



Introduction to Lean Six Sigma

Continuous Process Improvement (CPI) Technical Session

**Test & Evaluation in a Multi-Domain Operational Environment
El Paso, TX
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Agenda

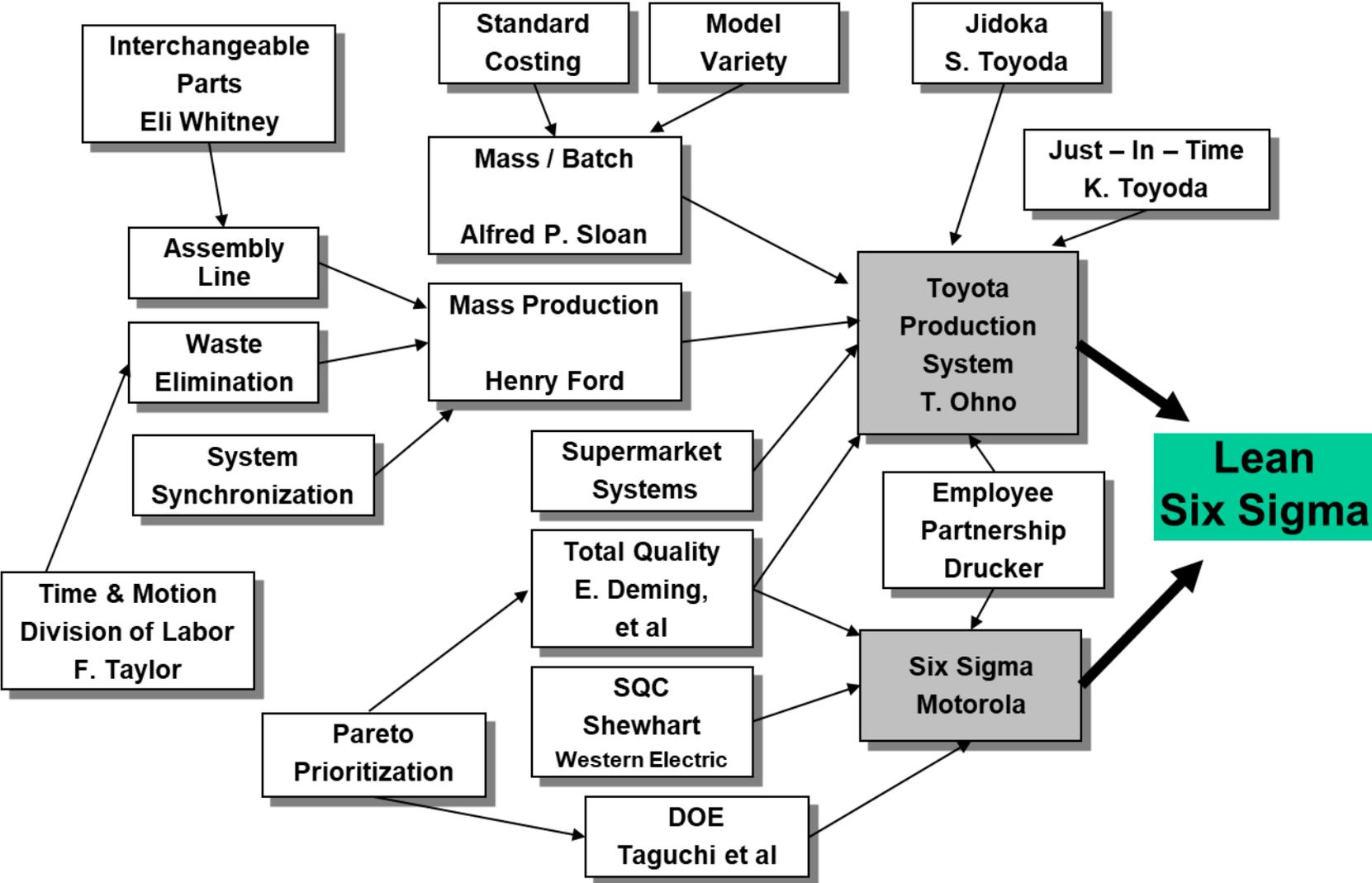
- The What and Why of Lean Six Sigma (LSS)
- Waste and Variation
- The DMAIC roadmap / methodology
- Key players and roles in LSS
- Lean Six Sigma projects

What is Lean Six Sigma

- Customer-Focused Continuous Process Improvement Strategy
- Driven by market requirements and company leaders
- Using a powerful methodology and
- Empowered teams with proven and powerful tools to
- Leverage talent and
- Deliver **greater value to the customer**

- **Better** products and services
- **Faster** to market
- **Lower cost**

Where Did It Come From?



The Major Reasons LSS Exists

.... to reduce the **Cost of Poor Quality (COPQ)** and
the **Cost of Waste (COW)** to reduce

