
IAQ Structured Improvement Think Tank

International Academy for Quality

IAQ THINK TANK PROJECT DESCRIPTION

IAQ Structured Improvement Think Tank:

PROJECT DESCRIPTION:

Established a joint development project managed by Laatukeskus Excellence Finland:

Purpose and Organization:

This project began with a desire by the Board of Directors of the European Organization for Quality (EOQ) to standardize training in Lean Six Sigma methods throughout Europe. But, it quickly realized that the need was much broader. In 2014 the International Academy for Quality (IAQ) established a Think Tank to define a generic "Systematic Improvement" methodology to satisfy the EOQ's requirement. Laatukeskus Excellence Finland was appointed by EOQ to manage this project and coordinate its application within Europe.

The project team has been requested to develop a generic model and engage a broader global quality community to reach consensus for a final model and to develop a data base of case studies that demonstrate how to apply the method.

IAQ Structured Improvement Think Tank:

TEAM MEMBERS:

Program Manager:

Tani Järvinen, Companion, IAQ; CEO, Laatukeskus [Finland]

Think Tank Chair:

Gregory H. Watson, Honorary Member, IAQ [Finland]

Team Members:

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

NOTES:

1. A team of Experienced Lean Six Sigma Master Black Belts will be engaged to develop case studies and application examples to demonstrate the Body of Knowledge.
2. Findings will be validated through coordination with the American Society for Quality (ASQ) and the Union of Japanese Scientists and Engineers (JUSE).

Team tasks:

- Conduct a survey of methods for structured improvement.
- Develop an archive of academic papers on this subject.
- Conduct a benchmarking study of alternative methods.
- Develop a generic approach as a structured improvement model.
- Test the proposed model in Small-to-Medium Enterprises (SME).
- Develop a competence model and body of knowledge for the model.
- Develop and publish case studies and articles to launch the model.
- Design a model training curriculum to support the model.
- Document results for EOQ Professional Registration Unit.

IAQ Structured Improvement Think Tank:

DETAILED TEAM APPROACH:

- Conduct a survey of the various approaches and models used to describe the continual improvement process within the European base of national quality organizations and their partnering consulting groups.
- Analyze continual improvement methodologies that are being promoted by information technology, accounting and human resources functions and also competing methods used by quality management or standards organizations.
- Conduct benchmarking studies to determine affinities and dissimilarities of these competing models and develop a new model which does not have any obvious bias related to the prior set of continual improvement alternative methods considered.
- Demonstrate the relationship of the proposed general model to the two standard approaches of the American Society for Quality and the Union of Japanese Scientists and Engineers and recommend a standardized way to conduct such analyses on a global basis.
- Test the generic model using real world scenarios and case studies that are derived from collaborating companies and publish the final results.

THE HISTORY OF PDCA AND DMAIC

Two quality models already 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.

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.

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.

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.

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.

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

DMAIC is from Motorola's 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.

CRITIQUE OF STRUCTURED IMPROVEMENT MODELS FOR PDCA, DMAIC AND LEAN

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.

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.

Issue: 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.

Problems identified – SME's lack structured 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.

Problems identified – SME's lack structured 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.

Problems identified – SME's lack structured 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.

Specific problems in the ISO Six Sigma documents:

- Requirements described without reference to industry or type of problem that is being pursued.
- DMAIC process does not follow the logical sequence of questions that must be addressed in a Lean Six Sigma project (starting with the 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., 8D) and many tools that appear to have been "thrown into the toolbox" with out rationale as to their use.
- The instructions seem more like educational documents without a clear set of behavioral learning objectives.

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.

Lessons learned in 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.

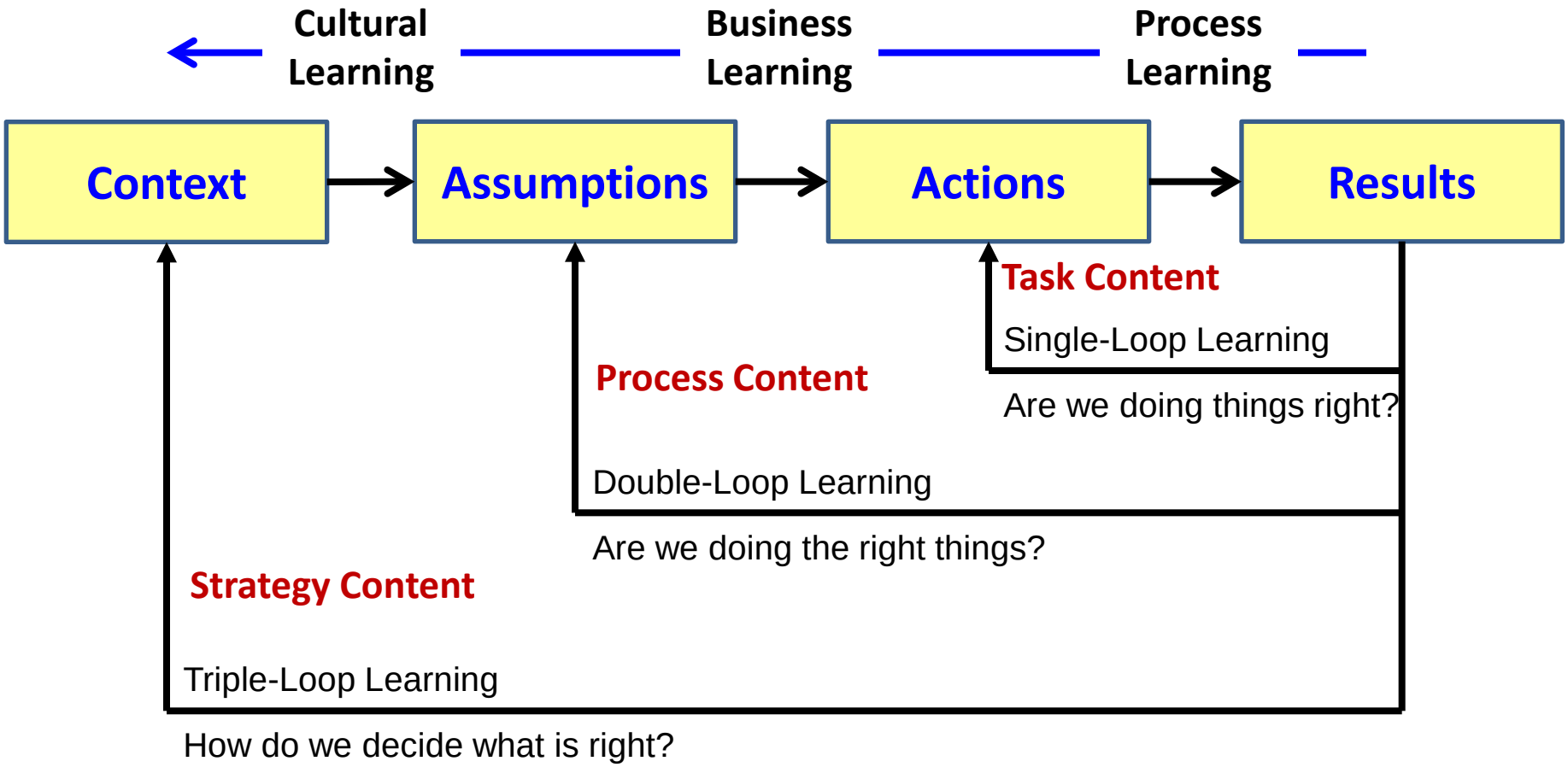
International Academy for Quality

GUIDELINES FOR DEVELOPMENT OF THE NEW STRUCTURED IMPROVEMENT MODEL

Integration of structured improvement and learning:

