Essentials

Bonus: Continuous Improvement

Continuous Improvement

Continuous Improvement (CI) is the ongoing improvement of products, services or processes through incremental breakthrough improvement over time. Continuous improvement is based on the following principles which align with the 6 Essentials to competitive results:

- Value lies in the eye of the customer (Connections Essential)
- All work is a process (Process-thinking Essential)
- Variation exists everywhere (Statistical-thinking Essential)
- Variation creates waste (Statistical and Process-Thinking Essentials)
- Understanding and reducing variation and waste are key to successful improvement (Process-thinking and Statistical-thinking Essentials)
- Involve and empower employees (Connections Essential)

Continuous improvement differs significantly from traditional improvement approaches as shown in the table below:

Organizational Issue	Traditional Approach	CI Approach
Problem Resolution	Fix (Symptoms)	Prevent (Causes)
Behavior	Reactive	Proactive
Decision-Making	Experience-Based	Data-Based
Process Adjustment	Tweaking	Controlling
Supplier Selection	Cost	Capability
Planning	Short-term	Long-term
Employee Training	If Time Permits	Required
Chain of Command	Hierarchy	Empowered Teams
Direction	Seat of Pants	Benchmarking and Metrics
Manpower	Cost	Asset

Continuous Improvement has evolved over the last 100 years:

1900-1920 Scientific Management and Statistics

– Frederick Taylor's techniques of scientific management.
– Henry Ford created the assembly line.
– Walter Shewhart developed the control chart; Fisher DOE; Dodge-Romig acceptance sampling.
– Field of industrial engineering initiated.

1950's: Deming, Juran, Feigenbaum

– Dr. W. Edwards Deming introduced statistical quality control (SQC) with a focus on management to Japan; modified & popularized PDCA Cycle.
– Henry Ford developed flow methodologies
– Dr. Joseph Juran developed the quality trilogy.

1960's to 1980's: Japanese Quality Revolution

– Toyota Production System developed and refined.

1980's to present: American Quality Revolution

– Motorola developed Six Sigma.

- Lean/flow methodologies rediscovered.
- Methodologies integrated and application expanded; innovation added.
- Performance Excellence and Quality Management Systems defined and standardized through ISO and national award systems.

We'll define the recent Continuous Improvement frameworks, key principles and tools, including the relationship between the frameworks and the Essentials for competitive results in the rest of this post. Then we'll explore the misconceptions and paradigms of these frameworks as well as an integrated framework created by SOS.

Malcolm Baldrige National Quality Award (MBNQA)

The Malcolm Baldrige National Quality Award was created in the US by public law 100-107 in 1987 with three categories (manufacturing, service and small business). It was expanded to five categories in 1999 with the addition of education and healthcare, to six categories in 2004 with the addition of the non-profit category. It consists of seven criteria that when fully implemented define a Performance Excellence system:

1. Leadership – defines key aspects of senior leaders' responsibilities, with the aim of creating a sustainable organization that fulfills its societal responsibilities and supports its key communities. (Cohesive Leadership Essential)
2. Strategic planning – the criterion asks how the organization (Clarity Essential)
    a. considers key elements of a strategic planning process, including strategic opportunities, challenges, and advantages;
    b. optimizes the use of resources, ensures the availability of a skilled workforce, and bridges short- and longer-term requirements that may entail capital expenditures, technology development or acquisition, supplier development, and new partnerships or collaborations; and
    c. ensures that implementation will be effective—that there are mechanisms to communicate requirements and achieve alignment on three levels: (1) the organization and executive level, (2) the key work system and work process level, and (3) the work unit and individual job level.
3. Customer & Market Focus - This criterion asks how your organization engages its customers for long-term marketplace success, including how the organization listens to the voice of the customer, builds customer relationships, and uses customer information to improve and to identify opportunities for innovation. (Connection Essential)
4. Measurement, Analysis and Knowledge Management - This criterion asks how the organization uses key information to effectively measure, analyze, and improve performance and manage organizational knowledge to drive improvement, innovation, and organizational competitiveness. In the simplest terms, criterion 4 is the "brain center" for the alignment of the organization's operations with its strategic objectives (Strategic-thinking Essential)
5. Workforce Focus - This criterion addresses key workforce practices—those directed toward creating and maintaining a high-performance work environment and toward engaging the workforce to enable it and the organization to adapt to change and to succeed. (Connections Essential)

6. Process Management - This criterion asks how the organization focuses on its work, product design and delivery, and operational effectiveness to achieve success and organizational sustainability. (Process-thinking Essential)
7. Results - This criterion provides a systems focus that encompasses all results necessary to sustain an enterprise: key process and product results, customer-focused results, workforce results, leadership and governance system results, and overall financial and market performance.

The relationship between the seven criteria is represented as a “hamburger:”

Applying for the award is not necessary to use the framework; many organizations have found value and competitive results applying the framework without ever applying for the award. In fact, countries around the world have copied the MBNQA to develop awards of their own.

