Surfing 101 for Statistics Professionals:
Riding the Six Sigma Wave

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INFORMS
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Today's Agenda

- **Six Sigma History**
- **Six Sigma Definition**
- **Six Sigma Roles**
- **Six Sigma Methodology**
- **Opportunities for Statistics Professionals**

Six Sigma History

Six Sigma History

- **In 1985, Motorola Engineer/Executive Bill Smith coined the term "Six Sigma".**
- **In 1988, Motorola won the Malcolm Baldridge National Quality Award and the world began to learn about their Six Sigma approach.**
- **In 1995, Larry Bossidy introduced Allied Signal to Six Sigma leading to $500+ million per year in savings.**
- **In 1996, Jack Welch brought Six Sigma to GE. To date, the return to the bottom line is on the order of $2.25B.**
- **Now, many companies are implementing Six Sigma, including Boston Scientific Corporation's competitors.**

Six Sigma at Boston Scientific

“Quality is the driver of Six Sigma in BSC. The improvement opportunities selected should be those that matter to the customer.”

“Six Sigma provides a road-map for making sure customer requirements are understood and translated into measurable performance goals.”

Jim Tobin, President and CEO

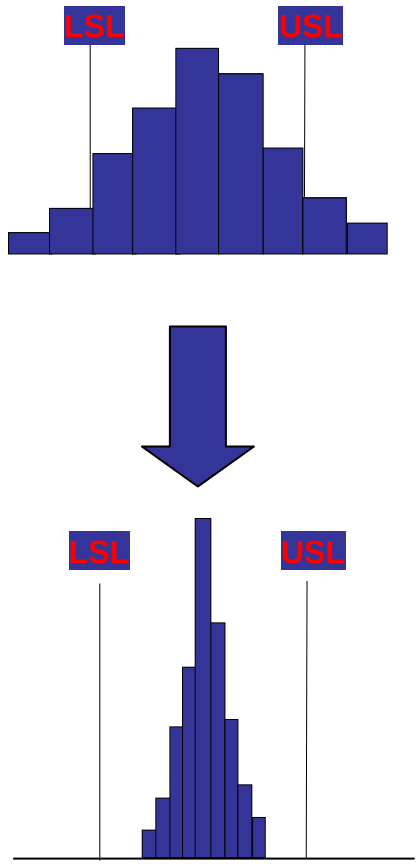
Critical Success Factors

- Senior Management Ownership
- A unique, company specific program
- Well defined program objectives
- Integration into existing company processes
- A clear and effective communication strategy
- A comprehensive, sustainable plan for implementation
- Demonstrated commitment through resource allocation

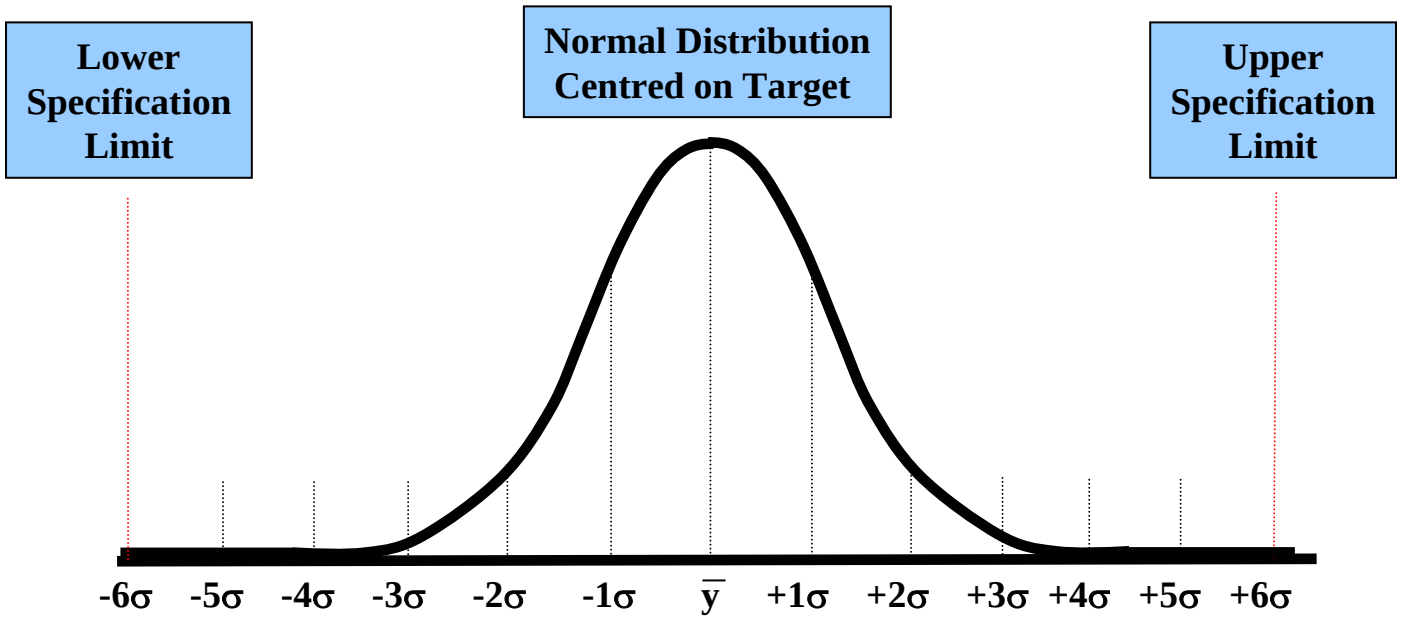
Six Sigma Definition

What is Six Sigma?