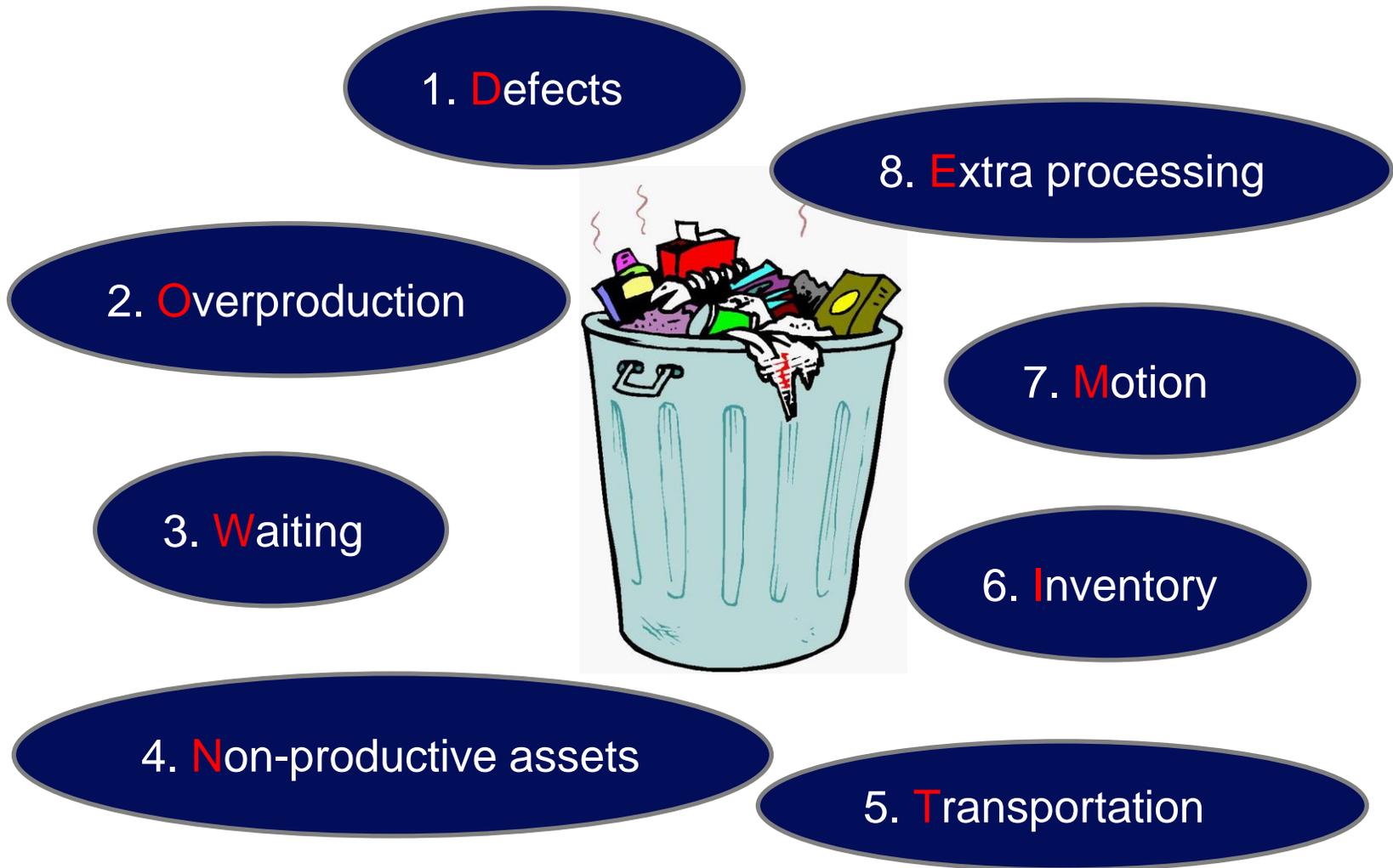
- Internal Failure Costs (incurred prior to reaching customer)
- External Failure Costs (incurred after reaching customer)
- Appraisal Costs
- Lost Opportunity Costs
- The usual suspects:



Waste & Variation



The 8 Wastes: D-O-W-N-T-I-M-E



Variation and Sigma (σ)

- σ is called the standard deviation
- It is a measure of variation

σ Capability is a measure of process capability. It compares the Voice of the Process with the Voice of the Customer and is correlated to the defect rate. It is computed from DPMO.

Yield is the probability that whatever we are producing (manufactured part, PO, shipped part, etc.) will pass through the entire process without rework and without defects.

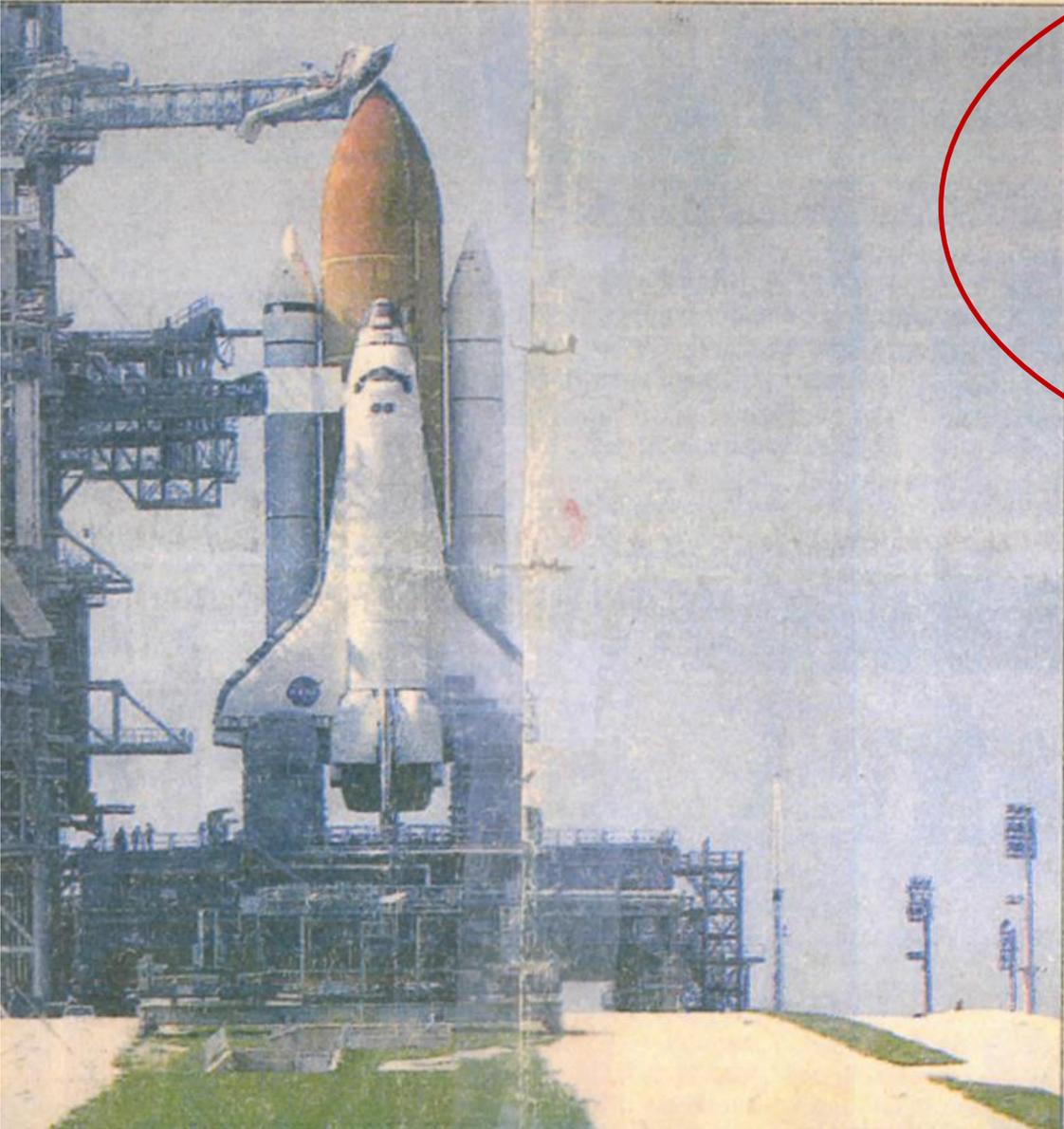
σ Capability	DPMO	RTY
2	308,537	69.1%
3	66,807	93.3%
4	6,210	99.4%
5	233	99.97%
6	3.4	99.99966%