ISO 9000

ISO 9000 is a set of international standards on quality. ISO 9000, 9001, 9004 define a coherent quality management system. They were first issued in 1987, revised in 1994, 2000, 2008 and 2015. Revisions have made the standards more user-friendly, restructured around the process approach, placed greater emphasis on the role of top management, increased emphasis on the customer, formalized continual improvement of the system, all in language that applies across sectors, sizes and kinds of organizations. The standards have been developed on a foundation of 8 principles:

1. Customer focus – organizations depend on customers and should therefore understand their current and future needs and strive to exceed expectations. (Connections Essential)
2. Leadership – leaders establish unity of purpose and direction for the organization (Cohesive Leadership Essential)
3. Involvement of people – people are the essence of the organization; full involvement enables their abilities to be used for the benefit of the organization (Connections Essential)
4. Process approach – results are achieved efficiently when activities and resources are managed as a process (Process-thinking Essential)

5. System approach to management - managing interrelated processes as a system contributes to the organization’s effectiveness and efficiency (Process-thinking Essential)
6. Continual improvement – overall organizational performance is obtained and sustained through daily incremental improvement
7. Fact-based decision-making – effective decisions are based on an analysis of data (statistical-thinking Essential)
8. Mutually beneficial supplier relationships – an organization and its suppliers are interdependent; a mutually beneficial relationship enhances the ability of both to create value. (Connections Essential)

A management system is an integrated set of processes and tools to translate strategy into operational action. Management systems help organizations achieve strategic objectives, sustain improvement, maintain capability for change, meet customer expectations and drive improvement on a daily basis. Management systems exist for environment (ISO 14000) and safety (Process Safety Management) as well. All have common elements:

- Management responsibility
- Documentation
- Internal audits
- Corrective/preventive action/risk-based thinking
- Workforce training
- Control of critical processes

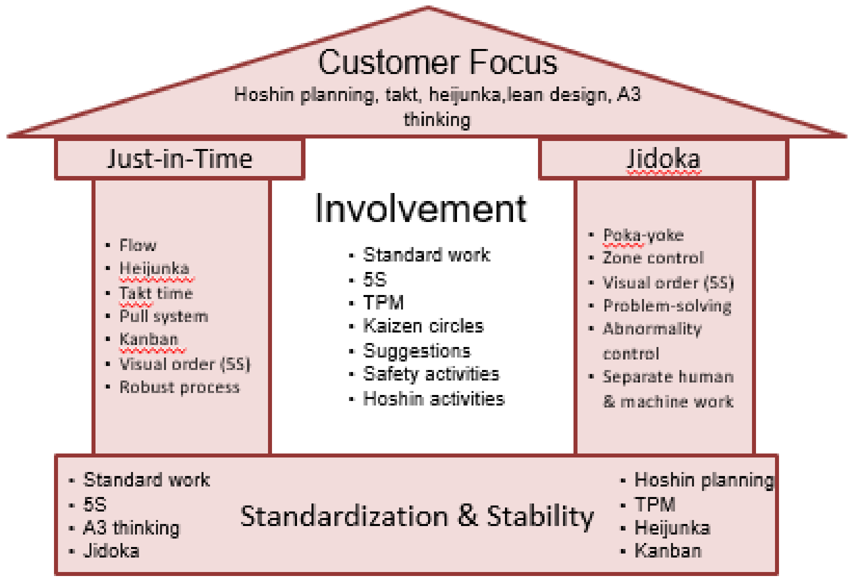
Many organizations have sought ISO 9001 registration (through third party audit) for the certificate without understanding the principles and implementing in a way that achieves long-term results; they simply check off the boxes. The documentation becomes the focus which over time becomes increasingly complex and burdensome. Implementation with full understanding of the principles, not only achieves results, but continuous improvement that leads to sustainable results over time.

Lean Manufacturing

Lean manufacturing is based on the Toyota Production System (and Ford process flow). It is focused on eliminating 8 forms of waste:

1. Defects
2. Overproduction
3. Waiting
4. Not engaging employees
5. Transportation
6. Inventory
7. Movement
8. Excessive processing

Lean involves five areas of work commonly represented as a house:



Based on: Pascal Dennis. Lean Production Simplified, 2nd edition. Boca Raton, FL: CRC Press, 2007.

1. Customer focus – doing the right things for customers by aligning resources and communicating and collaborating with customers (Connections Essential)
2. Standardization and Stability – defining standard work, providing skilled people, equipment and level demand. Standard work, and visual management using 5S and visual displays are key tools used to engage employees to achieve and sustain standardization and stability. (Process and Statistical-thinking Essentials)
3. Just-in-Time – producing and delivering the right item at the right time in the right quantity. Takt rate, pull/Kanban systems, and quick changeover are key tools used to eliminate overproduction, transportation, motion, and excess processing. (Process and Statistical-thinking Essentials)
4. Defect-free (Jidoka) – identifying defects and taking quick action/countermeasures to return the process to defect-free state. Poka-yoke, PDCA problem-solving are key tools to eliminate defects. (Statistical-thinking Essential)
5. Involvement – engaging everyone in the organization in improvement with respect. Key tools used to fully engage employees include standard work, Kaizen, quality circles and suggestion systems. (Connections Essential)

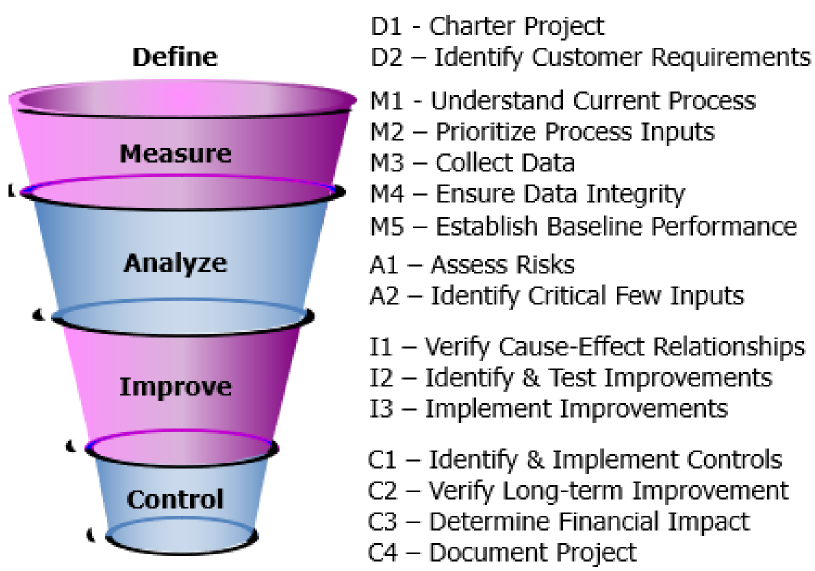
Lean is not only a CI framework, but a philosophy of improvement that requires leadership commitment to the philosophy and consistent implementation of the five areas of work, holistic implementation across the organization, and operational discipline.

