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# Metrics and Measurements

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# Learning Objectives

Upon successful completion of this module, the student should be able to:

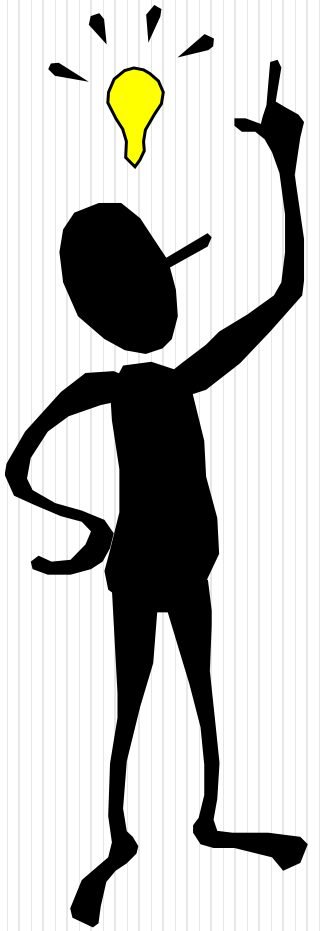
- Describe “Why” collect data
- Describe Sampling
- Understand Check Sheets
- Describe the “What” and “Why” of metrics
- Identify Levels of Metrics
- Use of metrics in Lean Six Sigma Process Improvement
- Define Types of Metrics
- Describe Data collection plan
  - Data sources
  - Grouping data (Stratification)

# Why Collect Data?

- Make process improvement decisions based on data
- To establish a baseline on process performance and conduct analyses

# SMART Metric

- Specific
  - Describe outputs, knowledge, task, experience, …
- Measurable
  - Time frames are included
  - Data can be obtained (preferably with ease)
- Achievable
  - Resources (knowledge, $, time, people) are available
  - Some risk, but success is possible
- Relevant
  - Link to the mission, vision, and goals
  - Meaningful to the user
- Trackable
  - Provide step-by-step views versus giant leap
  - Measurable at interim milestones



# Levels of Metrics

- **Enterprise:** Typically financial and operational summaries for shareholders, executive leadership and policy makers
- **Business:** Track how well products are meeting customer needs , they should have a long term perspective
- **Process Metrics:** Information that operators and supervisors need to run normal operations

# Examples of Metrics

- Enterprise Metrics
  - Customer Perception (Satisfaction)
  - Financial
  - Employee Satisfaction
  - Operational Availability
  - Reliability (Ready for Tasking)
  - Maintainability

# Examples of Metrics

- Business Metrics
  - Overtime
  - Labor Hours/FTE
  - Cost
  - Customer Returns
  - Quality Deficiency Reports

# Examples of Metrics

- Process Metrics (Data blocks)
  - Work in Process (WIP)/Work in Queue (WIQ)
  - Cycle Time
  - Scrap/Rework
  - First Pass Yield (FPY)/Rolling Throughput Yield (RPY)
  - Defects/Defect Rates
  - # steps or handoffs
  - Distance traveled
  - # Reviews or approvals

| Satellite Launch | **step number:** 1 |
|---|---|
| **Process Description:** Reciept of Launch Orders | |
| **Demand:** | 10 per year |
| **Trigger:** | Receive from Customer |
| **Done:** | Send to Dissassembly |
| **Flow Time:** | 7 |
| **Touch Time:** | 7 |
| **People:** | 1 |
| **Shifts:** | 1 |
| **No. Defects:** | |
| **WIP:** | |
| **WIQ:** | 1 |
| **Distance Traveled:** | |
| **Changeover:** | N/A |
| **Flow Stoppers:** | |

# Primary Metrics

- Used to measure process performance
- Tracks progress towards your goals and objectives
- Reported as baseline data, target performance, or actual performance
- Examples
  - Rolled throughput yield (RTY)
  - Process sigma level or Ppk
  - Defects per unit (DPU)

# Secondary Metrics

- Measurements of key output features, cycle time or process resource usage that may improve as a result of meeting objectives using the primary metric
- Examples
  - Primary metric: Cycle time
  - Secondary metric: Reduced backorders

  - Primary metric: Defects per unit
  - Secondary metric: Available floor space

# Consequential Metrics

- Metrics that measure possible unintended consequences of process changes
- It keeps you from passing your problem to another area
- Examples
  - Cycle time reduction
    - Primary metric: Cycle time / production unit
    - Consequential metric: Labor hours / production unit
  - Defect reduction
    - Primary metric: DPU, PPM, RTY
    - Consequential metric: Cost / unit, Cycle time / unit