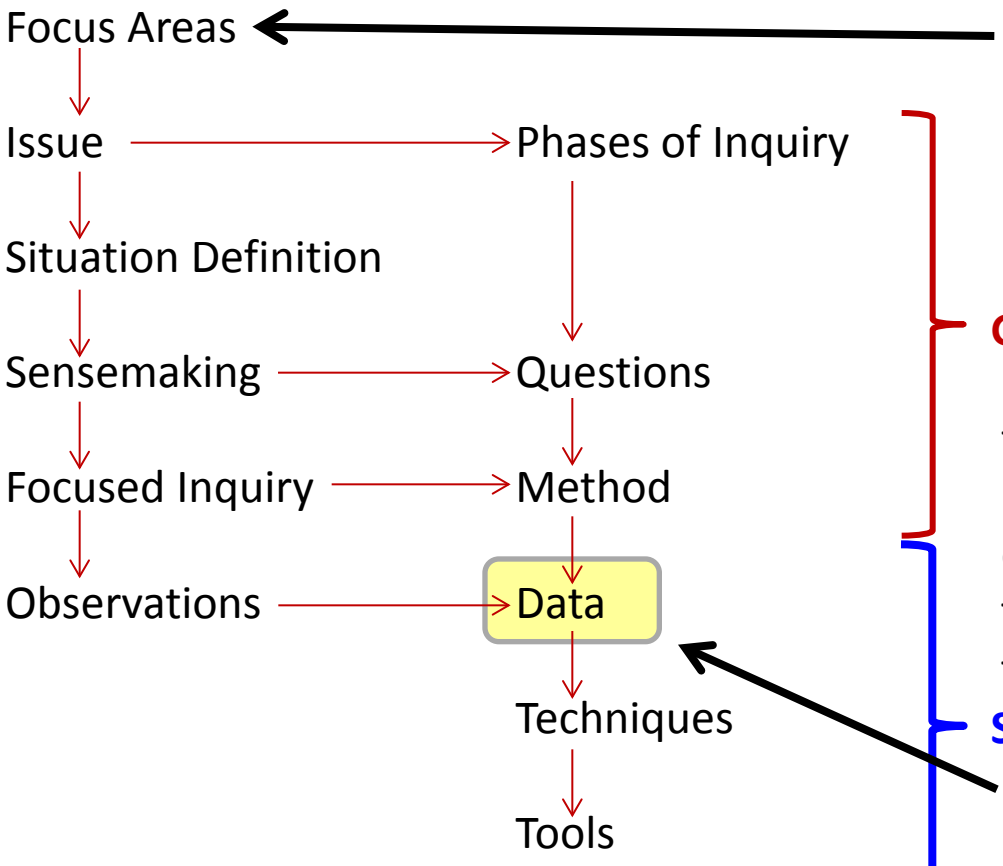
- Organizations learn by conducting structured reflection on the past experience to discover patterns and inquire about linkages among the factors that drive business performance.
- There are three levels of reflection required to capture learning for improvement:
  - Reflection at the work process level 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.

Integrating learning into the process of management:



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.



Strategic Perspective

A generic model can provide the high-level architecture for performing structured work process improvement.

Generic Approach Acceptable

Detailed application must be tailored to fit the competitive environment, industry norms, and specific business model of each organization. People need to learn how to think for themselves and become mindful of their specific needs for improvement.

Specific Approach Required

The nature of the questions addressed and the type of data analyzed determine what are best techniques and tools to apply.

How did we develop the "generic" mental models?

- Established a set of ground rules that would drive innovation in the approach:
  - No elements 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.

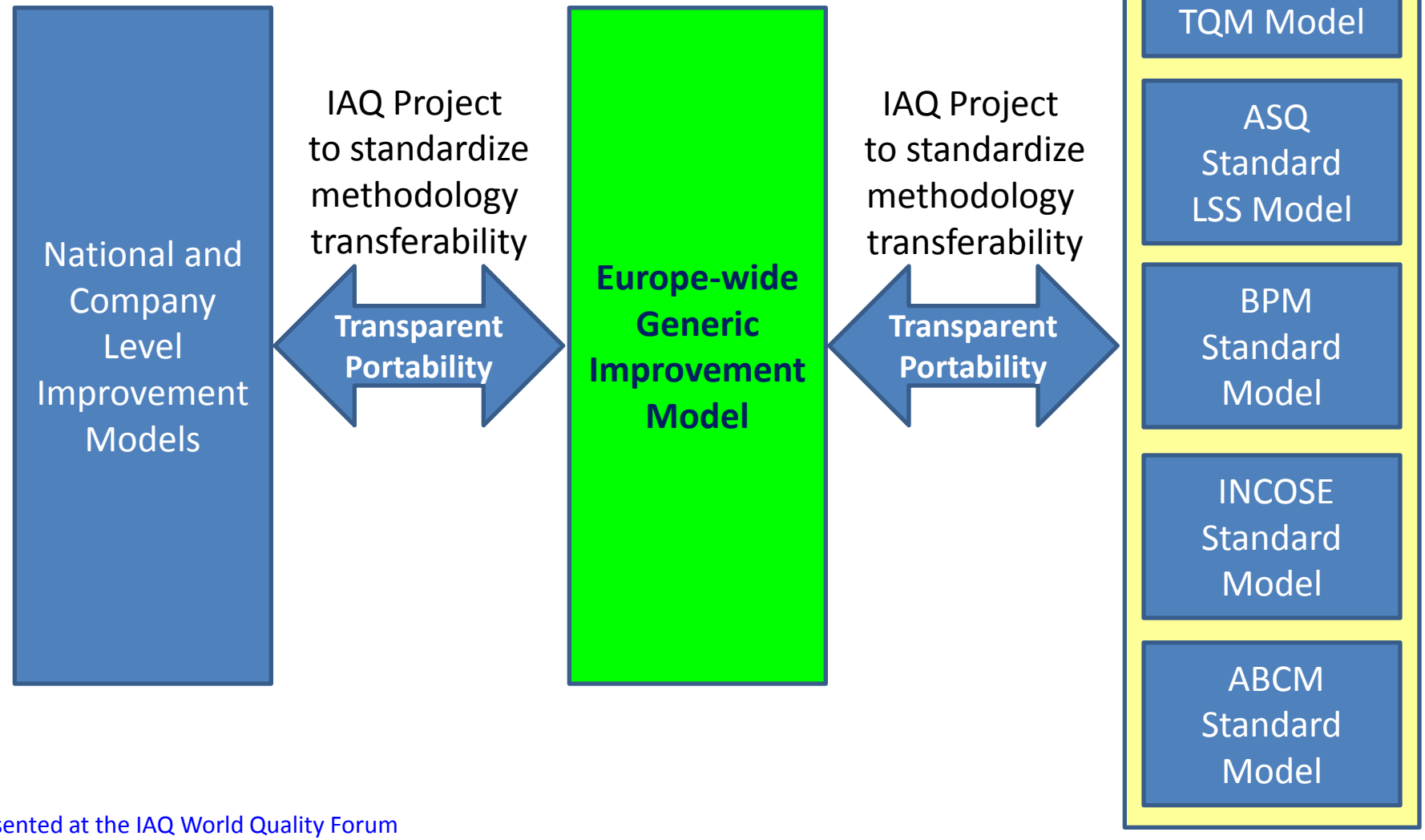
- Models must be developed that integrate all aspects of the various approaches to structured problem solving or process improvement.