Six Sigma

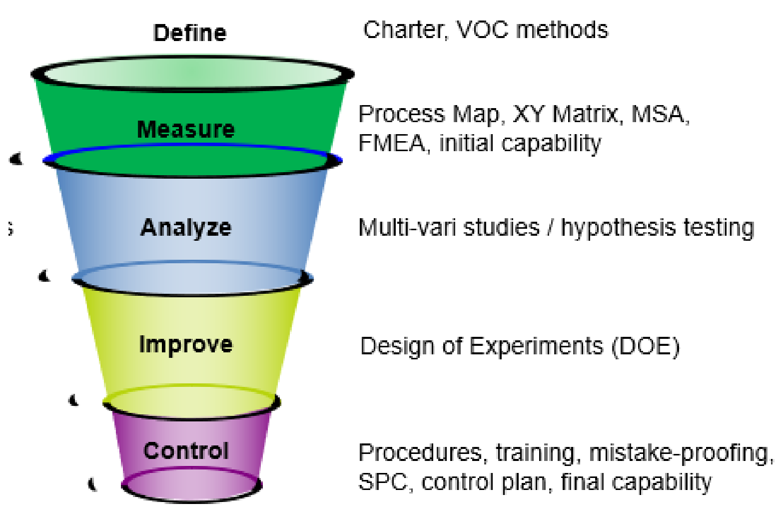
Six Sigma is an approach to improve the capability of processes through a decrease in variation. Six Sigma originated at Motorola in the late 1980's/early 1990's as a way to reduce variation in products, services, and processes to ≤ 3.4 defects per million. It was refined by other organizations as it expanded beyond Motorola. Six Sigma consists of 5 phases implemented on a project-by-project basis:

1. ***Define***: Define the problem and project objectives; quantify benefits; identify project team.
2. ***Measure***: Understand the current process; determine the capability of the current process and the measurement system; implement visual management.
3. ***Analyze***: Analyze process to understand patterns and trends between inputs and outputs that lead to variation/waste
4. ***Improve***: Verify critical inputs and determine optimum settings; identify solutions to achieve optimum settings and eliminate non-value add. Test and implement solutions.
5. ***Control***: Institute controls to "sustain the gains."

Deliverables for each of the 5 phases are depicted in the graphic below:



Tools used in each of the 5 phases are depicted in the graphic below:



As you might guess from the tools used in Six Sigma, it is heavily oriented around the use of data and statistics. While this has the benefit of fact-based decision-making, it makes implementation more complex and requires extensive training of different levels of resources (Master Black Belts, Black Belts, Green Belts).

No one framework is appropriate for every situation. Often, an integrated combination of approaches is needed. As we've seen throughout the descriptions, all are based on the 6 Essentials to some degree. Therefore, implementation of any one approach without the 6 Essentials will not achieve sustainable results.

Finding the Best Fit CI Method for Your Organization

The two most popular approaches, Lean and Six Sigma are, on the surface, concerned with getting more customers while eliminating unnecessary expenses, wastes and losses. Lean focuses on reducing process waste and increasing value of an organization's products/services to the customer. Six Sigma seeks near perfection in products/services to satisfy customers by eliminating variation (and costs) throughout the process. While the end result may appear similar, Lean and Six Sigma are different in many ways:

	Lean	**Six Sigma**
Who/When Developed	Toyota, 1960s-1990's with earlier roots in Ford assembly system	Motorola, 1980's- 1990's
Theory	Waste Reduction	Variation Reduction
Focus	Flow	Variation
Roadmap	1. Identify Value 2. Identify Value Stream 3. Flow 4. Pull 5. Perfect	1. Define 2. Measure 3. Analyze 4. Improve 5. Control
Tools	● Visual	● Data-oriented; mathematical and statistical
Assumptions	● Waste is the main barrier to profitability ● Many small improvements are better than large breakthrough improvements ● Waste can best be reduced by the people in	● Variation in products and processes is the main barrier to profitability ● Reduction of variation in all processes improves overall organization performance. ● A problem (defects) exists ● Problems are best solved in a project-by-project approach

	Lean	Six Sigma
	the process as part of daily work. ● People will participate in improvement they can see	● People appreciate data and that it can be used to obtain a deeper understanding of the process for improvement. ● Accurate data exists on product/process/problem ● Expert dedicated resources can solve the problem better than members of the process.
Primary effect	● Reduced flow time	● Uniform product/service/process output
Secondary effects	● Less waste ● Fast throughput ● Less inventory ● Improved quality	● Less variation ● Uniform output ● Less inventory ● Improved quality
Capabilities developed	● Skills developed in visualization, problem-solving, quick response ● Induces a culture of CI	● Skills developed in collecting and analyzing data, using software, managing databases, and planning ● Induces a culture of CI
Where capabilities developed	● Factory floor	● Staff resources

Just because an organization can improve a process does not mean it should. Implementing Lean or Six Sigma, therefore, without clarity on an organization's purpose, values, goals, and mechanisms to communicate them consistently throughout the organization will not allow the organization to focus Six Sigma on key strategic opportunities and may not result in cost savings. The total cost of implementation may outweigh the savings.

Lean requires many people in the value stream to work in synchronization so product/service flows are uninterrupted. This requires vast changes in how people perceive their roles and their relationships as well as real-time communication. Successful implementation of Lean, therefore, requires process thinking, operational discipline and strong internal communication systems.