# Financial Metrics

- Metrics that measure the financial impact when the primary metric is improved
- Validates the project results
- Examples
  - Primary metric: Cycle time
  - Financial metric: Labor hours * $$ / Hour

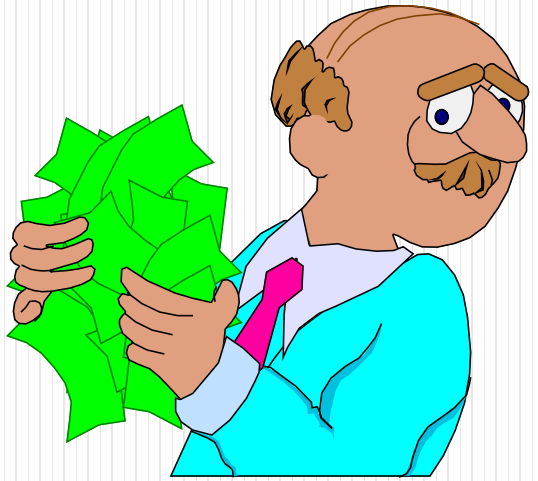
  - Primary metric: DPU
  - Financial metric: # Units needing rework * $$ Rework

# Metrics in Lean Six Sigma

- During Define:
  - Use data and measures to establish the case for action
  - From customer value and the vision, begin to define the needed measures and their connection to the strategy
- During Measure, use data and measures in prioritizing
- During Analyze:
  - Metrics is at the heart of Analyze!

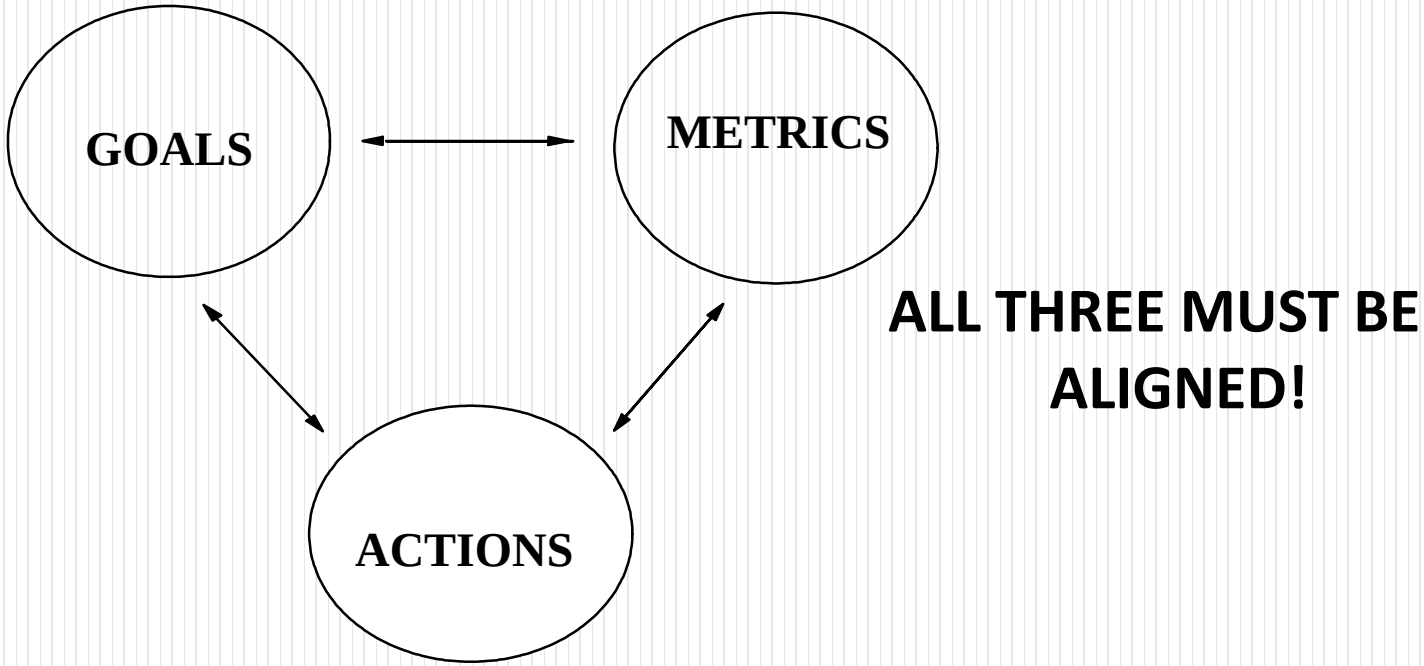
# Metrics in Lean Six Sigma

- During Improve
  - Develop the needed measures (part of the control system) to make the improvements stick!
- During Control
  - Implement and refine the metric system
  - Confirm the results achieved!