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.

Generic Improvement Model Concept:

How will a generic improvement model help?



THINK TANK ANALYTICAL CONTRIBUTIONS

International Academy for Quality

PART 1 – PROPOSED STANDARD MODEL: LEAN IMPROVEMENT

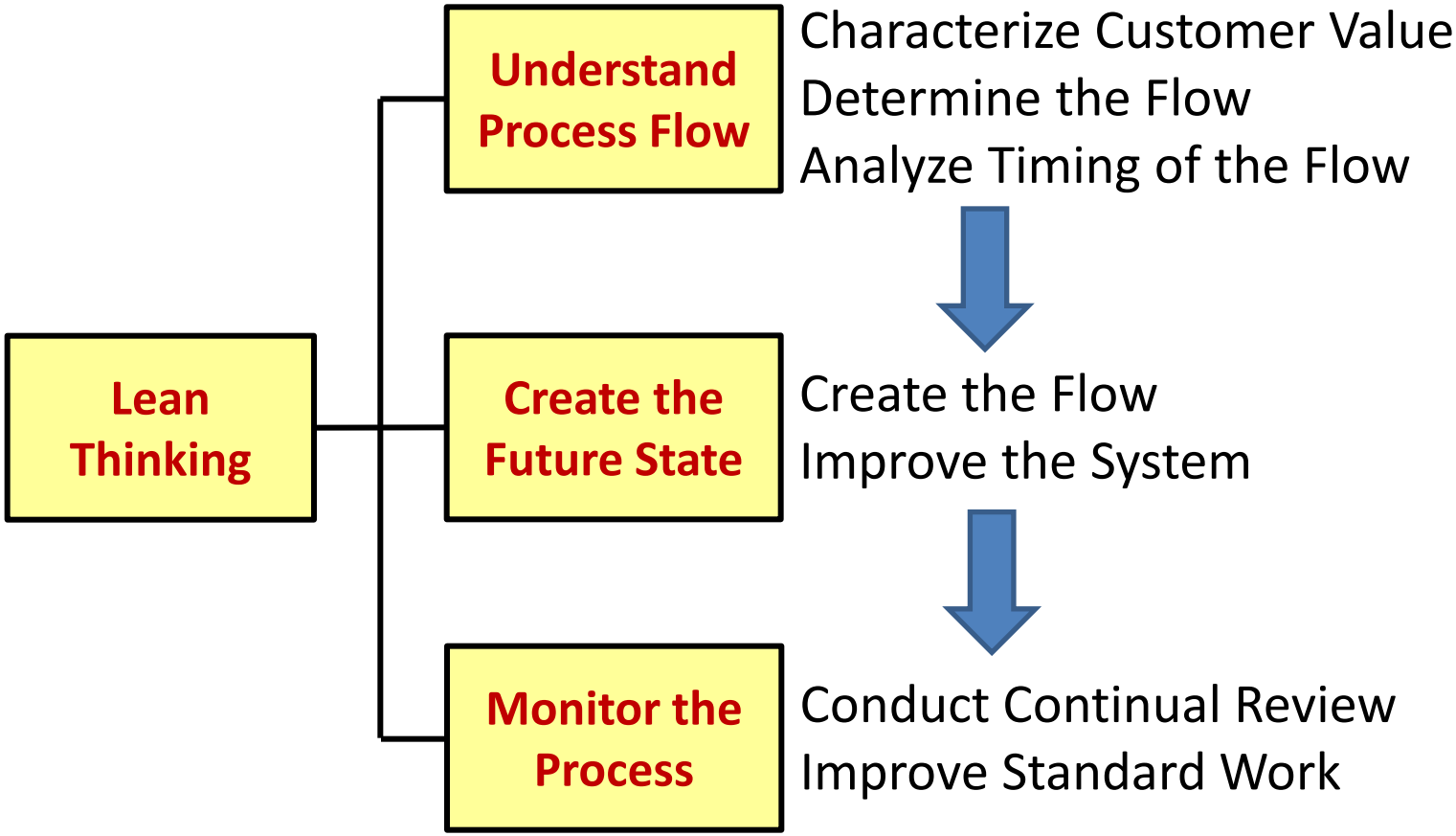
Initial problem: There is no mental model for lean!

- 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.

Proposed Lean Thinking Model:

Issue: Lean Methods do not have a standard mental process model.

Team Action: Develop a mental model for application of lean thinking.



Self-reflection: *Hansei* – The "*Zen*" of Lean Managing!

- *Hansei* (はんせい) literally refers to mental acts that lead to increased self-awareness through self-reflection, reconsideration, introspection, meditation, or contemplation. *Hansei* occurs during the "Check" steps of the PDCA and SDCA cycles and it "standardizes worrying!"
- *Hansei* has several features: there must be recognition of a problem which is primarily related to the personal performance of an individual rather than the failure of a process or overall system.
- ***The person creating a problem must accept personal responsibility for the shortcoming.*** Being reprimanded or scolded is not *hansei*.
- Instead, ***taking personal ownership for the mistake is a critical part of hansei reflection along with individual acceptance that the act was committed wrongly.*** The worker should possess a sense of shame (loss of pride in their work) for not having performed correctly, accept an obligation to make the task properly, and therefore commit to improvement in the future which is documented by taking affirmative action that corrects the standard work instructions.

