Measurement & Analysis in Lean Six Sigma

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Outline

- Measurement context is process performance improvement & control
- Background: Lean & Six Sigma – why they complement
- In –depth: DMAIC Roadmap
  - Define, Measure, Analyze, Improve, Control
  - Some techniques for each phase

Measuring for Performance-Driven Improvement

A pursuit of measurement that

- aligns with business and organizational goals
- plans, models, predicts, analyzes, tracks, and ensures high performance results
- enables confident management and risk assessment by coupling expert judgment with objective data
- consistently maintains focus on customer satisfaction

This pursuit represents the original essence of the Six Sigma business improvement model (Motorola then GE) as well as the Toyota Production System (Lean).

What Drives Process Behavior?

Ask these questions to find out about real process behavior:

- What is the normal or inherent process variation?
- What differentiates inherent from anomalous variation?
- What is causing the anomalous variation?

Statistics provides the methods and tools needed to measure and analyze process behavior, draw conclusions (i.e., statistical inferences) and drive improvement.

Lean and Six Sigma both heavily depend on the ability to measure process performance.

- Lean: linked to speed
  - Provides tools to reduce lead time of any process and eliminate nonvalue-add cost
- Six Sigma: linked to quality and variation
  - Offers a sequential problem-solving procedure and statistical tools to identify potential problems
  - Improves process capability and eliminates variation

Lower cost = speed + improved quality
Better customer satisfaction + Lower Cost = Lean + Six Sigma

Lean is bottom up strategy at the team level. Teams are able to lean themselves quickly.

Lean introduced at Toyota in 1970's

- Team focus that empowers each team to improve its own process.
- Improvement focus starts with the "value chain".
- Main principles are a focus on throughput and reducing waste.
- The first books are published in early 1980's.

Results?

In 2006, Toyota sold more automobiles than GM – 3 decades of work on process improvement.

Lean focuses on the team and requires active participation.

Measurements focused on reduction of lead times/cycle times to improve throughput (unit of size/time period).

Productivity (unit of size/effort) improved by reduction of rework.

Typical Measures at the team level include:

- Cycle time
- Size or unit-cost measure
- Throughput (size/time-effort)
- Productivity (size/effort)
- Rework

Lean

5S's; Value Stream Mapping; Throughput Analysis

Continuous effort to improve processes by simplification, reducing non-value added tasks and lead times, and optimizing throughput.

Six Sigma DMAIC

Define-Measure-Analyze-Improve-Control

Short term effort (<6 months) to solve well defined problems and/or drive incremental business improvements.

Six Sigma DMAD(O)V

Define-Measure-Analyze-Design-(Optimize)-Verify

Long term effort to solve problems and drive radical process improvement.

Six Sigma is tactical, focuses on the project level, and is tied to strategic goals.

Training

- The entire organization must understand the basics of measurement, statistics and problem solving.
- Some people will be required to be expert in statistical methods.

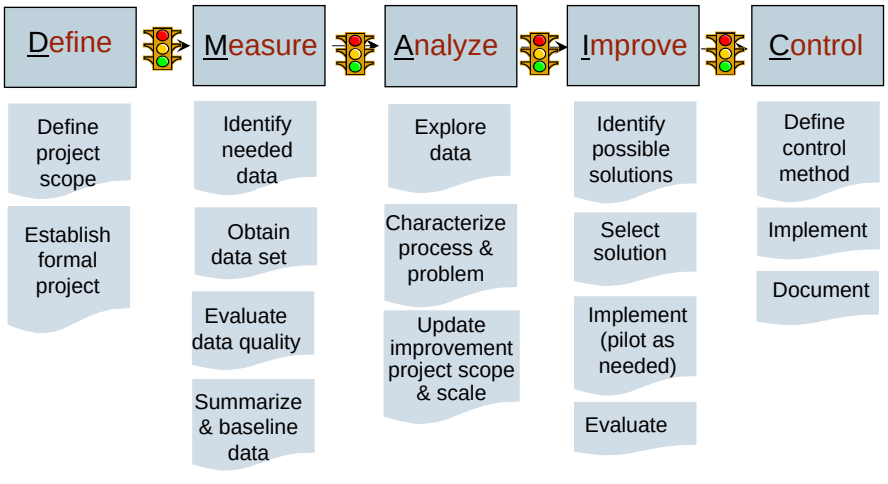
Dedicated Resources

- Six-Sigma "Black Belts" are needed on larger projects.
- Approximately 1% of staff should be qualified as Black Belts.