All change/improvement programs challenge existing ways of doing things. Understanding the assumptions upon which the CI methods are based is a good starting point for determining which method is a good fit for an organization and will dictate the speed at which the method is accepted.

- If an organization values data and analysis, Six Sigma may be the best place to start the CI journey.

- If an organization values quick visual change, Lean may be the best place to start the CI journey.
- If strategic goals require breakthrough improvements in a relatively short period of time, Six Sigma may be the best place to start the CI journey.
- If strategic goals can be accomplished with incremental improvement over time, Lean may be the best place to start the CI journey.
- If customers are demanding perfection (3.4 defects per million opportunities (DPMO) or less), such as in the aerospace and medial industries, Six Sigma may be the best place to start the CI journey.

Many organizations jump on Lean or Six Sigma for the wrong reasons – everyone else in their industry is doing it, a local university offers training, a customer invites to participate in an improvement effort – without understanding the underlying assumptions, effects or capabilities developed. This can result in a poor fit which does not yield desired or expected results. Organization leadership must critically assess each opportunity to implement CI. A recent study conducted by Industry Week of manufacturers noted that nearly 70% of all manufacturing plants in the US are employing Lean Manufacturing as an improvement methodology. However, only 25% of companies that responded to the survey have fully achieved their objectives and only 24% have reported significant results.

The selection of CI method may be obvious for some organizations, but as the Industry Week results suggest, it is not for all and results are not achieved. What is the alternative?

Some have combined Lean and Six Sigma to form Lean Six Sigma which embeds the visual tools of Lean into the Six Sigma DMAIC roadmap and allows the organization to use both tool sets depending on the strategic opportunity. The disadvantage to this approach is that due to the perceived statistical complexity of the Six Sigma tool kit, most organizations implement Lean Six Sigma with dedicated technical resources (Belts) to lead and execute projects. This minimizes the role of factory floor/process team members, does not develop their capability to problem-solve and respond quickly to deviations in process performance. It also creates a culture in which improvement is not valued unless it is a “project” with dedicated staffing.

What is needed is a structured method that reduces variation and improves flow with operation team members as part of their daily work. This requires the tools/roadmap to be simplified and standardized in a way that can easily be embedded into daily work aligned with the organization’s strategic goals, values and capabilities.

SOS worked with a manufacturer in the late 1990s/early 2000s to create a method which went beyond CI to “Operational Excellence.” We’ll summarize this method in the next section

Operations Excellence Methodology

While it is hard to argue against any improvement, the reality of business economics is we want the most improvement for the least investment. Improving all processes could actually have a detrimental effect on an organization’s ability to satisfy customer needs to provide products/services at the right time at the lowest cost.

What is needed is a structured method that reduces variation and improves flow with operation team members as part of their daily work. This requires the tools/roadmap to be simplified and standardized in a way that can easily be embedded into daily work aligned with the organization’s strategic goals, values and capabilities, or “Operational Excellence,” where Operational Excellence is defined as when “*each and every employee can see the flow of value to the customer and fix that flow before it breaks down without management telling them, allowing management to focus on growth of the business*.” Some say this is unachievable, a dream, but SOS Consulting has seen it in action.

SOS worked with one company to effectively implement a structured variability reduction methodology with operations teams that achieved operations excellence across many production lines. Over the course of four years of implementation the company would see a 4-6% annual increase in productivity across their manufacturing lines. It would also extend the methodology into logistics, customer service, and finance operations. Lessons learned from its structured implementation approach were also extended to other improvement methodologies.

Background

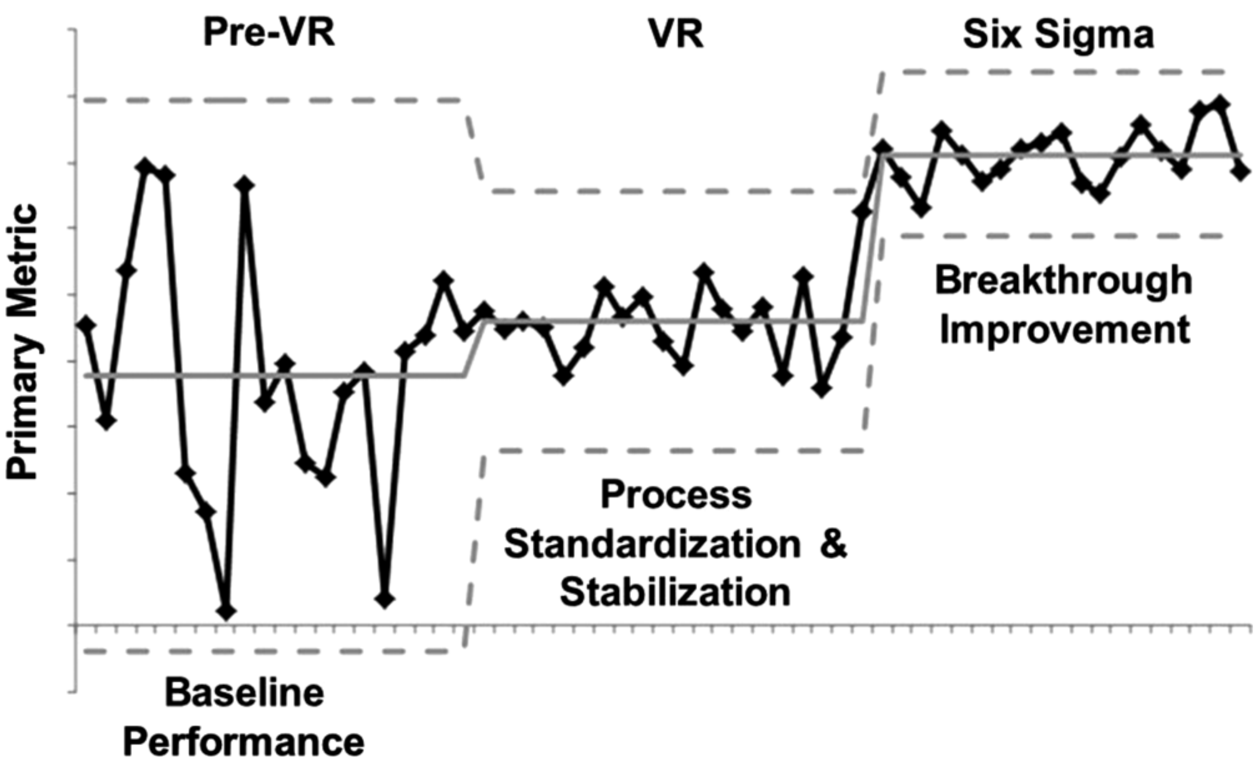
Beginning in the late 1990s a US printing company began a continuous improvement journey implementing Six Sigma, ISO 9000, 5S workplace organization and quick changeover, across their 26 North American manufacturing facilities. The continuous improvement journey began with Six Sigma. Several waves of Black Belts and Green Belts were trained during 1998-2000 with mixed results. Black Belts and Green Belts were finding little to no standard practices, limited data on process operation and performance and little experience within the operations teams to collect and use the data needed for their Six Sigma projects. Rather than working on identifying and implementing breakthrough improvements, the Belts were spending most of their time working with operations teams (pressmen and bindery operators) to develop and implement standard practices and basic data collection strategies. Several members of leadership realized that in order for Six Sigma to achieve the desired return-on-investment through breakthrough improvements, they needed to free the Belts from this work. In the past (until 1970s) pressmen went through an extensive and lengthy apprenticeship program that not only taught the art and science of printing, but best operating practices. By the late 1990’s these programs had disappeared and the standard practices along with them. An approach was needed to develop the capability of the operations teams to standardize and stabilize their own processes and to sustain the improvements on a daily basis while Six Sigma Belts focused on breakthrough improvements.