Leaders must persuade workers of benefits of change:

- How should manager's develop responsibility for quality in their workers? The essential action required is: *
  - Managers must persuade workers that the improvement activity is in their interest – demonstrating "what's in it for them" – and it is necessary for workers to participate in decisions that define the way that their work is accomplished and their targets are set.
- What does must occur before a manager can hold an individual worker accountable for the quality of their work? Three criteria must be applied: **
  1. People know what is expected of them, have targets to achieve the agreed results and performance measures to monitor progress.
  2. People are given the resources required to meet these targets and have the personal competence to perform their work.
  3. People are given authority to self-regulate and control outcomes in the performance of their work to achieve the desired results.

* Chester I. Barnard (1938), ***The Functions of the Executive*** (Cambridge: Harvard Press), pp. 165-180.

** Peter F. Drucker (1954), ***The Practice of Management*** (New York: Harper), pp. 133-135, 268-269, 302-308.

Who is responsible for what aspects of quality?

Basic Assumption in Human Activity: People want to do their job right and they become frustrated whenever their process does not work properly to deliver performance that meets customer expectations. People become increasingly more frustrated if asked to do things for which they have no training or if they are required to manage work to performance measures and goals over which they have from little to no control to deliver results.

Most organizations have not appropriately allocated responsibility for quality!

Everyone has some responsibility for the quality of their content and process!

- Job of the **worker**: assure quality of the work, maintain rate of production, make continual improvement in work process
- Job of **maintenance**: assure production availability, anticipate machinery and equipment problems, assure worker safety
- Job of **process engineer**: design production line flow, assure balance in the work, make continual process improvement, incorporate new technology
- Job of **supervisor**: assure standard work, train the workers, facilitate problem-solving and improvement efforts
- Job of **production manager**: encourage the workers, assure customers are delivered value, maintain relationships with suppliers, manage finances

Understanding Process Flow in Lean Management:

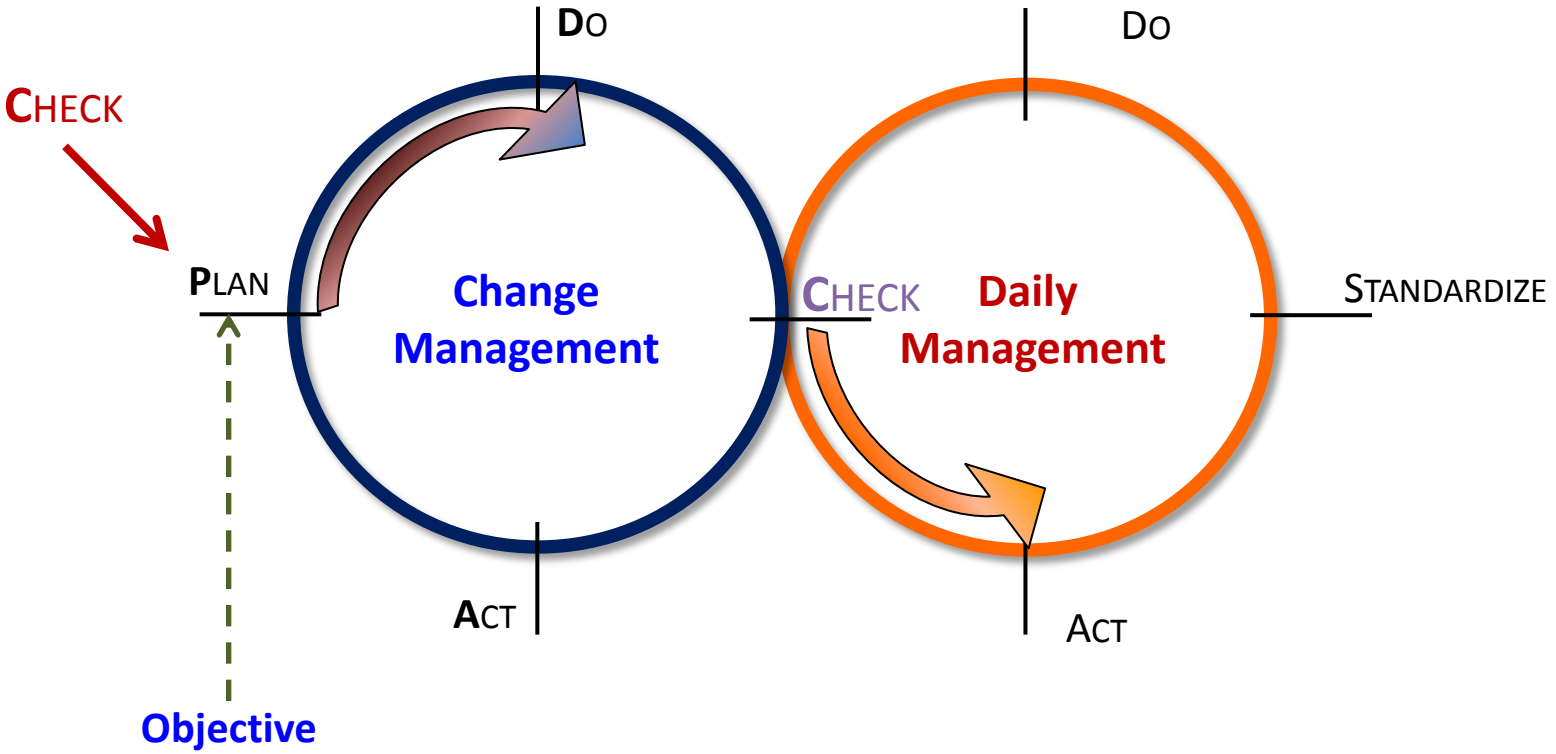
This initial step in the mental model of lean management is often the one that is missing or reduced in emphasis. This is the initial step of a 10-S process to understand current state performance.

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 ?

Performance Improvement Refines Daily Management:

All change must be implemented in the daily management system to be effective!