- **A strategic business initiative**
- **founded on a systematic approach to improving products and processes**
- **using statistical and managerial methods and tools**
- **to reduce variation and eliminate defects**
- **leading to breakthrough improvement in customer satisfaction.**

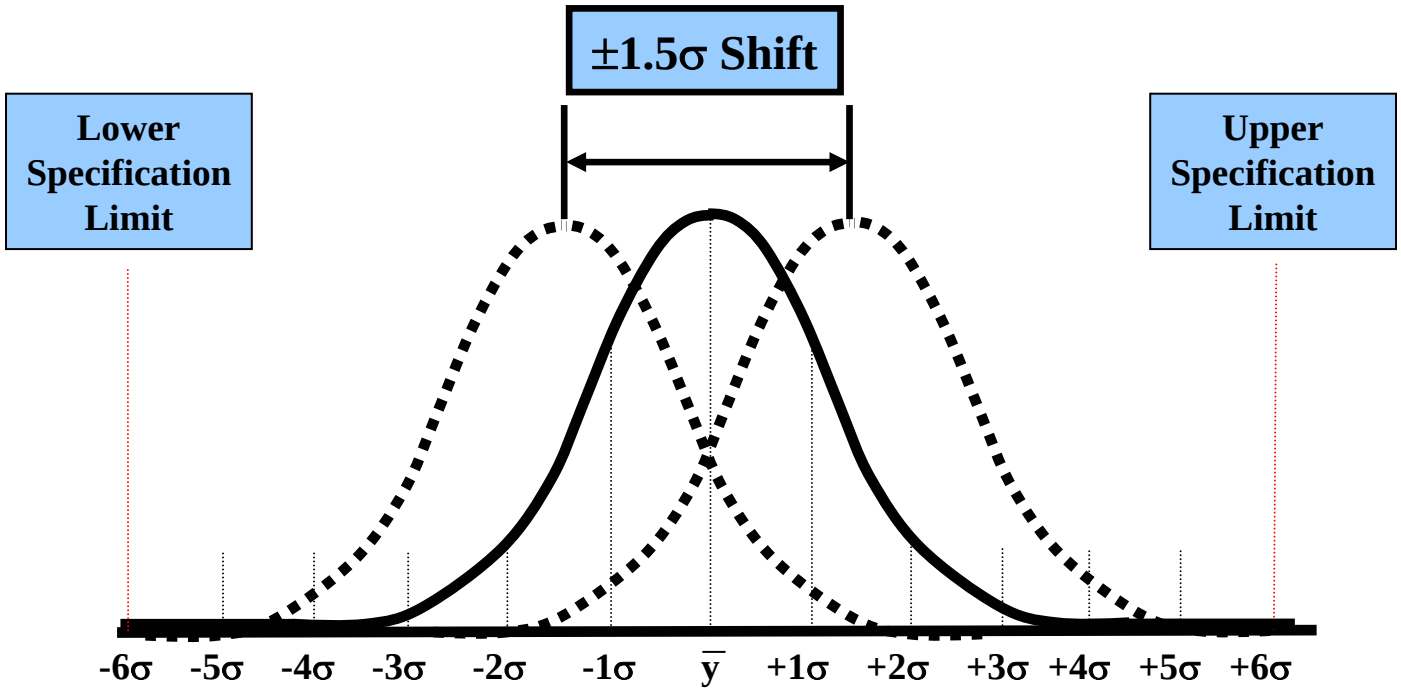


The Six Sigma Metric



Specification Limit	Percent within Specification	Defects Per Million
±1σ	68.27	317,300
±2σ	95.45	45,500
±3σ	99.73	2,700
±4σ	99.9937	63
±5σ	99.999943	0.57
±6σ	99.9999998	0.002

The Six Sigma Metric



The 1.5 Sigma Shift is expected to occur over the very long-term (typically years)