Process Capability	Defects per Million Opportunities	Rolled Throughput Yield
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**Six Sigma is a standard of Excellence.
It means less than 4 Defects per Million Opportunities.**

1/100 = 0.01 = 10,000 DPMO = 3.8 Sigma Capability

RETURN TO SPACE | DISCOVERY'S LAUNCH



NASA puts risk of failure at 1 in 100

THE NEW YORK TIMES

With new realism born of disaster, NASA says the risk of catastrophic failure during the Discovery's mission to the International Space Station is about 1 in 100 — more than twice as great as an upbeat estimate issued before the loss of the Columbia in 2003.

Discovery's launch from Cape Canaveral, Fla., is scheduled for 8:39 a.m. MDT today.

Although NASA is still working on an official estimate, said spokesman Allard Beutel, it has devised a rough one that will be refined by insights from the investigation of the Columbia disaster, in which seven astronauts died as the ship re-entered the Earth's atmosphere Feb. 1, 2003.

The rise in estimated danger, Beutel said, came about "be-

ABOUT THE LAUNCH

Launch: Scheduled for 8:39 a.m. MDT today.

Weather: 40 percent chance of conditions unfavorable for a launch.

Mission: A 12-day supply and repair mission to the International Space Station

Lean + Six Sigma ... A Powerful Combination

Traditional Lean

(Flow + Speed)

- Goal - remove wasted efforts and increase process speed
- Focus - identify non-value added activities and causes of delays, to improve the flow of value at the pull of the customer
- Method – value stream tools, teams, gemba walks

Traditional Six Sigma

(Quality + Culture)

- Goal - improve performance and quality
- Focus - eliminate defects and reduce variation; data-driven
- Method – DMAIC methodology and tools, teams, leadership engagement, Green and Black Belts, Project Champions / Sponsors

Lean Six Sigma Combines the Proven and Powerful Elements of Both Lean and Six Sigma

Lean SPEED Enables Six Sigma Quality



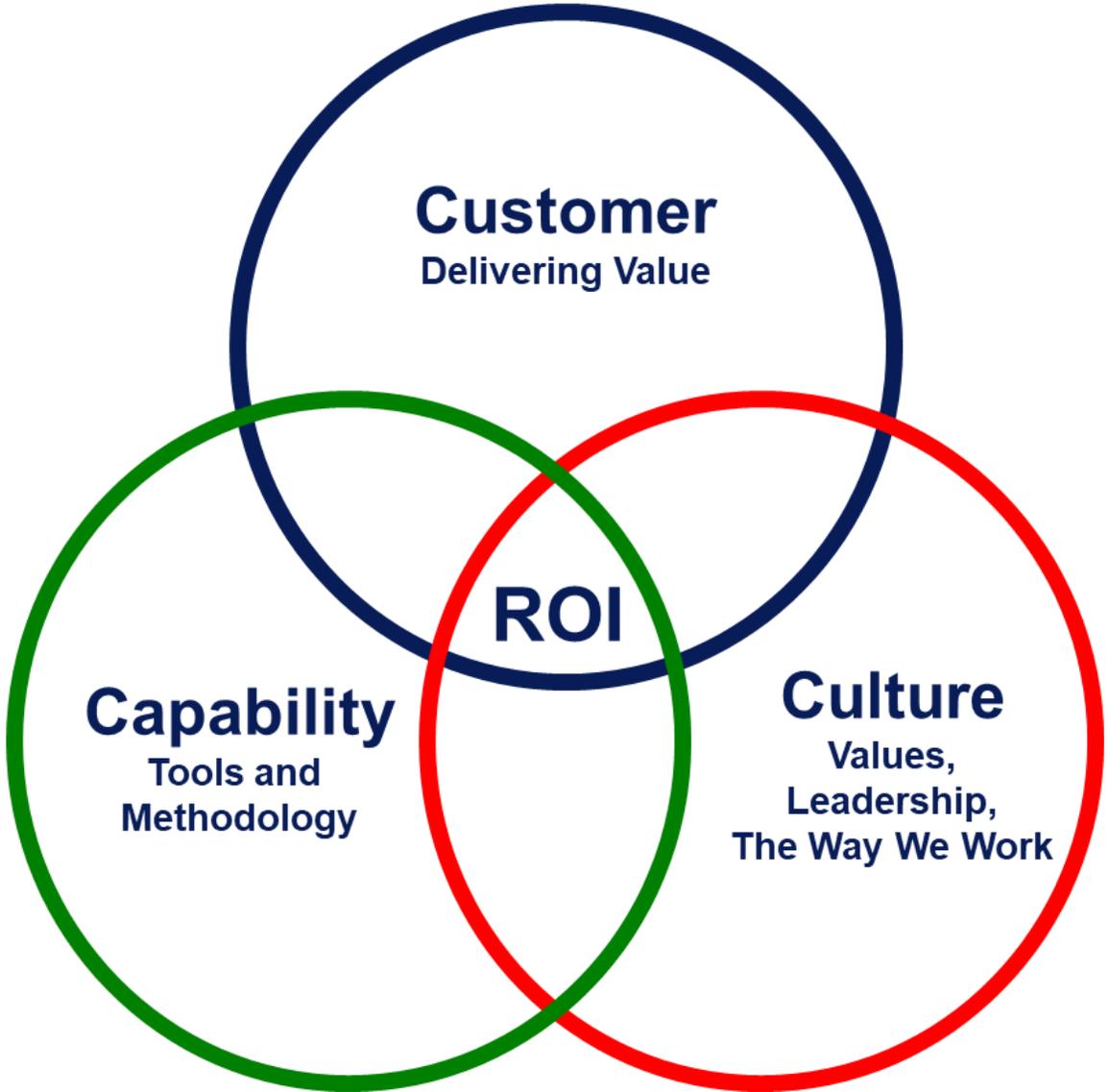
Six Sigma QUALITY Enables Lean Speed

Reduced COST (\$\$\$\$)