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

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

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

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	

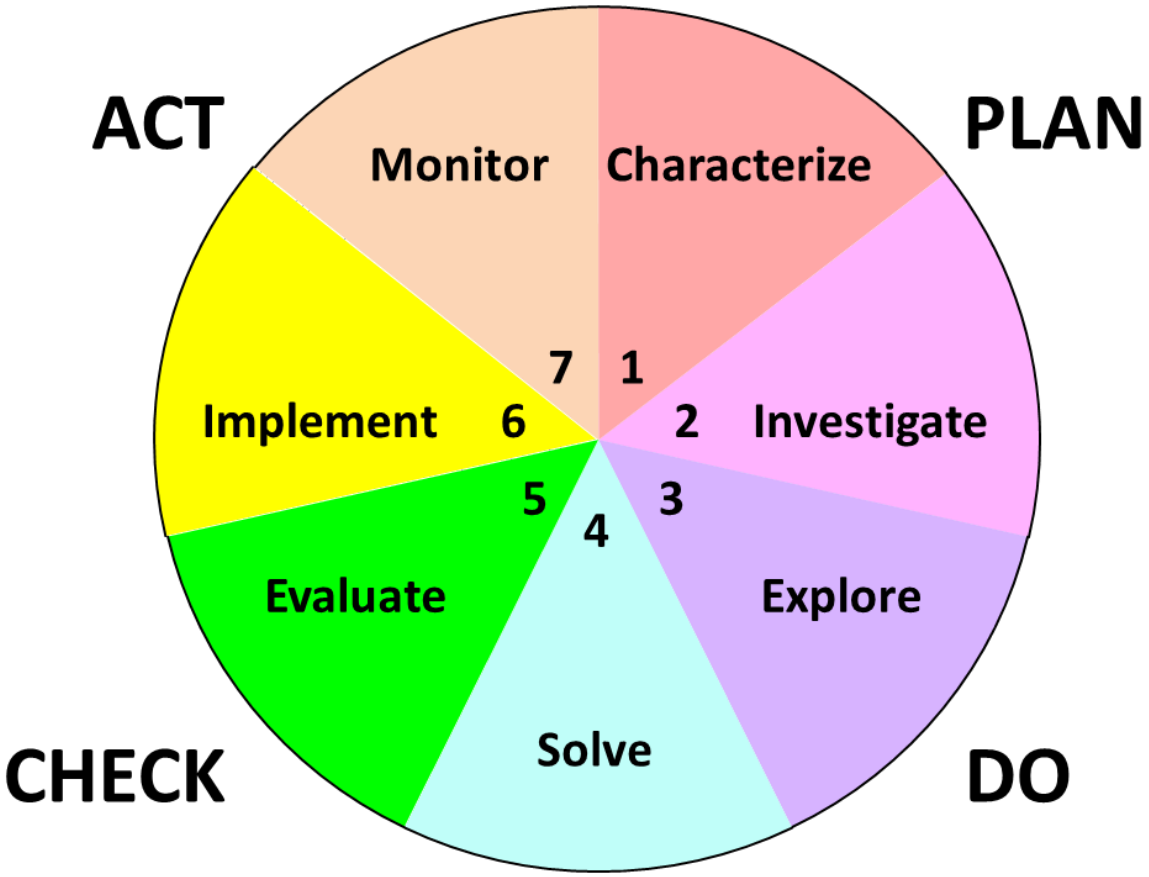
PART 2 – PROPOSED STANDARD MODEL: STRUCTURED IMPROVEMENT

The "generic" structured improvement mental model:

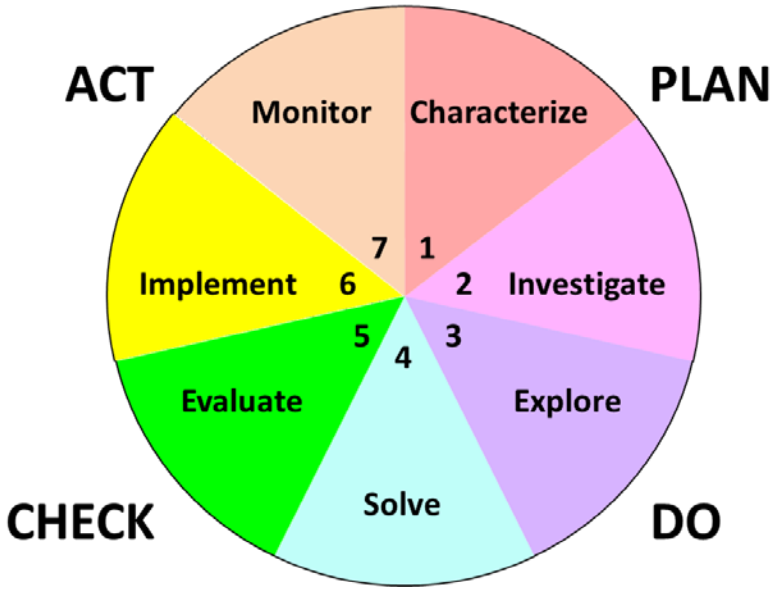
The proposed mental model addresses correction of some of the key deficiencies observed in other mental models for improvement:

- 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.

Proposed Structured Improvement Model:



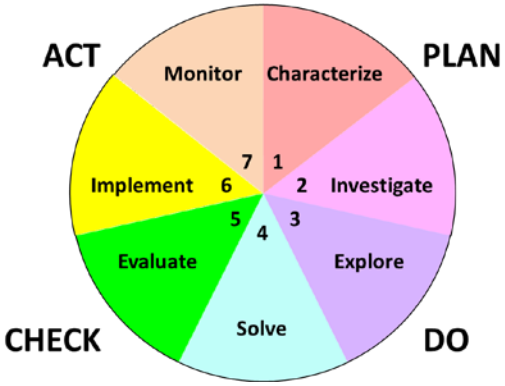
1. Characterize



NEW 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 – System 1 and System 2)
- Exploratory Data Analysis (Results Measures)

Systematic Continual Improvement: Characterize



Questions Addressed:

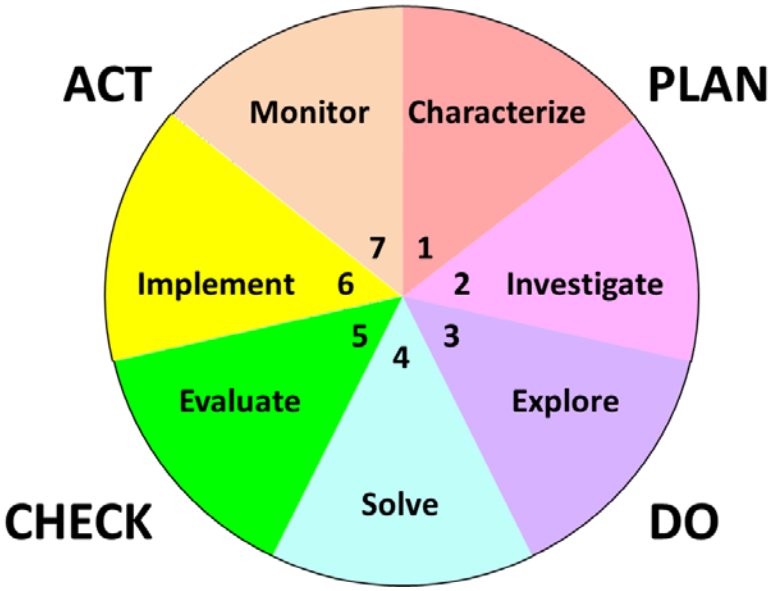
- What is the issue or concern?
- What are the symptoms?
- How big is the potential impact?
- Where is the situation occurring?
- How does it affect our customers?
- Who should take responsibility?