The Six Sigma Metric

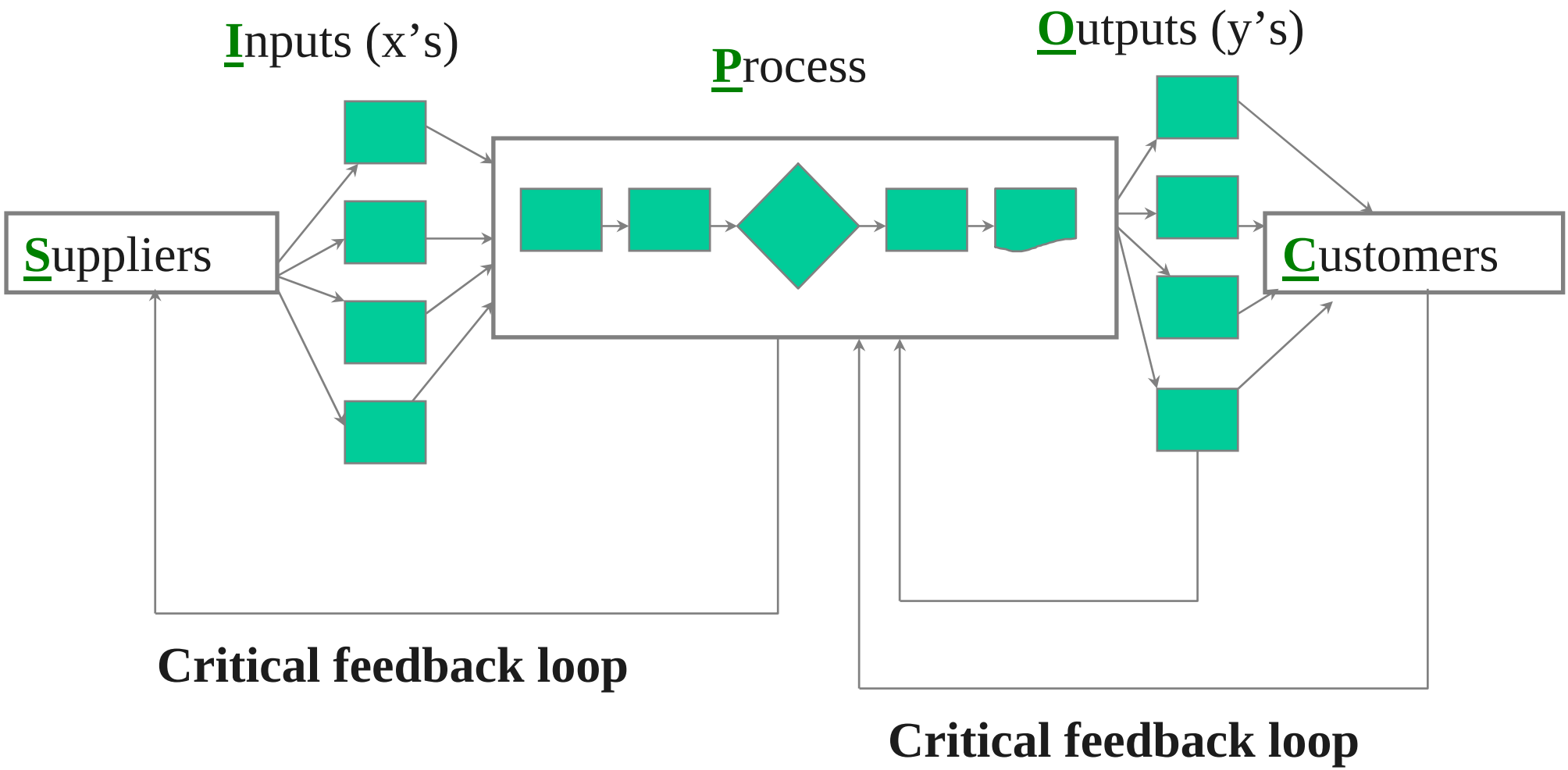
Specification Limit	Percent within Specification (Centered)	Percent within Specification (1.5σ shift)	Defects per million (Centered)	Defects per million (1.5σ shift)
± 1σ	68.27	30.23	317,300	697,700
± 2σ	95.45	69.13	45,500	308,700
± 3σ	99.73	93.32	2,700	66,810
± 4σ	99.9937	99.3790	63	6,210
± 5σ	99.999943	99.97670	0.57	233
± 6σ	99.9999998	99.999660	0.002	3.4

A common definition of a Six Sigma process is one which achieves 3.4 defects per million or less.

Is 99% Good Enough?