At the request of several manufacturing and continuous improvement leaders across the company, training materials on basic improvement tools (primarily the seven basic quality tools) for operations teams were drafted and piloted at several manufacturing facilities. After a few months of implementation with positive results, a design team was chartered to construct a methodology that could be consistently deployed across all North American manufacturing facilities, irrespective of equipment and product platform (books, magazines, etc.).

Variability Reduction (VR)

The result of the design team’s efforts was an operations team-based, structured variability reduction (VR) methodology that used data-based (i.e., statistical) problem-solving to reduce variability by standardizing and stabilizing daily operations.

The intent of VR was to establish a standard process, train the operations teams (pressmen and bindery operators in manufacturing; technicians in pre-press; and customer service representatives in customer service) in identifying and eliminating sources of variability within their control (stabilize the process), establish the daily disciplines necessary to sustain the improvements over time, and create an environment to facilitate breakthrough improvement through Six Sigma projects. In other words, “squeeze the variability out of the process and shift performance.” See the Figure below.



This approach, which aligns with Juran’s trilogy of quality planning, quality control and quality improvement, has many advantages:

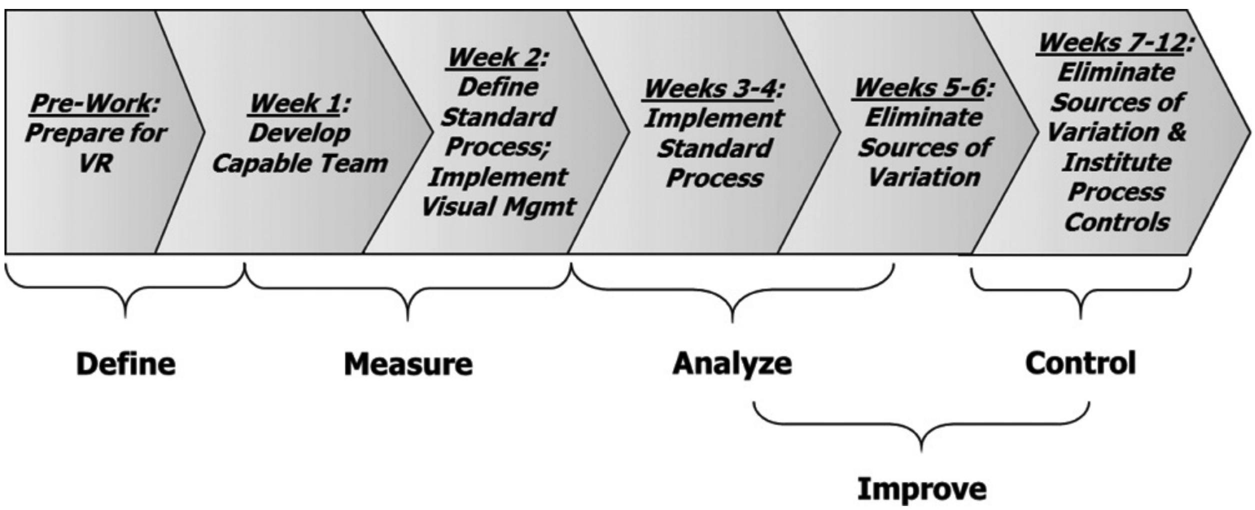
- Many people can participate in the work.
- Efforts to standardize and stabilize the process yield fast and efficient results as many, even hundreds of variables become more stable.
- It rarely requires capital or incurs risk.
- Standardization and stabilization of the process results in a lower noise environment for experimentation and more complex methods of understanding sources of variation (for which Six Sigma is well suited).

VR was designed to be accomplished over the course of 12 weeks following a structured roadmap. Once the initial 12 weeks were complete and the team “certified,” a VR team was expected to continue to sustain the behaviors and to continue to improve performance, either on their primary metric and/or a secondary metric, alone or in partnership with a Six Sigma Black Belt or Green Belt.