Methods Introduced:

- SIPOC map
- Tree diagram
- Operational definition
- Problem statement
- Pareto chart
- Customer table

- Describe those symptoms that cause concern; define the issue or problem statement that describes the situation; identify the boundary conditions (and limitations), business case (and assumptions); specify the customer Point of View (POV) and describe the impact on the Voice of the Customer (VOC); prepare a Supplier-Input-Process-Output-Customer (SIPOC) map; identify key improvement opportunities in the context of the high-level company-wide business process (financially quantified if all possible); and determine who are the stakeholders that need to be involved as well as the owner who is responsible for coordinating the improvement effort or problem solving project.
- The activity of this phase includes alignment with organization strategy, initial issue investigation, project management and initiation which relate to the DMAIC steps of Recognize and Define.

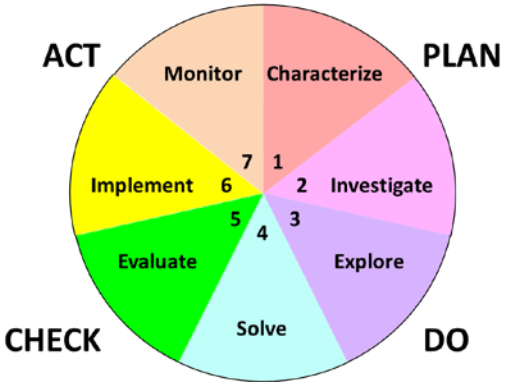
2. Investigate



NEW ELEMENTS INCLUDED IN THIS PHASE:

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

Systematic Continual Improvement: Investigate



Questions Addressed:

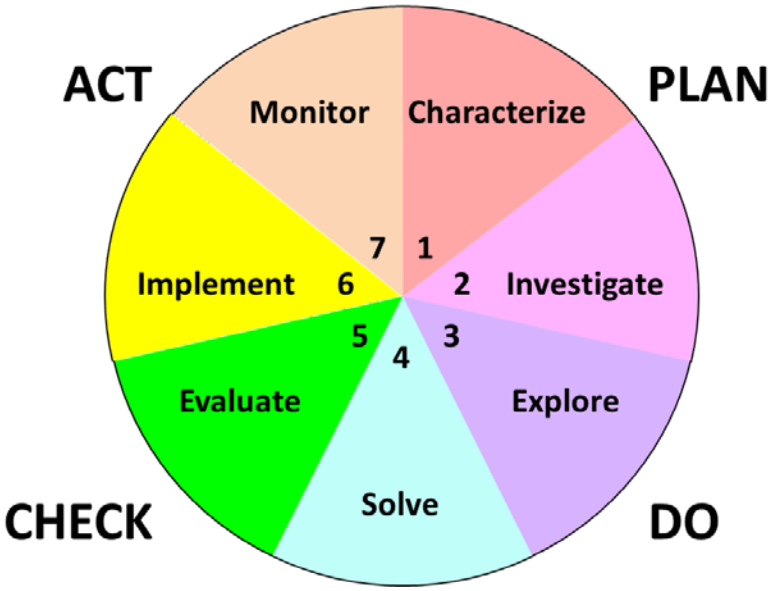
- What is the situation?
- How well is the process doing?
- How well could it be doing?
- Can the process detect problems?
- How can the process fail?
- What is the process loss function?
- Does the history show any trend?
- Where should the project focus?

Methods Introduced:

- Current State Process Map
- Exploratory data analysis
- Individuals Process Charts
- Potential Problem Analysis
- Fishbone Diagram
- Value Stream Map
- Process Capability Analysis
- Performance Baseline

- Determine the "As-Is" or state of the current situation for both its results as well as the process-related measures; identify the kind, quality, and amount of information needed to characterize the situation; determine the integrity (trustworthiness) of the data observations; set the baseline for the evaluation of performance improvement; represent graphically the end-to-end process flow as a value chain; assess the current requirement for process compliance with targeted results (or set an exploratory level of targeted performance); and define performance gaps.
- Activity includes the formal graphical process representation and exploratory data analysis to quantify performance capability and potential similar to the DMAIC steps of Define and Measure.

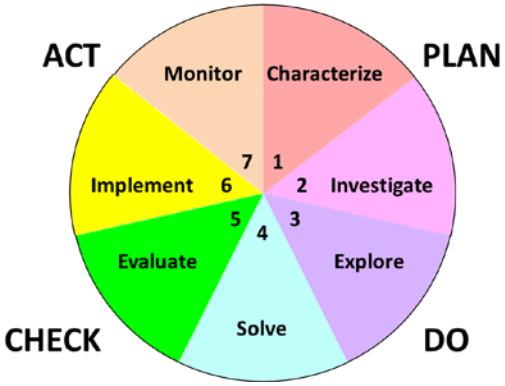
3. Explore



NEW 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

Systematic Continual Improvement: Explore



Questions Addressed:

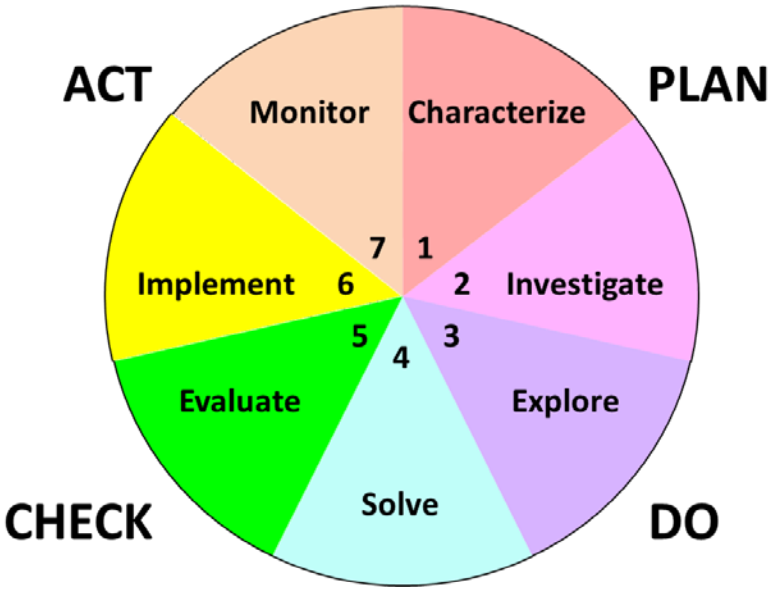
- Is anyone doing this work better?
- What are the potential causes?
- What is the cost of poor quality?
- How can the work be simplified?
- Which factors affect variation?
- Where is productive time lost?
- Where is cost wasted?
- How much variation is explained?
- What are potential root causes?
-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

Methods Introduced:

- Measurement Analysis
- 5-S Housekeeping
- Desired State Process Map
- Analysis of Variance
- 5 Why's Analysis
- Hypothesis Testing
- Cycle Time Analysis
- Analysis of Variance
- Regression Analysis
- Process Cost Analysis

- Determine the temporal and spatial performance trends and patterns that exist in data collected for process measures; establish causal relationships for observed variation and fix the potential sources among the factors that influence the situation; assess statistical, organizational, interpersonal and process dimensions of the problem and identify those factors most likely to influence the performance outcome. Eliminate waste from the process.
- This activity includes process analysis, data analysis, and work analysis for both equipment-related and human factors which are similar to aspects of the DMAIC steps of Measure and Analyze.