# Metrics and Behavior

- Measures communicate priorities
- Behaviors and actions are driven by what is measured
- When not aligned, goals are not met



# Keys to Success

- Metrics should be customer focused
  - Clearly related to business goals at all levels
  - Communicated to everyone
- Metrics should encourage the “parts” to do what is good for the “whole”
  - Meaningful at each level and related among the levels of the organization
  - Allow smart choices: Qualitative; financial; technical
- Metrics should direct focus to those parts that need attention or improvement
  - Identify the “vital few”; constraints or bottlenecks
  - Drive continuous improvement

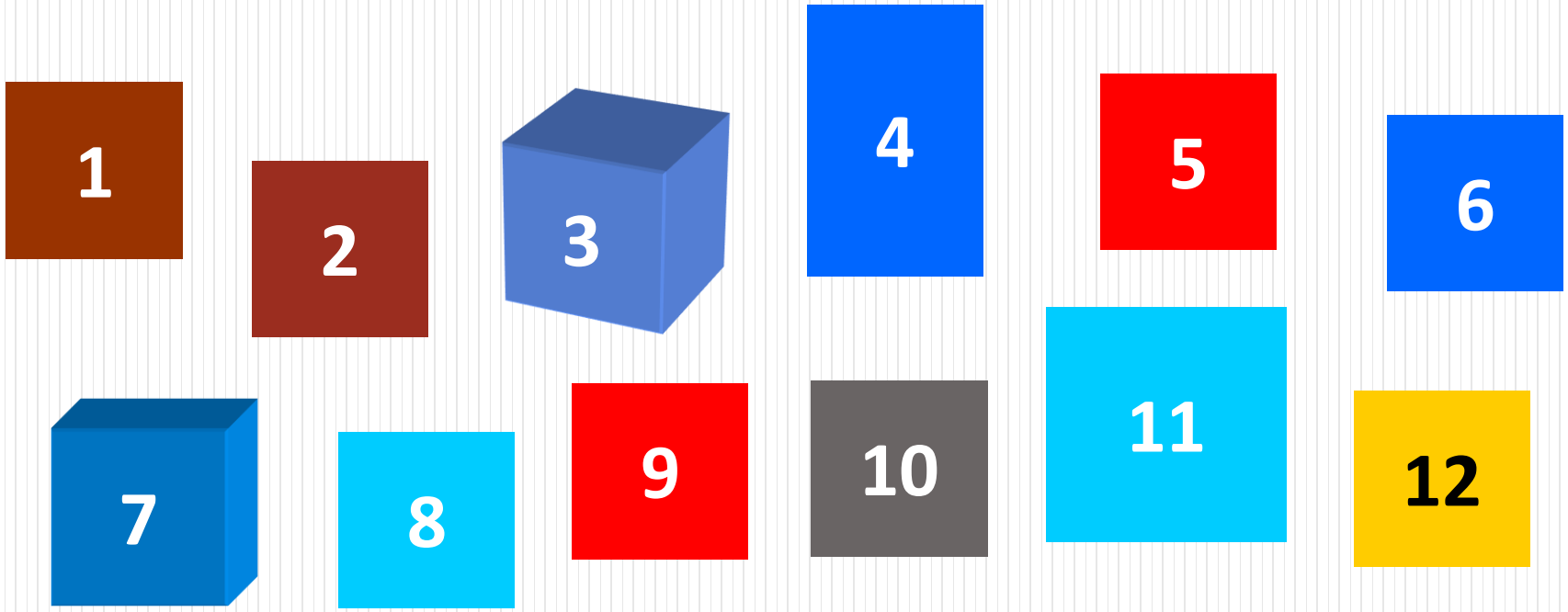
# The Value of Data

- Different types of data present a stronger or weaker case for the follow on analysis and the subsequent solutions.

- From Weakest to Strongest:
  - SME's opinions on values
  - Data from process as it use to be done
  - Small current process sample size
  - Robust set of current process data

# Define How to Measure

**In the following pictorial, identify by number, the blue blocks that you see:**




***Which ones are the blue blocks?***

# Purpose of a Data Collection Plan

- A well-prepared Data Collection Plan
  helps ensure successful analysis of the problem by making sure there is useful data collected
- Did we have one in the block exercise?  Did it matter?