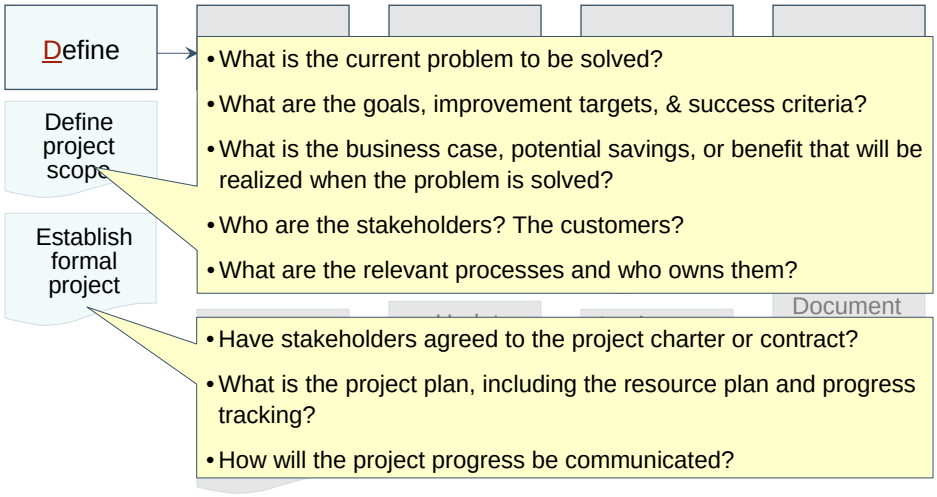
Project Selection

- A steering committee allocates resources for projects.
- Project selection should be tied to organization's strategic goals.

DMAIC Roadmap



Define Guidance Questions



DEFINE

Useful method: SIPOC

Suppliers	**I**nputs (and Resources)	**P**rocess	**O**utput	**C**ustomer
Corporate Support Group	Transaction Data; Analysts	Short Term Analysis	Monthly Forecasts	Financial Services Client
...				

We often reverse it to become COPIS

Customer	**O**utput	**P**rocess	**I**nputs (and Resources)	**S**uppliers
Financial Services Client	Monthly Forecasts	Short Term Analysis	Transaction Data; Analysts	Corporate Support Group
...				

DEFINE

Customer	Output
Financial Services	Monthly Forecast
...	

Output Exit Criteria		
Measure	**Target**	**Baseline**
On Time Accuracy	Before 5th of month	20% late (1 – 7 days)
	<1.1% error rate	0.5% error rate

How does the customer want to measure output?