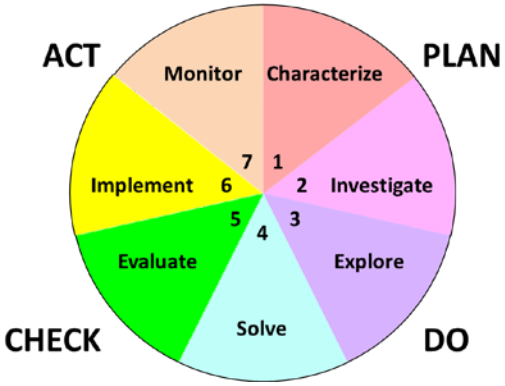
4. Solve



NEW ELEMENTS INCLUDED IN THIS PHASE:

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

Systematic Continual Improvement: **Solve**



Questions Addressed:

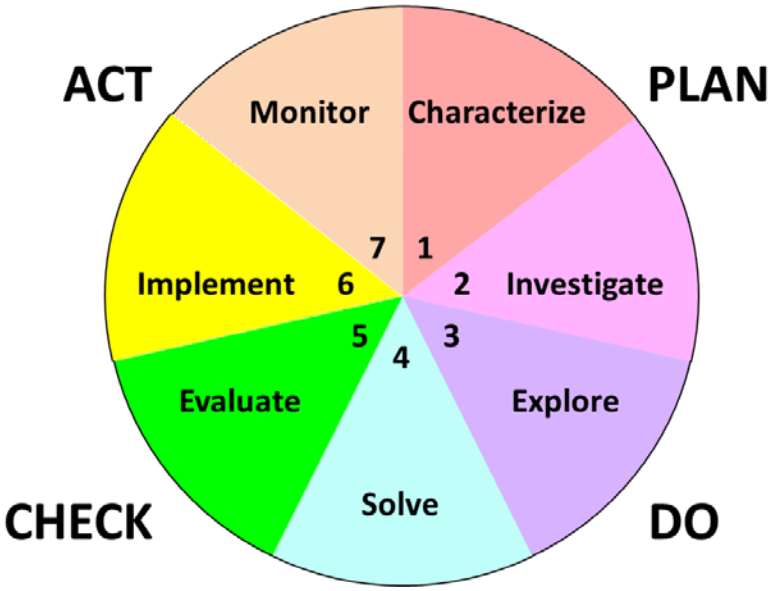
- Which factors affect performance?
- What factors manage variation?
- What factors shift the average?
- What factors reduce operating cost?
- What is their operating envelope?
- What happens outside this range?
- How are these factors controlled?
- How can the process be controlled?
- How easily can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

Methods Introduced:

- Brain Writing
- Affinity Diagram
- Prioritization Matrix
- Kaizen Process Blitz
- Decision Workout
- Process Laboratory
- Process Benchmarking
- Accelerated Life Test
- Simulation Analysis

- Establish the causal relationship between the critical process factors and the results measures and assure that causality is demonstrated and that the proposed solution actually corrects or improves the situation.
- This activity includes demonstration testing, experimentation, laboratory process analysis, process benchmarking, decision workout, and kaizen blitz activities which are conducted to establish the causality of events as well as verify and validate that supposed corrective actions perform properly and do not by themselves introduce “unintended consequences” to the situation. This is similar to the DMAIC Improve step.

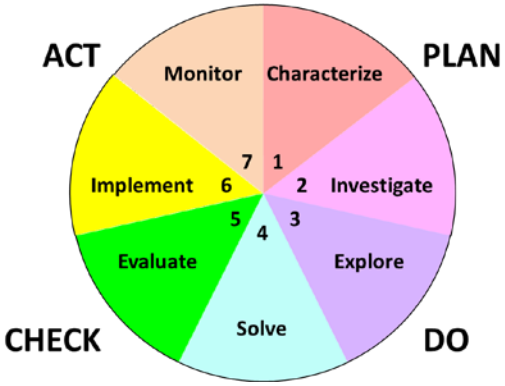
5. Evaluate



NEW ELEMENTS INCLUDED IN THIS PHASE:

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

Systematic Continual Improvement: **Evaluate**



Questions Addressed:

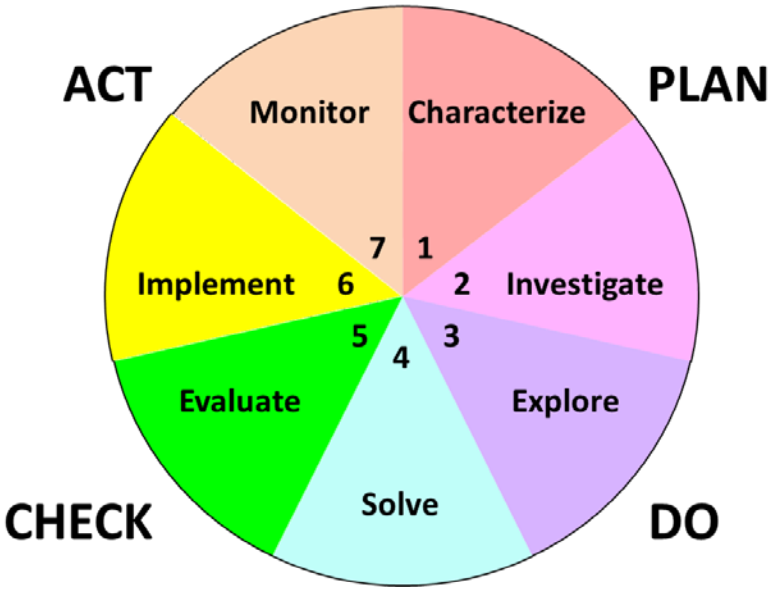
- How to optimize factor settings?
- Is the solution sufficiently robust?
- Do indicators need to change?
- Are measurement methods valid?
- What financial benefit will result?
- How to capture the benefits?
- Who is responsible for action?

Methods Introduced:

- Design of Experiments
- Taguchi Analysis
- Measurement Analysis
- Confirmation Experiment
- Target Cost Analysis
- Lean Accounting
- Benefit Capture Plan

- Demonstrate the efficacy of the proposed solution, the strength of its causal relationships and the influence of potential interaction effects that may exist among the process variables. Establish operating ranges, process flow rates, equipment settings, and performance tolerances. Confirm the results through an objective test of the proposed solution. In addition to assessing these factors in the test environment, it is important to extend the investigation to operational and customer environments to evaluate how the improvement will work in "worst-case scenarios."
- This step performs confirmation experiments and to demonstrate that the improvement is valid and works in all expected environmental conditions. This activity is similar to that which occurs in the later stage of DMAIC Improve step.