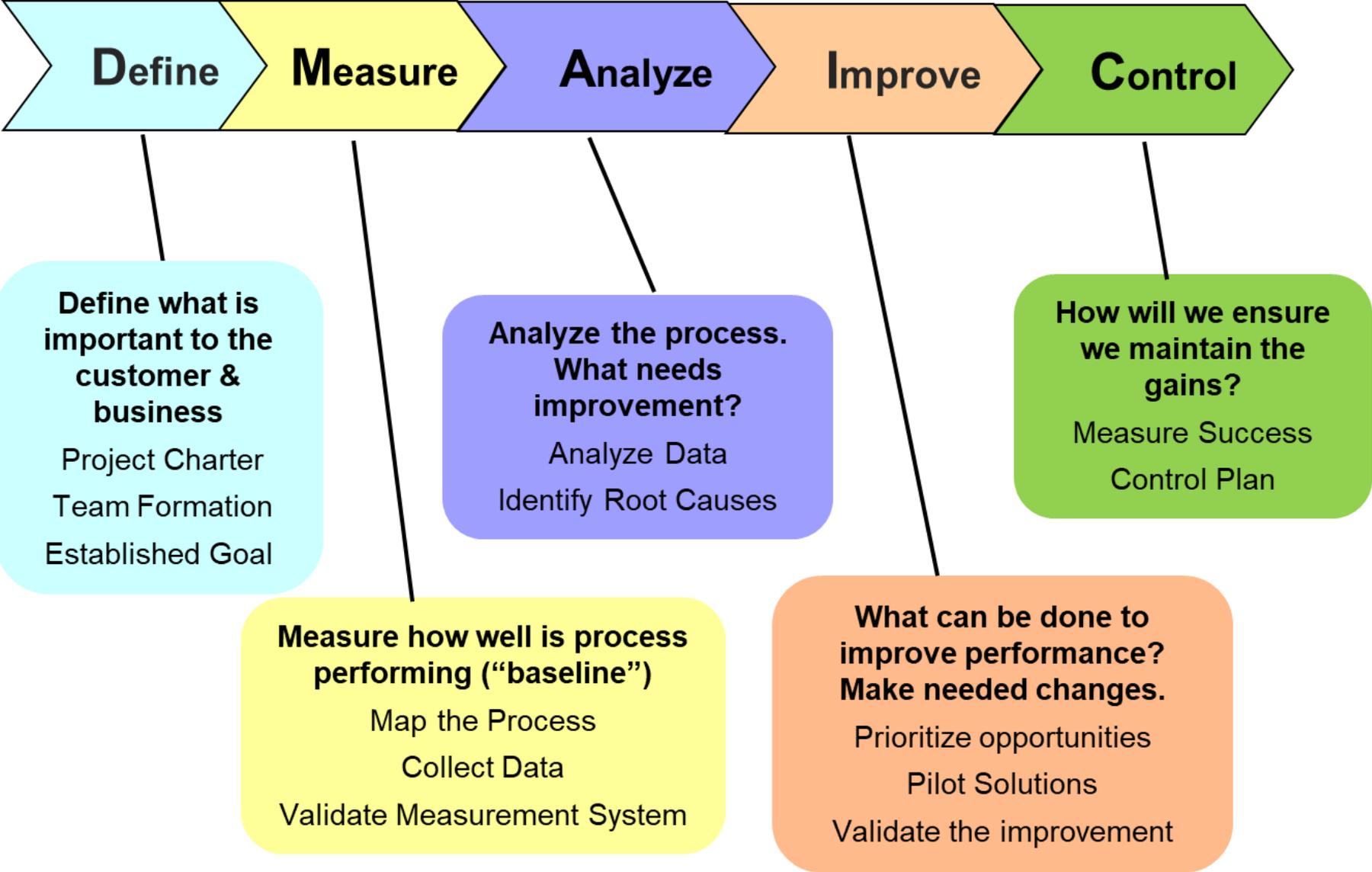
The 5 Guiding Principles of Lean Six Sigma

1. Specify value in the eyes of the Customer
 - Learn to see your processes from the perspective of your customer
2. Identify the value stream and eliminate waste/variation
 - Look at the combination of processes, not just a single process in isolation (how value is created for the customer), and remove waste and variation
3. Make value flow smoothly at the pull of the customer
 - Wait until you know what the customer wants before you start, and eliminate bottlenecks and impediments
4. Involve, align, and empower employees
 - Develop solutions using the people who are currently working in the process
5. Continuously improve knowledge in pursuit of perfection
 - Constantly challenge the organization to continue to learn more and more about their processes

The Impact Zones of Lean Six Sigma



DMAIC: A Powerful Problem Solving Methodology / Roadmap



DMAIC: Tools and Techniques



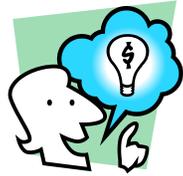
Define	Measure	Analyze	Improve	Control
Benchmarking	Data Template	Affinity Diagram	DOE	Benefits Capture
Gemba Walks	Variables Data	Brainstorming	Pairwise Comparison	Control Charts
Ohno Circles	Attribute Data	Cause & Effect Diagram	Multi-Voting	Control Plan
Interviews	Histogram	Constraint Analysis	Nominal Group Technique	Standard Work
IPO Diagram	Pareto Diagram	e-test	High Throughput Testing	Reaction Plan
Thematic Content Analysis	Measurement System Analysis	F-test	Kaizen	Run Charts
Kano's Model	Physical Process Flow	5 Whys	Kanban	
Knowledge Based Mgt	Process Capability Analysis	Fault Tree Analysis	Line Balancing	
SIPOC Model	Process Flow Diagram	Reality Tree	PF/CE/CNX/SOP	
Quality Function Deployment	Process Observation	Force Field Analysis	Mistake Proofing	
Voice of Customer	Time Value Map	Histogram	Setup Reduction	
8 Wastes	Waste Analysis	Historical Data Analysis	Strategic Inventories	
Value Stream Mapping	Work Sampling	Regression Analysis	Takt Time	
		Scatter Diagram	Theory of Constraints	
		t-test	Total Productive Maintenance	
		Thematic Content Analysis	TRIZ	
		Tukey End Count Test	5S	
			Workplace Organization	