99% = 3.8 Sigma Quality	Type of Failure	99.9997% = 6 Sigma Quality
2 per day	Short or long landings at major airports	1 every 4.6 years
200,000 per year	Incorrect drug prescriptions	60 per year
5,000 per week	Incorrect surgical operations	1.5 per week
50 per day	Newborn babies dropped at birth by doctors	1 every 9 weeks
22,000 per hour	Checks deducted from the wrong bank account	6.6 per hour
32,000 per year	Missed heartbeats per person	9.6 per year
7 hours per month	Time without electricity	7.6 seconds per month
9 per page	Misspelled words in a magazine	1 per 370 pages

A Process Approach



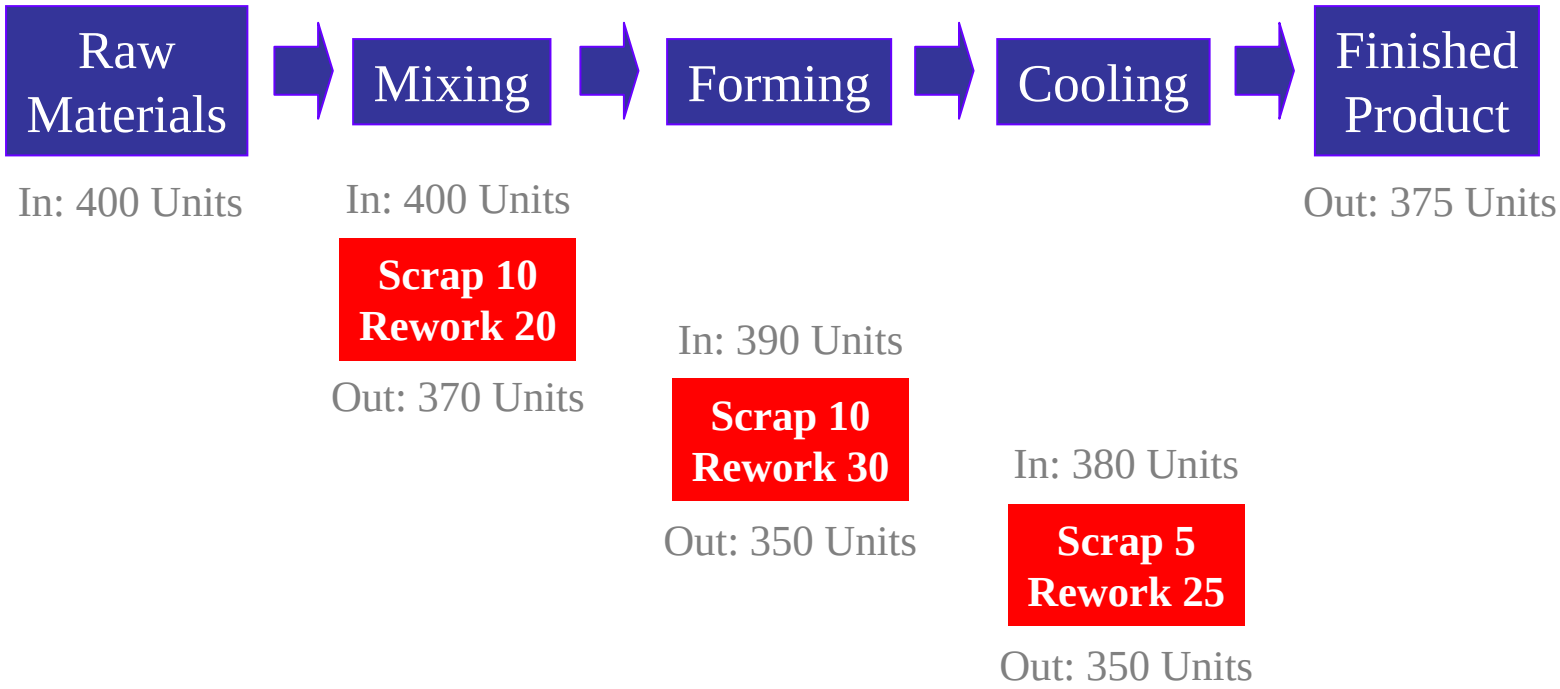
Is This A Good Process?

In: 400 Units

Out: 375 Units

$$\textbf{Yield} = \frac{375}{400} = 93.75\%$$

Is This A Good Process?



$$\text{Rolled Throughput Yield} = \frac{370}{400} \times \frac{350}{390} \times \frac{350}{380} = 76.46\%$$

Six Sigma Roles

Yellow Belt

- **Understands basic Six Sigma concepts and methods**
- **Trained in Six Sigma tools appropriate to needs**
- **Applies tools to designated project, problem, or process improvement opportunity in their area**
- **Typical focus is Problem Solving**
- **Retains current position title**

Green Belt

- **Proficient in Six Sigma methods and basic tools**
- **Applies Six Sigma process relevant to own function/role**
- **Leads application of Six Sigma tools on less technical projects (may lead projects)**
- **May participate as team member on BB project**
- **Trains and mentors Yellow Belts**
- **Retains current position title**

Black Belt

- **Expert in application of Six Sigma methodology and tools**
- **Coaches project teams in use of Six Sigma tools (may lead projects)**
- **Fields and resolves Six Sigma questions**
- **Coaches individuals in use of Six Sigma tools (may conduct classroom training)**
- **Retains current position title (may be dedicated to Six Sigma full or part-time)**