# Definition of Data Collection Plan

- A data collection plan is the documentation of 5 Ws and 1H:
  - What data will be collected
  - Why it is needed
  - Who is responsible
  - How it will be collected
  - When it will be collected
  - Where it will be collected

# Data Collection Plan Example

| Objective (Why) | Measures/ Data (What) | Data Collection Method (How) | Data Sources (Where) | Timing (When) | Responsible Party (Who) |
|---|---|---|---|---|---|
| Collect feedback in regards to instructor performance | Survey questions on a scale of 1 to 5 | Class evaluation form | Students | At the end of each day | Instructor |

# Data Collection Plan

- Ask the following questions:
  - Identify data sources
  - What knowledge is desired about the process?
  - What are the potential sources of variation in the process? (X's)
  - Are there cycles in the process?
  - Are data available? If not, how will the data be collected?
  - How much time is needed to collect data to capture a true picture?
  - Who will be collecting the data?
  - How will the measurement system be tested?
  - Are the operational definitions for measurement detailed enough?
  - Where could data collection errors occur? How will data collection errors be handled?
  - How will the data be displayed?

# Data Collection Plan

**Data Sources**

Existing versus New

What data do you have?

What new data are needed?

Determine what you want to know (Y)

Determine the factors affecting this (X)

Determine what data you have / don't have

# A Question of Observation

- How easy is it to observe what is taking place in a process?
  - Depending on the process, a couple of hours may be all that is needed
  - In many instances, observations can take days, weeks, months, or years
  - Individuals documenting processes need to take copious notes
  - Do not interfere in the process

# Grouping Data

- Stratification
  - Data analysis technique by which data is sorted into various categories in order to surface patterns and uncover differences in processes
  - Purpose:  To examine the difference in measurement values between different subgroups in an attempt to understand potential variation
  - Example:  From the decannual US Census economists are often breaking out their data based on region, age, ethnicity, etc.

# Grouping Data

- How do you decide what characteristics to stratify?
  - Use CTXs as a discriminator
  - What are the key items from your SIPOC analysis?
  - What does common sense or subject matter expertise tell you?