Note:
Tools May Be
Used In
Multiple
Phases



DMAIC Quick Reference.pdf

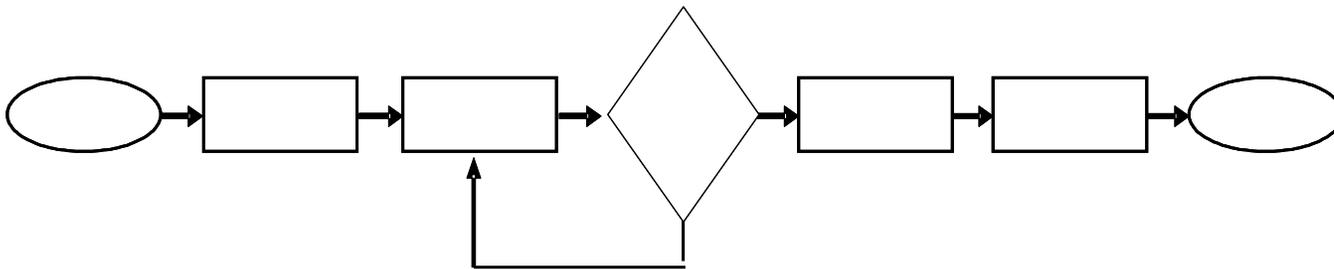
How to Reduce Variation and Turn an Art into a Science



PF / CE / CNX / SOP

Removes waste, reduces variation, and decreases cycle time

(1) PROCESS FLOW (PF) or PROCESS MAP

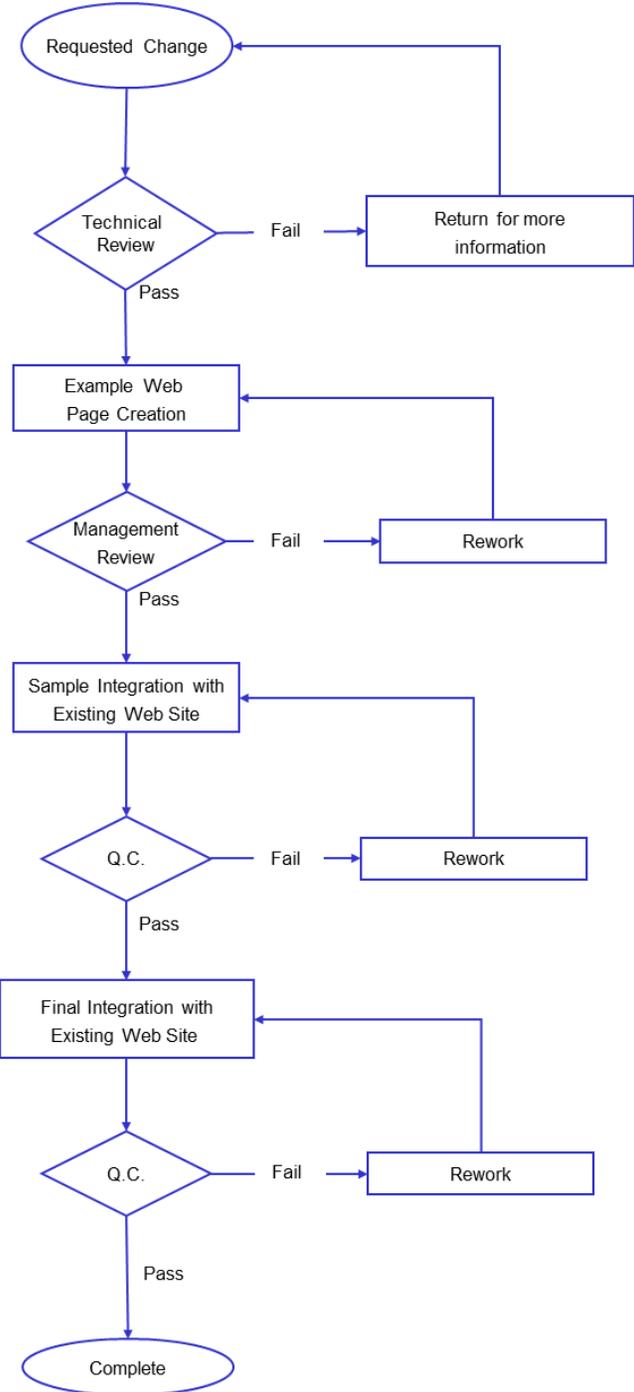


- A visual representation of the major steps and decision points in a process which helps to:
 - Gain a better understanding of the process
 - See potential problem areas and opportunities for improvement
 - Identify data collection points
 - Review the sequence of steps and look for missing or unnecessary (non-value added) steps
 - Highlight the Diamond (“loops”) . . . which can lead you to defects, bottlenecks, cycle time drains, dollars, etc.



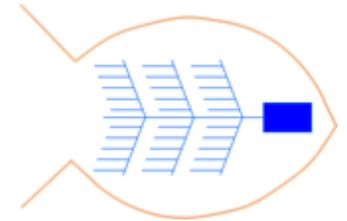
For video instruction on generating process flow (PF) diagrams, go to:
<https://airacad.com/our-insights/training-videos/spc-xl/>