Master Black Belt

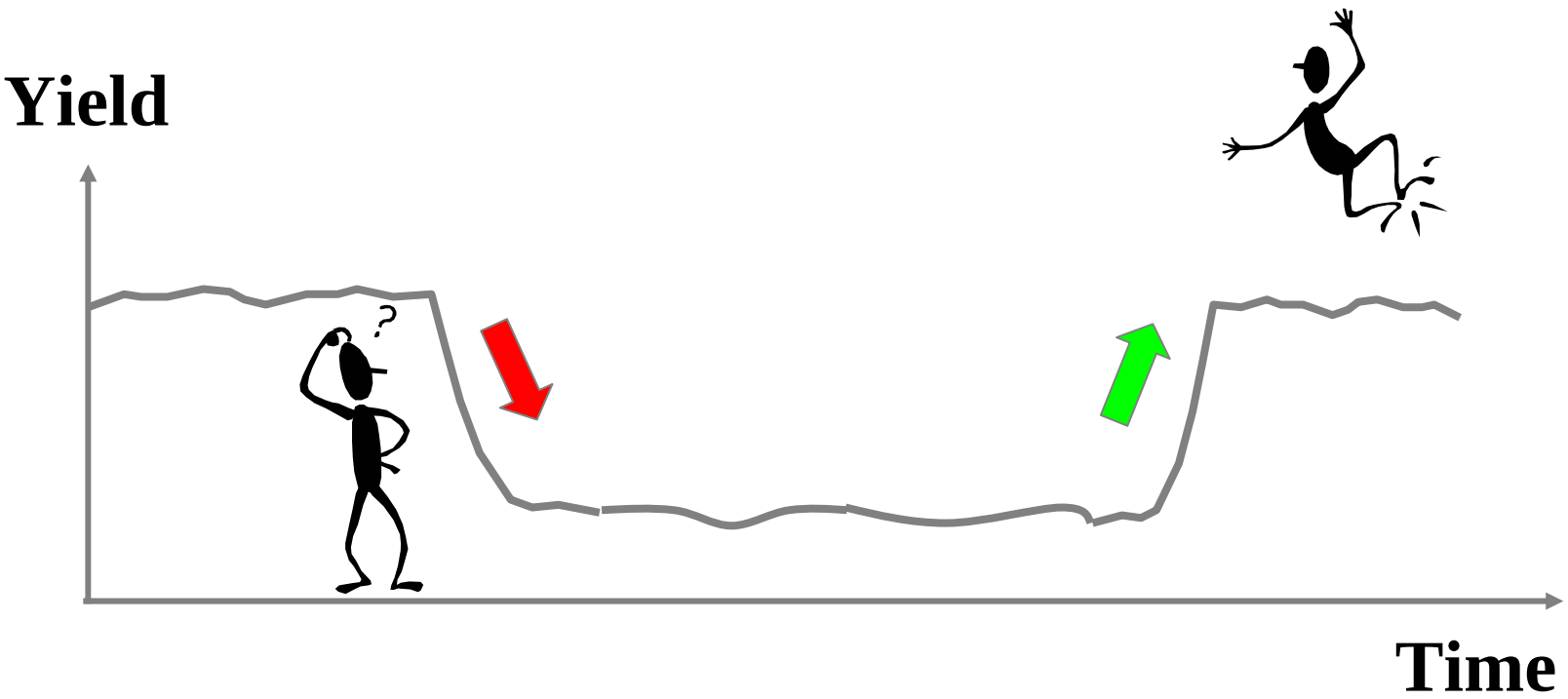
- **Expert in Six Sigma methodology and tools**
- **Advises site steering team in Six Sigma deployment**
- **Provides technical leadership**
- **Guides Six Sigma project teams; facilitates teams**
- **Oversees Six Sigma training, including trainer certification**
- **Trains, develops and coaches Black Belts and Champions (functional managers)**
- **May support multiple sites**

Statistician

- **Advises Black Belts in selecting appropriate statistical methods**
- **Mentors Master Black Belts to expand their knowledge of statistical tools**
- **When assumptions are violated, identifies and assists in applying appropriate remedial methods**
- **Advises management on corrective actions and safeguards**
- **Serves as consultant on projects calling for complex statistical analyses**