The VR 12-week roadmap consisted of six phases:

1. Pre-Work – Prioritize manufacturing line/process based on business need; select core team and collect baseline data
2. Week 1 - Develop capable team through training
3. Week 2 – Initiate standard practices, work team communications and data collection; make performance visible
4. Weeks 3 & 4 – Implement standard practices; audit VR progress
5. Weeks 5 & 6 – Eliminate sources of variation using data and analysis tools
6. Weeks 7-12 – Refine implementation of standard practices and elimination of sources of variation; institute process controls and audit VR progress for certification

Similar language and examples were used in Six Sigma and VR to help Belt and operations teams to view them as complementary methodologies rather than as separate and competing methodologies. The 12-week roadmap was easily aligned with the Six Sigma Define-Measure-Analyze-Improve-Control (DMAIC) roadmap. See the Figure below.



The key tools used throughout the 12-week roadmap included tools to understand and standardize the process, analyze the sources of variation, and communicate and manage the project. The tools included the seven basic quality tools, tools from lean manufacturing, and project management:

- Process Understanding and Standardization
  - Process maps/flow charts
  - Work instructions
  - Workplace organization
- Process Analysis
  - Check sheet
  - Basic statistics (average, median, range, standard deviation)
  - Pareto chart
  - Histogram
  - Run chart
  - Scatter plot
  - Fishbone diagram

- Brainstorming
    - 5 why's
    - Value added analysis
    - Spaghetti diagram
- Communication and Project Management
    - Team charter
    - Goal setting worksheet
    - Visual display
    - Action plan
    - Report card
    - Project plan

VR Phases, Deliverables and Tools:

VR Phase	VR Phase Deliverables	VR Tools
Pre-Work	Prepare for VR implementation	Basic statistics Histogram Run Chart
Week 1	Develop capable VR Team	Team Charter Goal Setting Worksheet VR Project Plan
Week 2	Initiate standard practices, communication & data collection	Process Map/Flow Chart Work Instructions Check Sheet Visual Display Action Plan
Weeks 3 & 4	Implement standard practices and collect data	Work Instructions Check Sheet Basic Statistics Visual Display Action Plan
Weeks 5 & 6	Eliminate sources of variation using data	Process Map/Flow Chart/Value Added Analysis/Spaghetti Diagram Basic Statistics Histogram Run Charts Fishbone Diagram Pareto Diagram 5 Whys Brainstorming Scatter Plot Visual Display Action Plan

VR Phase	VR Phase Deliverables	VR Tools
Weeks 7-12	Refine standard practices and elimination of sources of variation; institute process controls	Process Map/Flow Chart/Value Added Analysis/Spaghetti Diagram Work Instructions Basic Statistics Histogram Run Charts Fishbone Diagram Pareto Diagram 5 Whys Brainstorming Scatter Plot Visual Display Action Plan, Report Card

Process understanding and standardization tools were primarily used during weeks 2 through 4 while process analysis tools were primarily used throughout weeks 5 through 12. Communication and project management tools were used throughout the entire twelve-week VR roadmap and helped to build strong teams that could work together across shifts to address sources of variation.

The tools were sequenced to enable learning of the tools and methods and allow the teams to rapidly attack sources of variation in their processes. For instance, a manufacturing VR team would first establish a standard process they all agreed to follow by using process maps/flow charts, value added analysis, and spaghetti diagrams; the standard process would be documented as a work instruction. They would then create check sheets to collect data on the delays (machine breakdowns, jams, product quality issues, etc.) contributing to low throughput. They used this data to create a “delay Pareto” to identify the top delays which they would explore in more detail using histograms and run charts to understand if the delay was due to a special cause or was a chronic delay. Further investigation using brainstorming, the fishbone diagram, and/or 5 Whys was used to identify potential root causes for further data collection and analysis. The scatter plot was used to verify potential relationships between a potential cause and effect. In general, the operations teams were taught to understand the work flow using process maps/flow charts, streamline and standardize the work flow, then to collect data and to explore it statistically and graphically to identify and verify sources of variation before implementing a potential improvement. This provided the teams with a common language, allowed the teams to see their operation more holistically and to deal with more complex issues than they had been able to deal with previously.

Given the educational background of the operation teams, simple analysis and graphical tools that could be quickly and easily created by hand and/or with Excel were used. With the help of information technology and equipment automation, some calculations and graphics were automated as part of the creation of a common VR scorecard. If more advanced statistical analysis tools were needed (e.g., hypothesis testing, regression, design of experiments, etc.) to identify a source of variation, the opportunity was identified as a potential Six Sigma project and given to a Green Belt or Black Belt (depending on the complexity and scope of the opportunity). The Green Belt or Black Belt could then focus on the analysis and solution of the problem knowing that the operations team, through VR, had standard practices and data collection in place to assist with the analysis. Some members of the VR teams even became Six Sigma Green Belts, expanding their tool kit, and worked with their fellow team members to broaden the scope of issues on which they could work. Once VR certified, the operations teams continued to use the tools to identify and eliminate sources of variability within their control (special causes) and to sustain the improvements over time.

VR as a System

The VR design team recognized that in order to effectively deploy and sustain VR throughout the organization, a system would need to be defined and implemented to guide the deployment. As such, they identified seven elements that needed to be included in the system for effective implementation:

1. Linkage to the business strategy – Improvement opportunities using the methodology are prioritized based on linkage to the business strategy and annual objectives.
2. Performance tracking – The methodology includes metrics and reporting using a standard report card.
3. Documentation – A mechanism to capture, document, and share best practices associated with the methodology is incorporated into implementation plans.
4. Training –Deployment of the methodology includes a common training curriculum and certification of trainers.
5. Audit - The methodology includes an assessment process to hold individuals and teams accountable for results and ensure long-term sustainability.
6. Roles and responsibilities – An organizational structure to support the tasks associated with the methodology is defined and incorporated into daily work.
7. Certification – A process to qualify and recognize individuals and teams for successful implementation is incorporated into the deployment of the methodology.