Website Change Process Flow Diagram



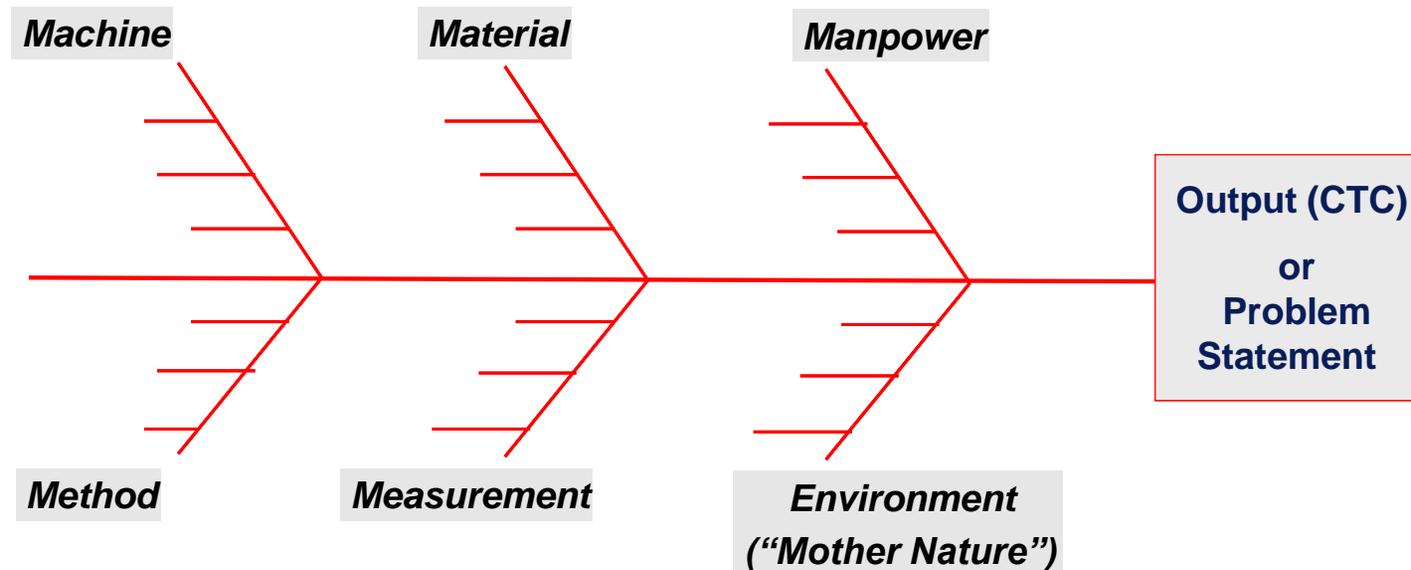
How to Reduce Variation and Turn an Art into a Science (cont.)

PF / CE / CNX / SOP



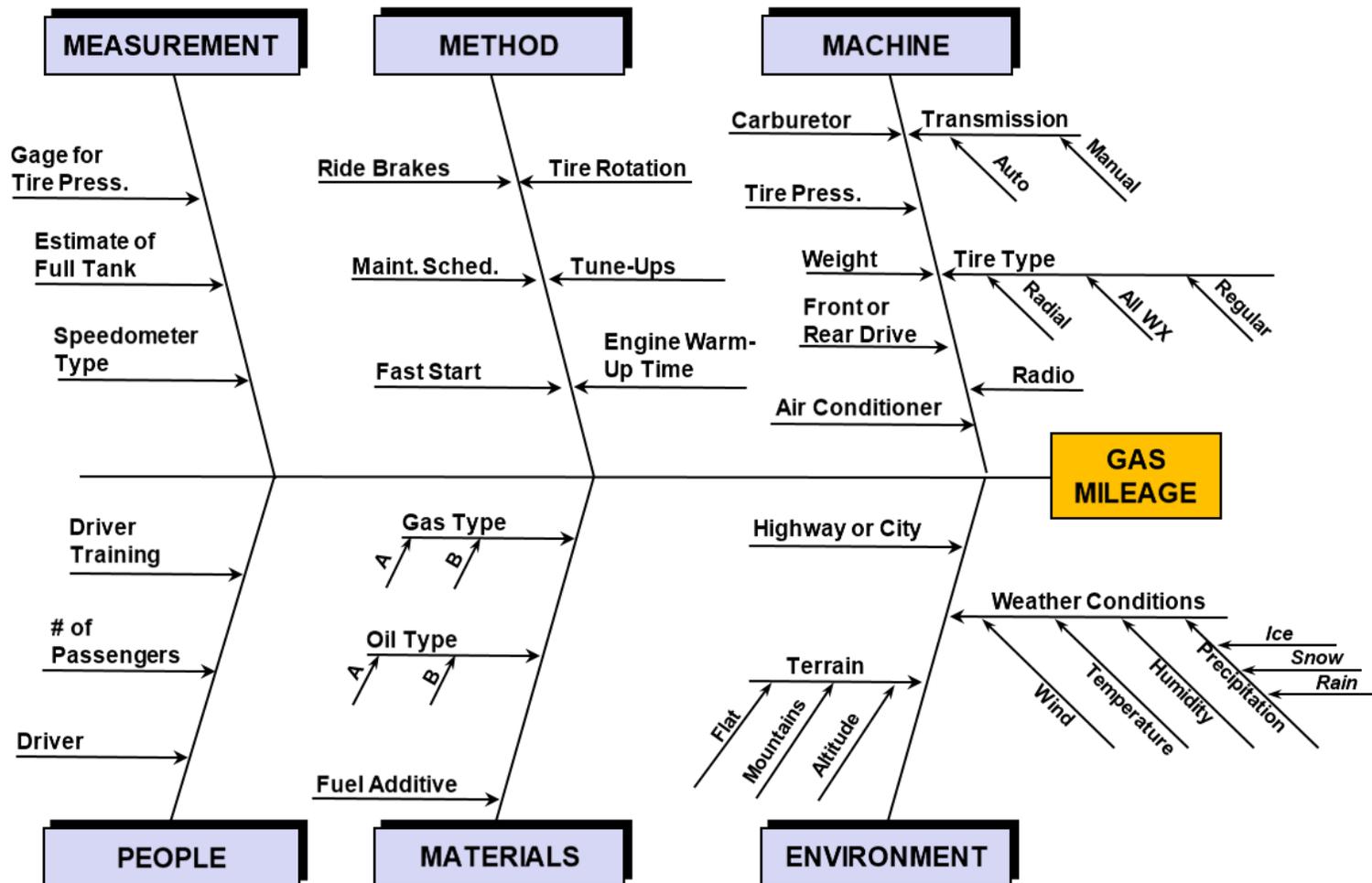
(2) CAUSE AND EFFECT (CE) (a.k.a. “Fishbone”)

Brainstorm all the possible causes of the problem (sources of variation that may affect the output)



CE Example (Gas Mileage)

- Brainstorming the variables that may affect gas mileage . . .