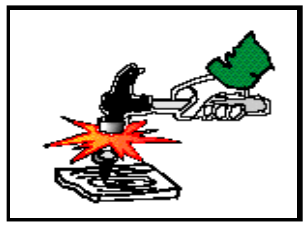
Structured Problem Solving Methodology

Structured Problem Solving

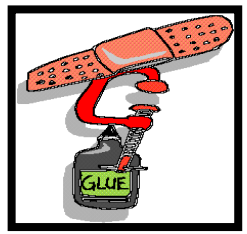


Structured Problem Solving Process

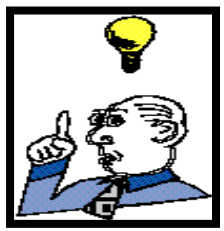
1. Define the Problem



6. Implement Permanent Solution

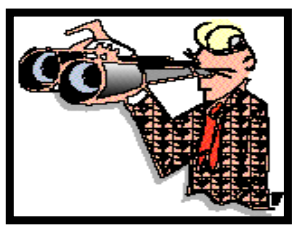


2. Interim Actions



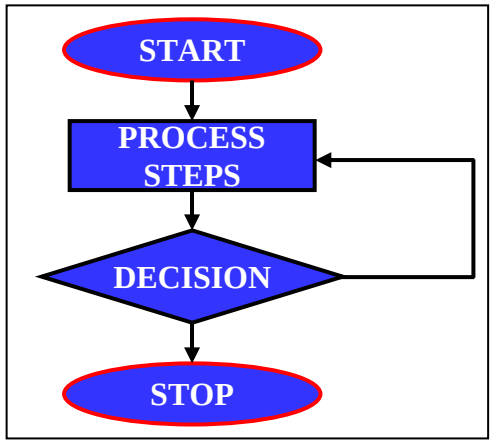
5. Determine and Verify Solution

3. Identify Potential Causes

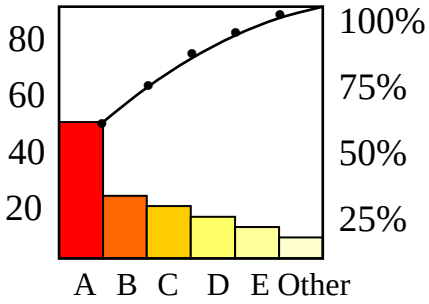


4. Determine Root Cause

Seven Basic Tools



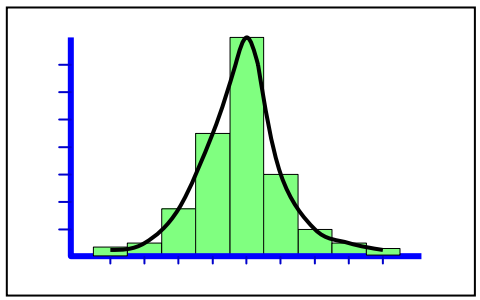
Flow Chart

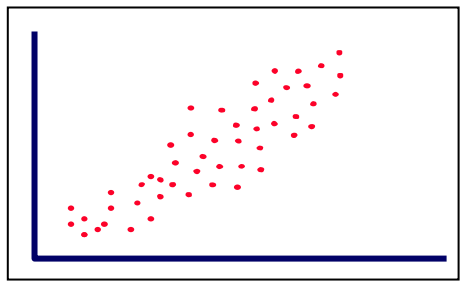


Pareto Chart

Check Sheet

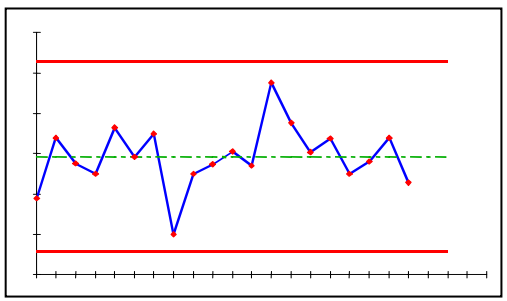
Histogram

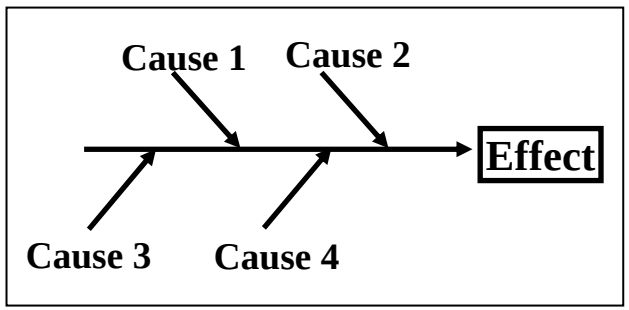




Scatter Diagram

Control Chart

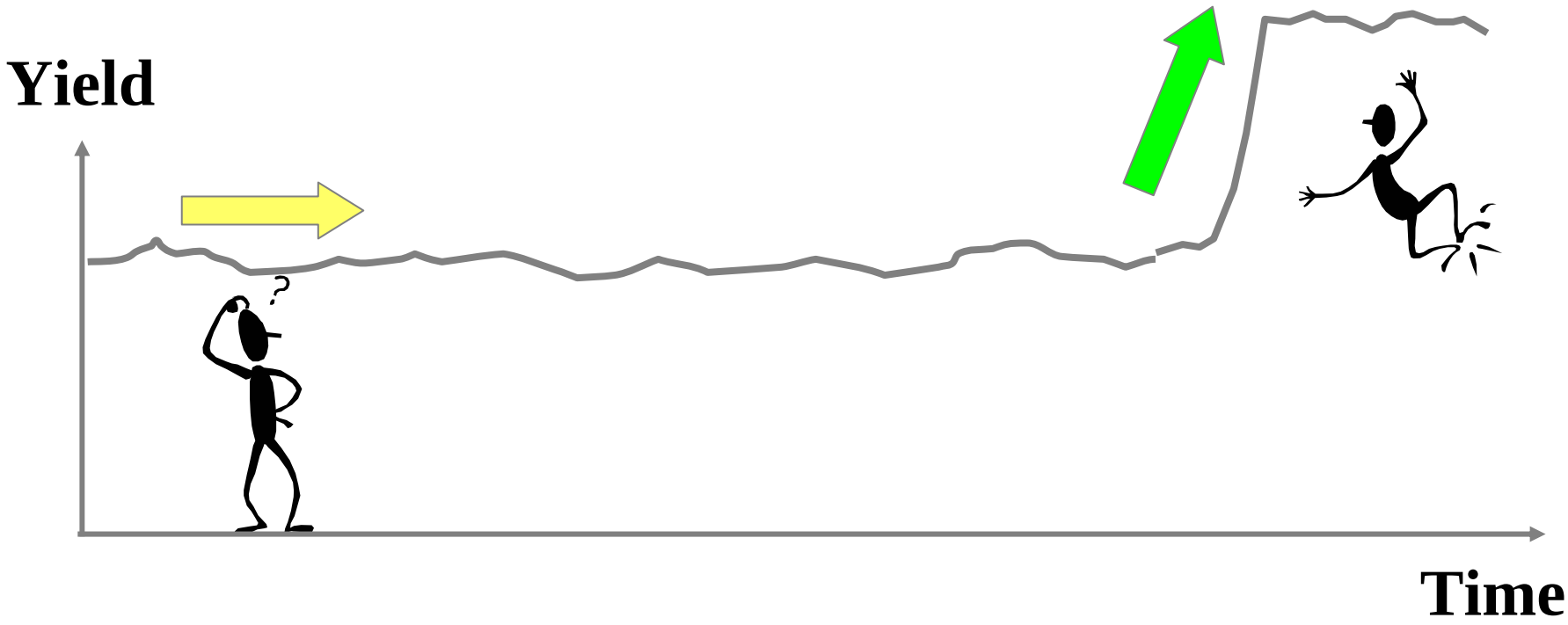




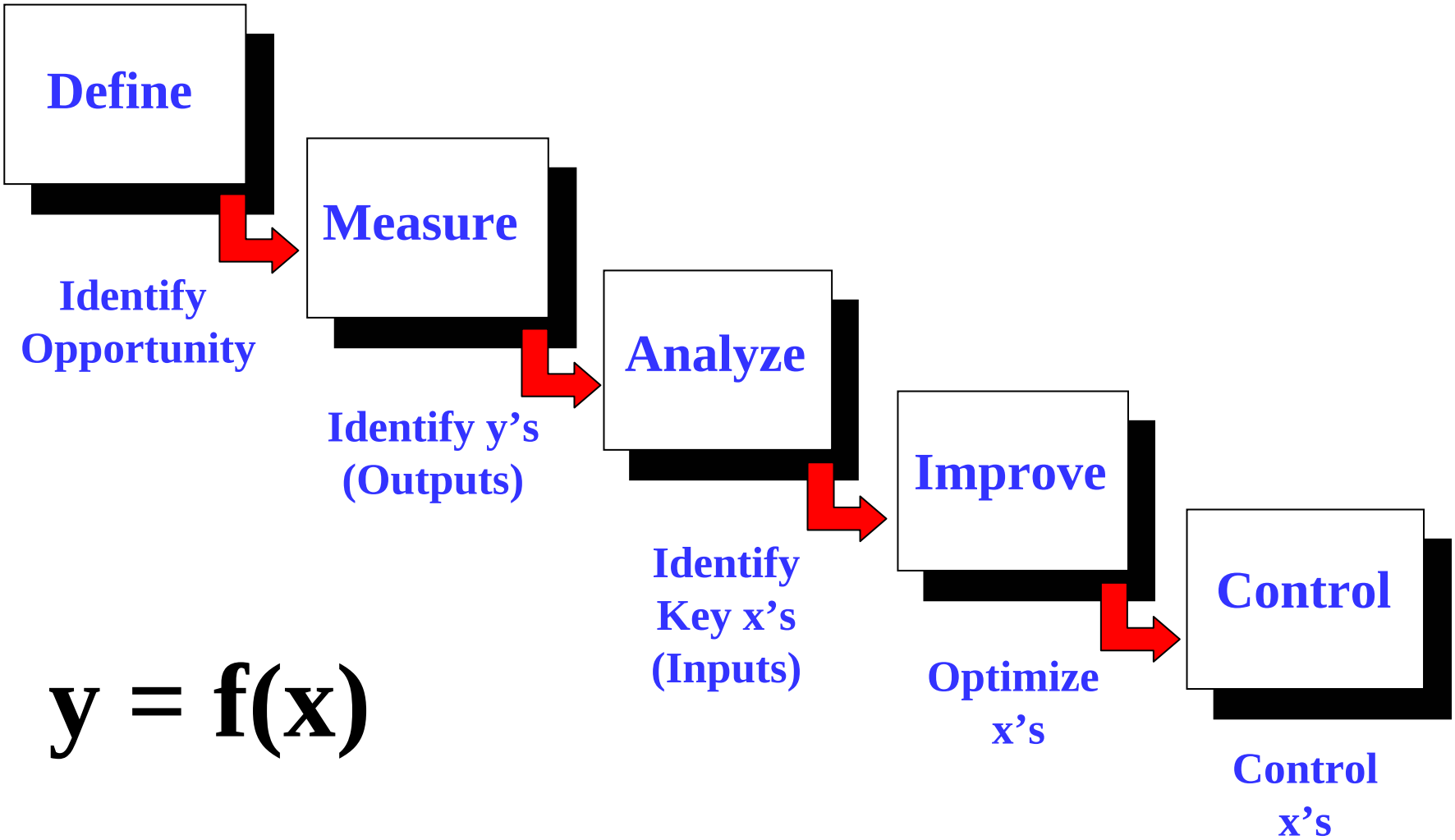
Cause & Effect Diagram

Six Sigma Breakthrough Improvement Methodology

Breakthrough Improvement



The DMAIC Process



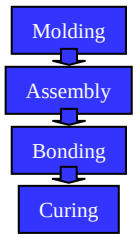