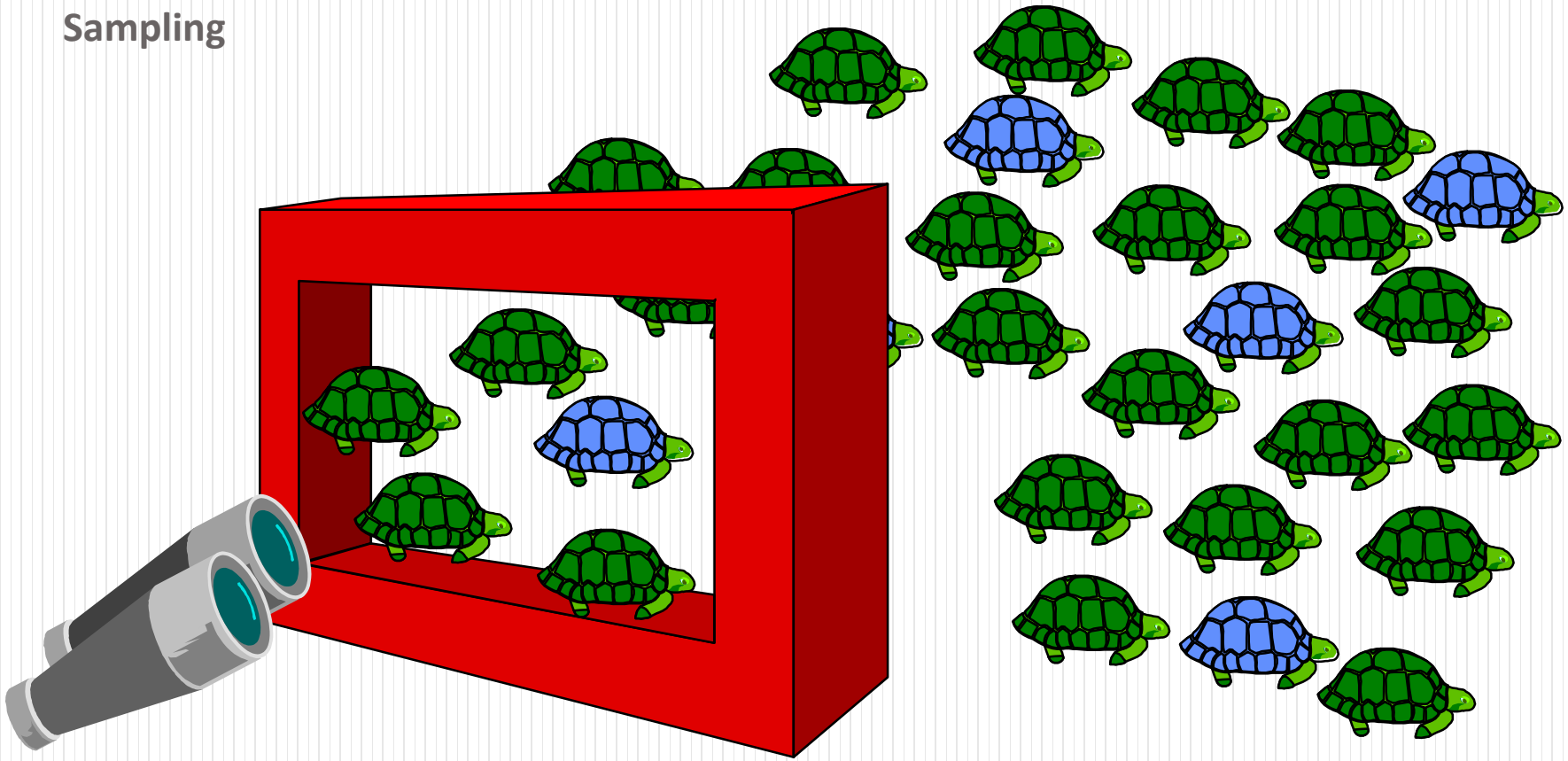
# Grouping Data

- When applying data stratification, you should consider common factors

| Factor | Example |
|---|---|
| **What** | Type Complaints, Defects, Car Models |
| **When** | Year, Month, Week, Day |
| **Where** | Country, Region, City, Work Site |
| **Who** | Business, Department, Individual |

# Data Collection

**Sampling**



# Purpose of Sampling

- It is often impractical or too costly to collect all the data
- Sometimes data collection is a destructive process
- Statistics is based on the sense that we are able to draw conclusions based on looking at part of the population
- Sound conclusions can often be made from a relatively small amount of data

# Sampling Requirements

- For statistics, a valid statistical sample is any sample size equal-to or greater-than 30
  - Large sample sizes (30 or greater) tend to center about the mean (normally distributed)
  - It displays the familiar “Bell-shaped” curve
- Samples sizes less than 30 is not recommended; but if sample sizes less than 30 are used advanced statistical methods will be required

# Sample Data Collection / Metrics

| Data Collection / Metrics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project / Event Name:** | | | | | | **Project Sponsor:** | | |
| **Y(s) Solving For:** | | | | | | **Black Belt:** | | |
| | | | | | | **Master Black Belt:** | | |
| **Supporting Documents:** | | | | | | **Date of Project / Event:** | | |
| | | | | | | **Takt Time (CS/FS):** | **Hours** | **Hours** |

| POA&M Item(s) | Metric | Current | Target | Daily Progress | | | | | % Change | Future Target | 1 Week Later | 2 Weeks Later | 3 Weeks Later |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | | | | | |
| | 1. Demand per _____ | | | | | | | | | | | | |
| | 2. Staffing | | | | | | | | | | | | |
| | 3. Overtime Hours per Week | | | | | | | | | | | | |
| | 4. Output per Week | | | | | | | | | | | | |
| | 5. Productivity (hrs / unit or units / hr) | | | | | | | | | | | | |
| | 6. Work in Process | | | | | | | | | | | | |
| | 7. Work in Queue | | | | | | | | | | | | |
| | 8. Total Cycle Time | | | | | | | | | | | | |
| | 9. Set-up Time | | | | | | | | | | | | |
| | 10. Lead Time | | | | | | | | | | | | |
| | 11. Floor Space | | | | | | | | | | | | |
| | 12. Product Travel (Feet) | | | | | | | | | | | | |
| | 13. People Travel (Feet) | | | | | | | | | | | | |
| | 14. 5S Audit Score | | | | | | | | | | | | |
| | 15. Rolled Throughput Yield | | | | | | | | | | | | |
| | 16. Safety Issues | | | | | | | | | | | | |
| | 17.Visual Controls | | | | | | | | | | | | |

# Summary

In this module you have learned about:

- Metrics are a critical element of Lean Six Sigma; they provide the information necessary to continually improve work processes, based on data.
- If you can't measure it, you can't manage it.
  - And if you cannot or do not measure it you aren't using LSS.
- Focus on the "majors" (Pareto principle)
  - Spend more time on the "majors" and get a great return
- The impact from less time on the "minors" will be easily offset
- Data collection plan
  - Documentation of 5W's and 1H
  - Sources
  - Stratification
  - Sampling

# Homework: Develop a Data Collection Plan

- Develop a Data Collection Plan for the Virtual Project

| Objective (Why) | Measures/ Data (What) | Data Collection Method (How) | Data Sources (Where) | Timing (When) | Responsible Party (Who) |
|---|---|---|---|---|---|
| | | | | | |