How to Reduce Variation and Turn an Art into a Science (cont.)

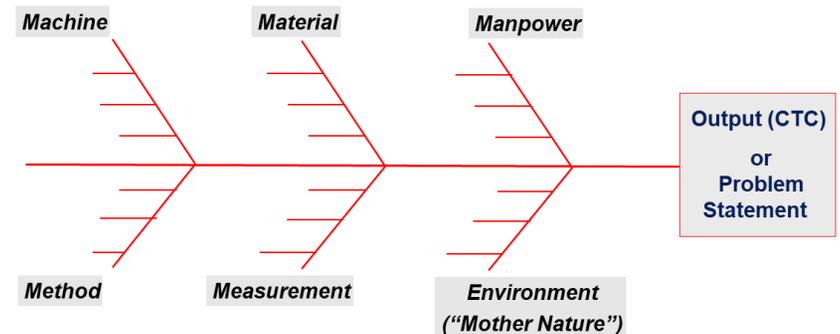
PF / CE / CNX / SOP

(3) PARTITION THE VARIABLES (CNX)

C = Controlled (constant) (via SOPs)

N = Noise (noisy, uncontrolled)

X = eXperimental



(4) IDENTIFY STANDARD OPERATING PROCEDURES (SOPs) FOR EACH “C”

- Detail the action and work sequence of the process/worker
- Provide a routine to achieve consistency of an operation / procedure
- Specify the best process/settings we currently know and understand for controlling variation
- Provide a basis for future improvements
- Employees should be trained and motivated to follow the SOPs

Partitioning the Variables



C = Constant

- To hold a variable as Constant as possible requires controlling the variable via Mistake Proofing and SOPs to eliminate errors and reduce variation.
- Holding a variable constant doesn't just happen. It must be engineered into the process.
- Mistake Proofing: The process of eliminating conditions (errors) that lead to variation in the CTCs and ultimately cause defects.

N = Noise

- Noise variables are those that are not being controlled or held as constant as possible.
- Mistake Proofing is needed to change an "N" variable to a "C" variable.

X = Experimental

- These are key process (experimental) variables to be tested to determine what effect each has on the output and what their optimal settings should be to achieve customer-desired performance.

**PF/CE/CNX/SOP alone can reduce
up to 60-70% of extraneous process variation**

Lean Six Sigma Infrastructure ... Roles and Responsibilities

Deployment Champion (Leader)

The Deployment Champion (Leader) is responsible for deploying and implementing LSS throughout an organization. This Champion will coach the Leadership team and project Champions in the deployment.

Project/Study Champions

Project champions (“sponsors”) are responsible for chartering and supporting a LSS project or study, ensuring that it crosses the finish line.

GREEN BELT

Green Belts are competent in the core competency areas of LSS and can apply these tools and methods within their functional areas on a daily basis. Green Belt projects are typically smaller in scope, and may involve studies supporting Black Belt projects.

BLACK BELT

The Black Belt is a key resource for LSS projects. They are competent in a broad spectrum of the LSS tools and methods, and thus can be assigned to technically mentor (coach) Green Belts. They typically lead larger-scoped projects. They should be people targeted for future leadership roles.

MASTER BLACK BELT

A Master Black Belt is a technical mentor and resource for BBs and GBs. MBBs provide coaching and may also provide training. A Master Black Belt is an experienced Black Belt who has completed several significant projects as well as received additional training in LSS and advanced techniques.

The Role of a Green Belt or Black Belt is to ...

- Develop required competency to support DMAIC improvement process - Proficient in the basic Lean Six Sigma tools
- Lead Lean Six Sigma project team through the process
- Assist management in identifying key performance issues to measure, set goals, improve, document, and sustain gains
- Take charge in areas of needed improvement identified by their Sponsor. Rigorously analyzes the causes of problems and helps develop strong and lasting countermeasures
- Provide leadership within their area of expertise plus the use of Lean Six Sigma philosophies and methodologies
- Promote out-of-the-box and critical thinking
- Motivate others to set and accomplish stretch goals using Lean Six Sigma philosophies and methodologies



The Role of a Project Sponsor (Champion)

- Knows the basic what and why of Lean Six Sigma
- Identifies and defines key projects that can best benefit the organization
- Helps identify belt candidates and aligns them with the projects
- Provides financial and organizational resources to train and equip belts to accomplish project goals
- Reviews and discusses project progress
- Helps create and maintain project momentum
- Breaks down barriers to project completion and helps push the project over the finish line
- Recognizes and rewards success
- Propagates and communicates success stories to generate cultural change

Lean Six Sigma Projects

- Projects play a vital role
 - Gain confidence with DMAIC and put the tools learned into practice
 - Generate verifiable business benefits and deliver customer value
 - They provide the focus and accountability needed to get the job done
- Project opportunities – Where to Find Projects?
 - “Burning issues” in the organizations (bottlenecks, problems, etc.)
 - Customer needs, issues, complaints
 - Processes with long cycle times, high rework and/or defect rates
 - Business needs, strategic goals
 - Key metrics (operating costs, revenue, inventory, etc.) moving in the wrong direction or needing improvement