$$y = f(x)$$

The DMAIC Process

Define

- Identify Opportunity

- Define Project Goal
- Define Process
- ID Leader & Team

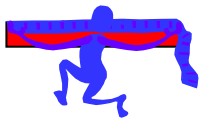


- Establish Boundaries
- Identify Customer Requirements

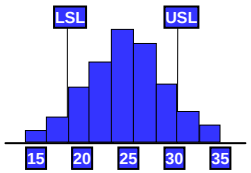
Phase Review

Measure

- Develop Measures (y's)



- Evaluate Measurement System
- Determine Process Stability
- Determine Process Capability

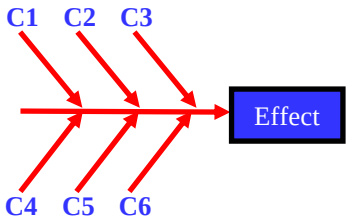


- Determine the Improvement Approach Required

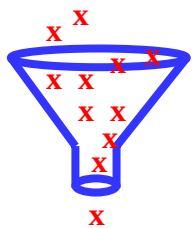
Phase Review

Analyze

- Identify Potential x's



- Analyze x's



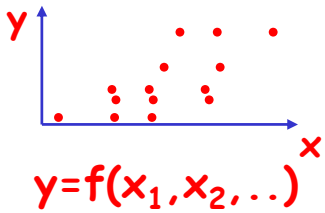
- Identify Key x's

Run	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

Phase Review

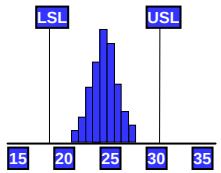
Improve

- Determine Stability & Capability of Key x's
- Establish Relationships between y's and x's



- Establish Targets & Tolerances for Key x's

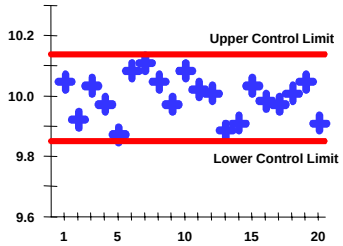
- Implement Mistake Proofing
- Verify Process Improvement



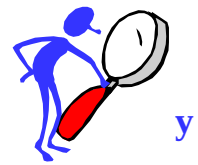
Phase Review

Control

- Control Key x's



- Validate Process
- Monitor y's



- Finalize Project Charter

Phase Review

Your Statistical Tool Box

- Basic Statistics
- Hypothesis Testing
- Confidence Intervals
- Measurement Systems Analysis (Gage R&R)
- Process Capability Studies
- Control Charts
- Screening Experiments
- Response Surface Methods
- Taguchi Methods
- Robust Tolerance Analysis
- Seven Basic Tools
- Analysis of Variance
- Variance Components
- Regression Analysis
- Fault tree Analysis
- Failure Modes & Effects Analysis
- Mistake Proofing
- Acceptance Sampling
- Reliability/Survival Analysis

Opportunities for Statistics Professionals

Opportunities

- **As an active participant in a Six Sigma initiative**
- **As an internal or external statistical consultant**
- **As a trainer on statistical methods for Quality**
- **As a researcher/developer of new statistical methods to support Six Sigma**

Questions?

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