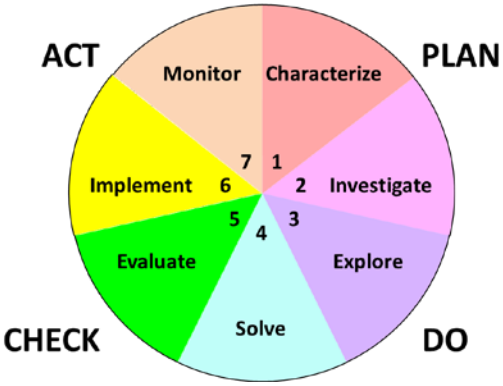
6. Implement



NEW ELEMENTS INCLUDED IN THIS PHASE:

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

Systematic Continual Improvement: **Implement**



Questions Addressed:

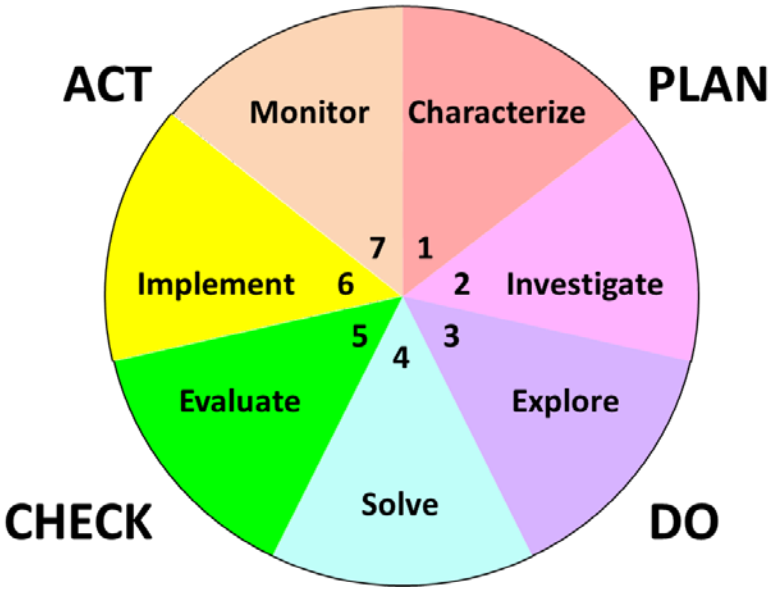
- What will be standard work?
- Which factors must be managed?
- What is their tolerance range?
- How will the process be maintained?
- What training will operators need?
- How will work errors be prevented?
- What is the action plan?
- How to leverage this knowledge?
- How to capture the benefits?

Methods Introduced:

- Mistake-proofing
- Tolerance Analysis
- 5-S Process Discipline
- Process Monitor & Control
- Standard Work Procedure
- Process Control Plan
- Implementation Plan
- Benefit Capture Plan
- Realization Review

- Develop implementation plan (risk analysis, communication plan, training plan, and work instructions / SOP) and benefit capture action plan to assure that the recommended change is implemented. This phase transitions the improvement project back into “normal process management” system.
- This activity includes development of control plans, training of operators, physical process changeover, and actual implementation which are part of the DMAIC Control step (as well as the Implement and Standardize optional steps that are used by some DMAIC processes to complete the method). Monitor transitions the project to routine management reinforced by the continual (evolutionary) improvement of (supervised) work.

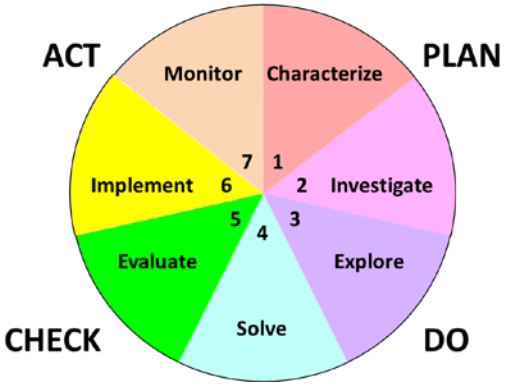
7. Monitor



NEW ELEMENTS INCLUDED IN THIS PHASE:

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

Systematic Continual Improvement: **Monitor**



Questions Addressed:

- 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?

Methods Introduced:

- PDCA/SDCA
- 7 Basic Quality Tools
- Work Instructions
- Zero QC - Self Inspection
- Hansei and Kaizen
- Control Plan for QCDSM
- 3S Work Discipline
- 4-Up Chart / Radar Chart

- Process operations are stabilized in the proper control zone, results are monitored for compliance and to identify opportunities for improvement, and local managers or process owners conduct realization reviews and conscientiously follow-up on implementing findings on improvement and process control. Improvements are replicated or extended to similar work processes to leverage the benefits of the learning. In addition, the process owners encourage workers to identify further improvement opportunities.
- This activity represents the routine management as well as the continual (or evolutionary) improvement of the natural work processes under supervision of the daily management team as routine work performance.

STATUS OF THE IAQ THINK TANK PROJECT

Continuing IAQ Think Tank activities:

The following reports are in the process of finalization:

- Benchmarking Study: Japanese Models of PDCA
- Benchmarking Study: European DMAIC Models
- Critique of the DGQ DMAIC Model
- Critique of the ISO Lean Six Sigma Standards

A working session among Think Tank team members attending the IAQ WQF has been conducted to construct a final report that will be presented to the EOQ General Meeting in Vienna during early December.

After approval by EOQ, the report will be circulated for comment by ASQ and JUSE. After review their feedback and making corrections and improvements then the team will develop documents to support the EOQ PRU certification scheme and competence model as well as a recommended curriculum that will meet the objectives of these specializations.

What will be the follow-on steps in this project?

1. Develop a detailed body of knowledge to specify the options for executing the proposed systematic continual Improvement process.
2. Develop a competence model to support a three-tiered set of skills, aptitudes and knowledge to mastered at the equivalent to the LSS Green Belt, LSS Black Belt and LSS Master Black Belt competence levels.
3. Prepare an IAQ technical report describing the model; method map; and competence scheme and provide for review by ASQ and JUSE.
4. Seek opportunities to pilot and test this generic model across Europe.
5. Convene the MBB panel to develop examples and case studies that define how the methodology is applied.
6. Standardize the model and its sub-elements and document the process.
7. Develop a model educational curriculum for training providers to support the competence certification process (applicable to SMEs).
8. Develop a comprehensive qualified question bank to support the EOQ Personal Registration Unit (PRU) examinations for three-tier certification.
9. Identify methodology advancements that need to be developed and set a schedule for preparation of supporting papers for academic journals.