Characteristics of a Good LSS Project

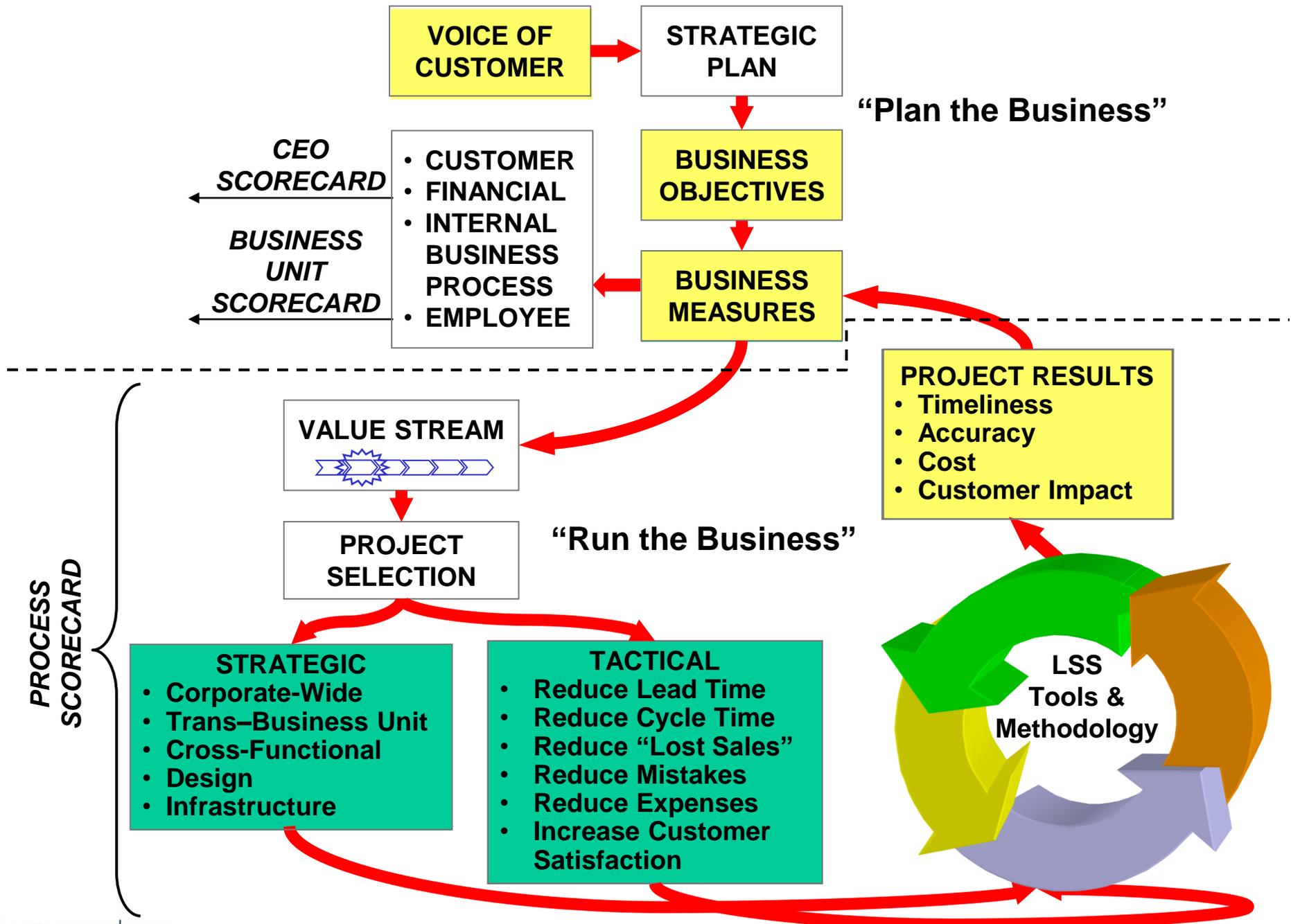
- Has no known or preferred solution in advance
- Is aimed at making a process better, faster, and/or lower in cost
- Is focused on business profitability and/or customer value
- Makes use of the DMAIC roadmap for focus and discipline
- Has a strong business case with clearly understood and defined project goals and scope
- Scope is doable in 2-4 months for GB and 4-6 months for BB. Rapid Improvement Events are faster
- Has measurements and data readily available or able to be gathered
- Has resources, management support, and **proper reviews**
- Makes use of a team that is provided **adequate coaching and mentoring**

Project Mentoring and Coaching

- Increases the likelihood of timely project completion and greater benefits
- Accomplished before, during, between, and after training sessions
- Mentoring is the role of a Champion and it is a continuous activity
- Coaching is performed by a Certified Black Belt/Master Black Belt
 - Ultimately by an internal resource
 - May need external resources to start with
- Coaching must be scheduled – if it is not on the schedule, it won't get done
- Everyone needs a lifeline!!*

* Note: Even professional athletes, like Tom Brady and Lebron James, have coaches. Employees who undergo training will need out-of-class coaching on their projects or studies. Without adequate coaching, projects oftentimes drift in and out of the various DMAIC phases seemingly at random. A strong disciplined approach is needed, and expert coaching will ensure that the right tools are used correctly, and that the project is scoped properly. Without expert coaching for those practitioners working on their initial projects, the blind will be leading the blind.

Linking LSS to the Business Strategy



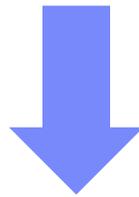
Top 5 Deployment Best Practices

(taken from *Reversing the Culture of Waste: 50 Best Practices for Achieving Process Excellence*)

- Expert coaching and mentoring on all projects and studies
- A Keep-It-Simple-Statistically (KISS) approach with easy-to-comprehend materials and easy-to-use software
- The use of rapid improvement events and studies to gain quick-hitting, impactful results
- Getting leadership and management on board and continuously aligning and re-invigorating them
- Developing a culture of continuous improvement for achieving process excellence

What is Culture?

“Culture is the shadow created by the machine of rules, norms, mandates and incentives that drive everyday decisions.”*



If we want to change the shadow, we will have to change the machine, piece by piece: baby steps.

*** Chris Chambers, professor of cognitive neuroscience at Cardiff University and the author of *The Seven Deadly Sins of Psychology: A Manifesto for Reforming the Culture of Scientific Practice*.**

Key Takeaways

- Lean Six Sigma means all of the following:
 - A measure of process capability
 - A powerful methodology (DMAIC)
 - A set of tools
 - A knowledge-gaining philosophy and activity
 - A business improvement strategy
 - A framework for systematic improvement and innovation
 - A vision

The Vision and Focus for Lean Six Sigma

- Empowers a *best-in-class* improvement strategy
- Provides a *disciplined improvement and innovation methodology and language* that can be shared and used by all
- Promotes *teamwork* and *rewards* success
- Combines *aggressive goals* with a *method* and a set of *tools*
- Requires the *application* of *tools* throughout *entire lifecycle* of a product or service
- Produces knowledge for *improved cycle time*, *reduced defects*, and *lower cost and risk*

Better products and services
delivered ***faster*** at ***lower cost and lower risk***
=
Improved Customer Value and Business Success

Thank You

Questions



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