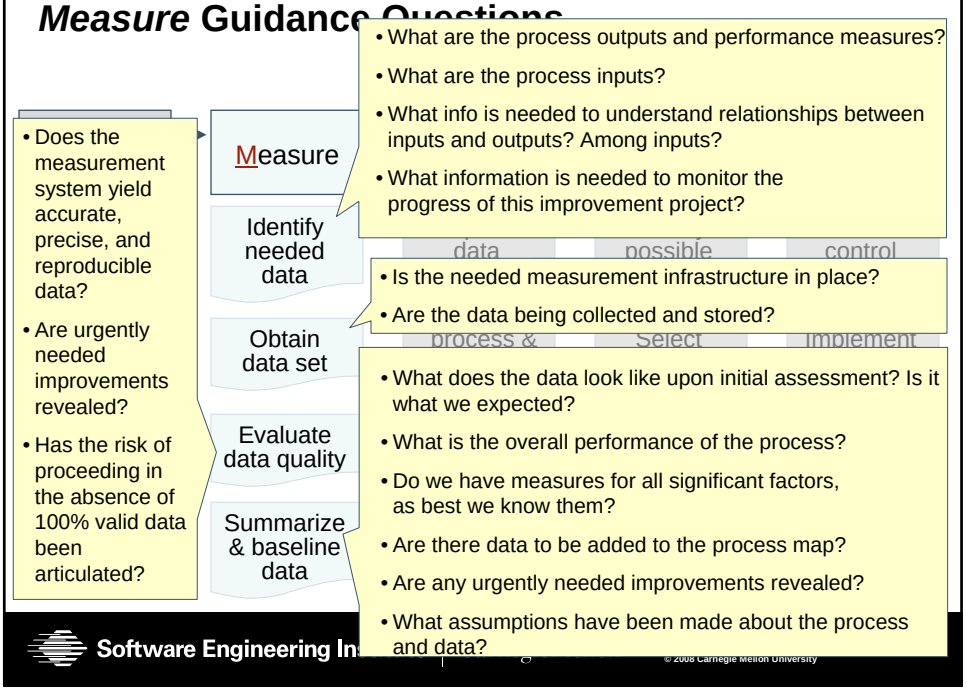
DEFINE

Process	Inputs	Suppliers
Short Term Analysis	Transaction Data Analysts	Financial Institutions, Support
...		

Entry / Inputs		
Measure	**Target**	**Baseline**
Completeness Accuracy Availability	100% ready; <0.1% error; 5 analysts FT for 3 days	95% ready; 1% error rate

How do we want the input to be measured and verified?

Measure Guidance Questions



MEASURE: Identifying Needed Data

What are the process outputs and performance measures? What are the inputs? What are the relationships among outputs and inputs?

We need to find out what contributes to performance.

- What are the process outputs (y's) that drive performance?
- What are key process inputs (x's) that drive outputs and overall performance?

Techniques to address these questions

- segmentation / stratification
- input and output analysis
- Y to x trees, fishbone diagrams, etc.

MEASURE: Segmentation vs. Stratification

Segmentation (nominal data)

- grouping the data according to one of the data elements (e.g., day of week, call type, region, etc.)
- gives discrete categories
- in general we focus on the largest, most expensive, best/worst – guides "where to look"

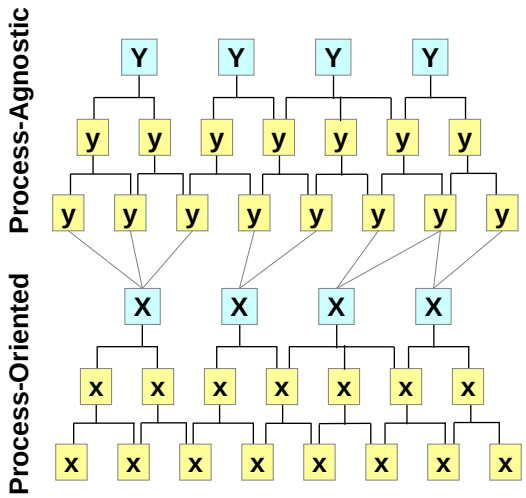
Stratification (ordinal data)

grouping the data according to the value range of one of the data elements (e.g., all records for days with "high" volume vs. all records with "low" volume days)

- choice of ranges is a matter of judgment
- enables comparison of attributes associated with "high" and "low" groups – what's different about these groups?
- guides diagnosis

ANOVA can confirm the differences!

MEASURE: Flowdown (Y-to-x) Tree



High Level Business Goals

(Balanced Scorecard)

Subordinate Business Goals

(e.g., $ Buckets, % Performance)

High Level Process Areas

(e.g., SEI CMMI PAs)

Subordinate Processes

(e.g., Down to a Vital x sub-process to be tackled by DMAIC team)

Tools for Summarizing & Baselining

The following are fundamental tools for establishing visual baselines of processes and performance.

The basic tools are:

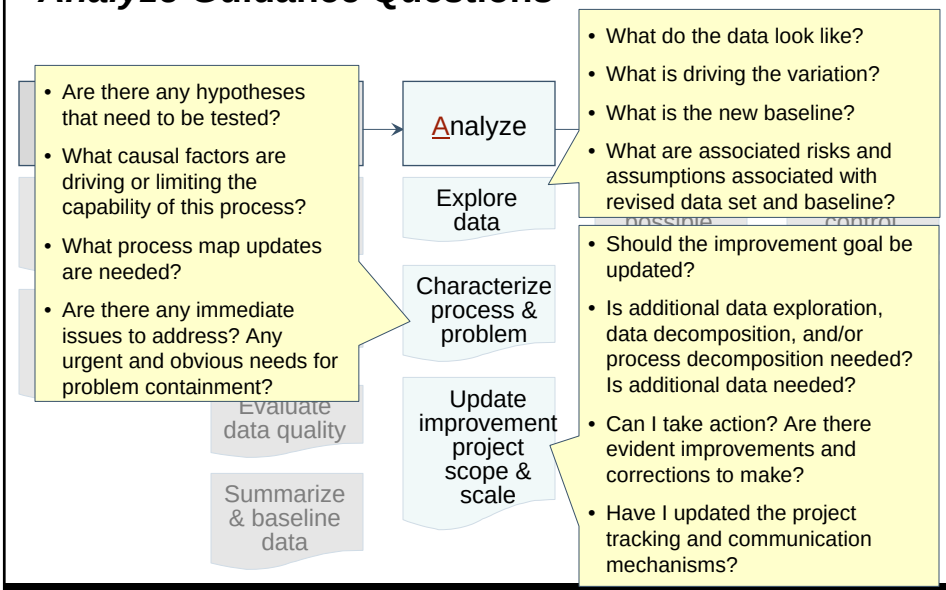
- histograms
- scatter plots
- run charts
- pareto charts
- Box plots
- SPC charts

The list varies depending on the source.

Alternatives include the following:

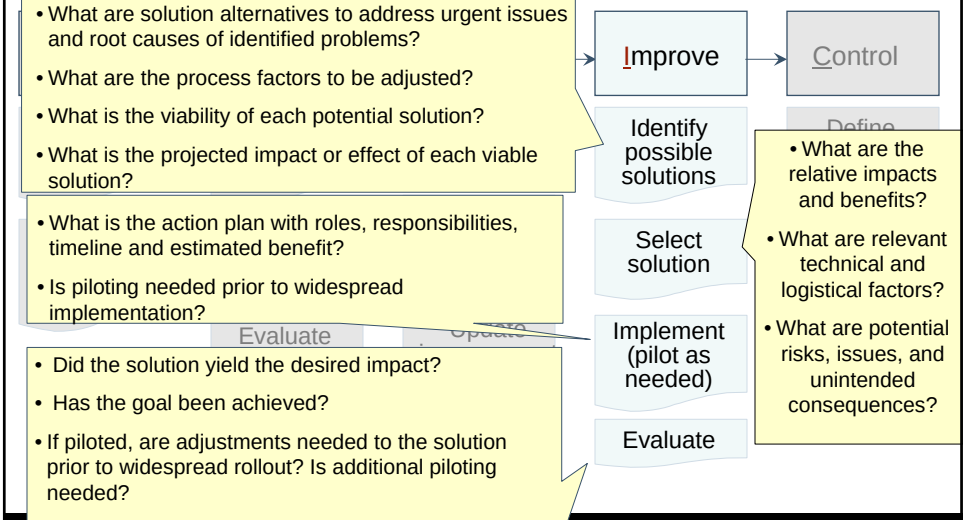
- statistical process control charts
- descriptive statistics (mean, median, standard deviation, etc.)
- check sheets

Analyze Guidance Questions



Improve Guidance Questions

- What type of improvement is needed?
- What are solution alternatives to address urgent issues and root causes of identified problems?
- What are the process factors to be adjusted?
- What is the viability of each potential solution?
- What is the projected impact or effect of each viable solution?



- What is the action plan with roles, responsibilities, timeline and estimated benefit?
- Is piloting needed prior to widespread implementation?

- Did the solution yield the desired impact?
- Has the goal been achieved?
- If piloted, are adjustments needed to the solution prior to widespread rollout? Is additional piloting needed?
- How will baselines, dashboards, and other analyses change?