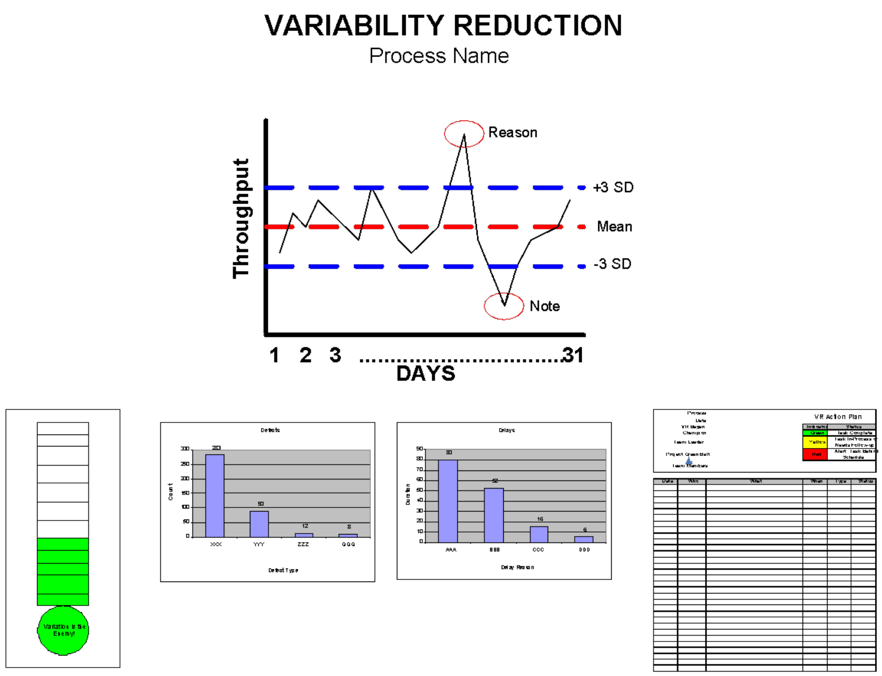
As implemented, VR contained all the elements needed for "operations excellence." This approach was later expanded to the company's deployment of Six Sigma, ISO 9001, 5S, and quick changeover.

Management commitment and involvement was recognized as a key component to VR success. Thus, the manufacturing vice-president for each business unit was identified and trained as the VR sponsor. The department manager was the VR champion and the process supervisor was the VR team leader and coach. Members of the operations team (for instance, pressmen from each shift, and material handlers) formed the VR team. A plant Six Sigma Green Belt was assigned as a data analysis resource. Support was also provided from HR, engineering, maintenance and information technology as needed. Roles, responsibilities, and deliverables were integrated with daily work, thus helping to institutionalize VR.

VR Roles and Responsibilities

Role	Responsibilities
VR Sponsor	● Understand and commit to using VR within the function/facility. ● Prioritize VR opportunities. ● Review VR scorecard for each team weekly. ● Review progress monthly with VR champions. ● Help teams and champions overcome barriers. ● Follow-up on VR audit corrective actions.
VR Champion	● Understand and commit to using VR within the department. ● Participate in VR Champion training. ● Assist sponsor to prioritize VR opportunities. ● Provide resources to begin and sustain VR within the department. ● Review visual display and scorecard for each team at least weekly. ● Ensure VR teams follow the roadmap and utilize the tools to make data-based decisions. ● Help team(s) overcome barriers. ● Conduct work instruction audits.
VR Team Leader	● Understand and commit to leading VR within their operation. ● Participate in VR team training. ● Lead the VR team through the roadmap and utilization of the tools to make data-based decisions; engage other process team members in VR implementation. ● Communicate team progress and concerns to leadership and key stakeholders. ● Conduct work instruction audits.
VR Team	● Understand and commit to leading VR within their operation. ● Participate in VR team training. ○ Use the VR roadmap and tools to make data-based decisions to continuously improve process by recording accurate and timely data, adhering to agreed work instructions, and taking positive action to address sources of variation. ● Engage other process team members in VR implementation.
Green Belt	▪ Assist team with data analysis and making data-based decisions. ▪ Coach the VR team leader on use of data analysis tools.

Manufacturing processes, press and binding lines, within a manufacturing facility were prioritized based on business need (volume, growth potential, and the gap between current and needed performance). The primary metric of focus for all manufacturing lines was throughput rate. The primary metric for transactional processes was either cycle time or defect rate. A visual display, typically a white board containing graphical summaries of the primary metric and status of VR efforts (see Figure below for a graphical representation), was required at each piece of equipment or process area associated with a VR team. The VR visual display was a highly visible focal point for teams to communicate the performance of the manufacturing line/process and results of their VR efforts across shifts and with others supporting their efforts, including management. Shift turnover meetings were typically held in front of the visual display. Standard report cards were also developed and automated with the assistance of information technology resources. The reports were visible through the company intranet at the plant, business unit, and corporate levels.



Graphical Representation of VR Visual Display

To ensure consistent rollout of VR across multiple manufacturing facilities in North America, a VR Implementation Guide was developed which detailed the VR roadmap, tools, roles and responsibilities, audit processes, certification levels, and incorporated the lessons learned from the pilots. The Implementation Guide was maintained and updated on a bi-annual basis by a cross business unit team. Weekly checklists were also provided to each VR team. The checklists specified the sequence of activities and tools appropriate for each week of the 12-week roadmap. A VR website was maintained on the company intranet for sharing best practices and success stories.

The concepts and tools of VR were new to most VR team members, process supervisors, and even some champions. Hence, training played a critical role in deployment. The VR training curriculum included ½ day champion training, 2 days of interactive training on the VR roadmap and tools for the VR team members, 5 days of change management training for the VR team leader, ½ day team building, and ½ day team chartering and project management training. Supplemental root cause analysis training was also available on an as-needed basis. VR trainers were identified for each facility and worked closely with the department managers and process supervisors to ensure each VR team had the training and skills needed to be effective. VR trainers were at a minimum Green Belt certified and were certified to conduct VR training through a three-stage process of observation, co-training with an experienced VR trainer, and finally leading with observation and feedback from an experienced VR trainer.

Audits were integrated into the VR roadmap at four-week intervals (weeks 4, 8, and 12). The primary purpose of the audits was to assess team progress and provide firm, honest feedback to the team. The audits served to hold the VR teams accountable for results and to ensure long-term sustainability of VR practices. The audits were conducted by a second party experienced in VR. Audit teams were created and rotated between manufacturing facilities. VR team leaders and Six Sigma Green Belts most often formed these teams. Detailed checklists and definitions of conformance were developed and documented in the VR Implementation Guide. Auditors received audit training and participated on a minimum of two VR audit teams prior to being certified to lead VR audits. Audit reports were shared with the VR champion at a closing meeting and corrective actions and timing agreed upon. The VR sponsor (typically at the vice-president level) also received a copy of the audit report and corrective action plans for further follow-up. Audits were scheduled and monitored at a corporate level as part of a continuous improvement scorecard. Once a VR team was certified, the audits were reduced in frequency to quarterly. If performance deteriorated or two consecutive audits resulted in low scores, the audit frequency was increased to monthly while corrective actions were taken. This approach integrated ISO internal audit practices into VR and provided team accountability.

Individual and team recognition was provided at two levels: silver certification and gold certification. Teams that demonstrated effective application of VR at the completion of the 12- week roadmap were “silver certified”. This involved completion of all steps in the VR roadmap, demonstration of knowledge and application of the VR tools by the team (individually and collectively), and elimination or reduction of a major source of variation. Upon certification, team members received individual recognition and a VR silver certification banner was hung over the equipment/in the process work area. Teams that demonstrated sustained improvement could qualify for “gold certification”. To achieve gold certification, a team had to demonstrate: all VR elements were sustained for a minimum of 90 days after silver certification; an on-going sustainability plan through audits was in place with records of audit findings and actions taken; data integrity; and a minimum 15% improvement in the average of their primary metric and reduction in process standard deviation of at least 10%. The improvements had to be statistically validated using the appropriate hypothesis tests. This meant that the VR team had to work closely with a Green Belt or Black Belt to demonstrate eligibility for gold certification. Over four years of implementation, 485 VR teams were silver certified and 95 VR teams were gold certified (20%).

<u>Benefits of VR</u>
In addition to the 4-6% annual increase in productivity, the organization saw the following benefits through the implementation of VR:

- Operations teams owned daily process improvement activities, including work instructions, daily performance tracking, and problem resolution using data-based problem-solving.
- The majority of manufacturing VR teams could successfully implement VR in twelve to sixteen weeks.
- Quality management activities involving document management and control, training, and auditing were integrated into daily operations.
- Capital expenditures for the productivity improvements were minimal.

- Increased efficiency of Six Sigma resources. Black Belts and Green Belts were able to focus on breakthrough improvements versus simply standardizing and stabilizing the process.
- Increased sustainability for improvements as the operations teams had the discipline and tools to sustain the improvements over time.
- Conformance to schedule for VR manufacturing assets improved with the reduction in variability. This in turn allowed customer service to commit to new work within a specified time period with more confidence.
- ISO 9001 activities involving document management and control, training, and auditing were integrated into daily work on VR assets.
- Increased efficiency of Six Sigma resources. Black Belts and Green Belts were able to focus on problems with unknown solutions beyond the skill and control of the operations team. The average savings per Black Belt project increased from $258k in 2002 to $299k in 2003. With over 70 Black Belts completing at least two projects per year, this had the potential for generating approximately $5.6 million in additional savings per year.

While not originally designed for non-manufacturing process teams, VR was found to work in transactional processes (e.g., logistics, customer service and finance). The primary metric for transactional processes was either cycle time or defect rate. However, due to the fact that transactional processes do not always operate every day, transactional VR teams required sixteen to twenty weeks to meet the deliverables.

The successful deployment of VR across the organization led to the seven continuous improvement methodology system elements being extended to other continuous improvement efforts. While today we recognize that linking projects to strategic business needs, defined roles and responsibilities, performance tracking, best practice documentation, a common training curriculum and recognition through certification are keys to successful Six Sigma deployment, such a structured approach was not part of many Six Sigma deployments in 1999-2002. The initial implementation of Six Sigma at this organization consisted primarily of training and certification. Beginning in 2003, the seven elements were extended to Six Sigma, 5S, quick changeover and ISO 9001 deployments. Projects for all continuous improvement efforts were strategically selected and scheduled during the annual budgeting process, roles & responsibilities were defined for each methodology and documented in methodology Implementation Guides, performance was monitored and tracked via scorecards available through the company intranet, training curricula were developed and delivered using certified trainers, audits were systematically conducted using certified auditors at critical points of implementation, and individuals and teams were recognized for various levels of achievement.

Summary

Continuous improvement differs significantly from traditional improvement approaches. It has evolved significantly over the last 100 years from scientific management to lean manufacturing to Six Sigma. Each approach has it place; leadership should be intentional in their selection of approach. The SOS VR approach integrates the “best” of Six Sigma, Lean and ISO 9000 to go beyond continuous improvement and achieve “operations excellence.” VR develops skills in visualization, collecting and analyzing data, problem-solving, and quick response to problems in factory floor personnel while leveraging dedicated technical staff and providing business leaders time to focus on growing the business.

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