To measure Improvement you need to Baseline

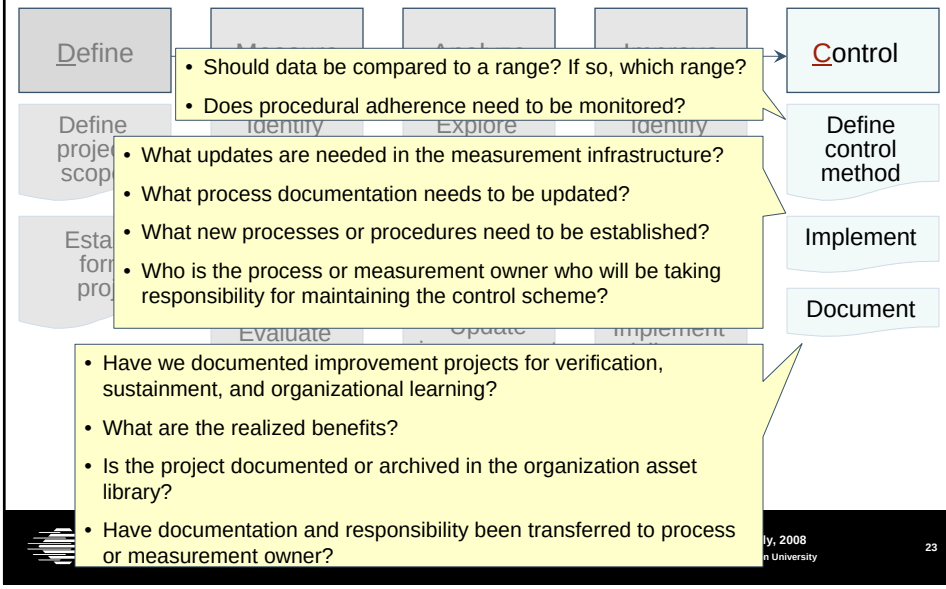
The baseline gives you the starting point data which you compare to improvement results.

ANOVA is very useful for determining effects between/among factors and outcomes, but even proportion tests give you insight.

Goal is to achieve prediction, which can be done through the use of regression models, SPC charts, etc.

Predictability enables control and flexibility.

Control Guidance Questions



my take:

Lean indicates what you should be looking for in process performance.

DMAIC enables you to identify and mitigate process performance problems.

DMADV enables the construction of new, innovative processes.

ALL these methods aim at improving customer satisfaction.

ALL these methods rely on clear measurements and useful analyses.

M & A Workshop

List of methods employed by example/context.

List of desired techniques.

Goals & Objectives for doing M & A.

Fusion

Extras

The 5 S's

1. Seiri - tidiness
2. Seiton - orderliness
3. Seiso - cleanliness
4. Seiketsu - standardization
5. Shitsuke - discipline

Lean Six Sigma

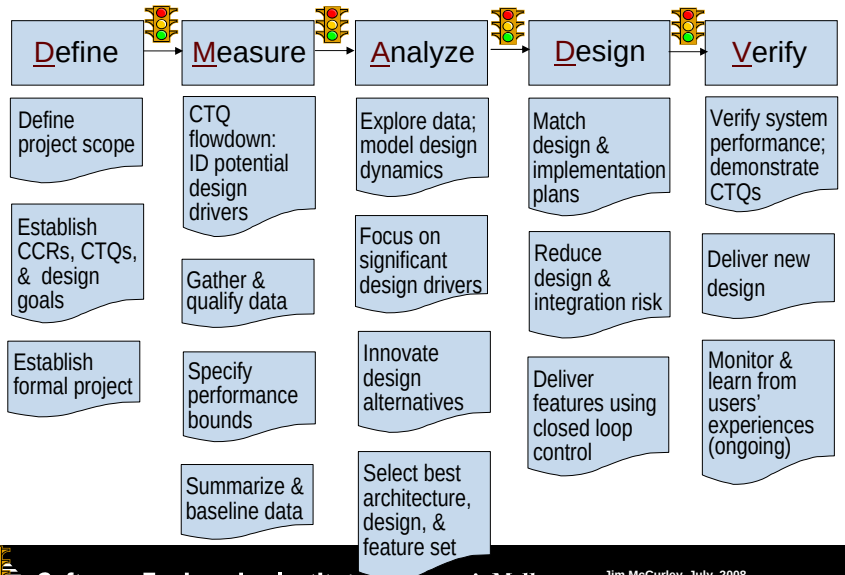
Lean Six Sigma

- Value-chain focus
- Identifies non-value producing aspects in products, resources and time.
- Statistical tool kit for problem solving
- Uses modeling to reduce variation and increase quality

Make your goals SMART

- Specific
- Measurable
- Actionable
- Realistic or Relevant
- Timely or Timebound

DMADV Roadmap



Conclusion

"The SEI's CMMI and LSS have independently changed the way organizations think about their processes by addressing systemic problems in a constructive manner. These approaches are complementary. They both apply to the acquisition and development of complex systems."

Dr. Kenneth D. Shere, The Aerospace Corporation