Successful Implementation of Six Sigma
A Champion Overview
Section 1
Introduction:
What is Six Sigma?
Ljubljana, Slovenia
April 6, 2004

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Table of Content

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 1.2

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Today's Business Realities:

- New competing products and technologies
- Competitors with similar products and technologies invade markets
- Shorter product life cycles — bigger market pressure
- Learning effects: competitors learn ever faster to execute better, faster and cheaper
- Competitors emerge in other countries with significantly different cost structures
- World wide communication technology and modern container shipping makes the market truly global and extremely competitive

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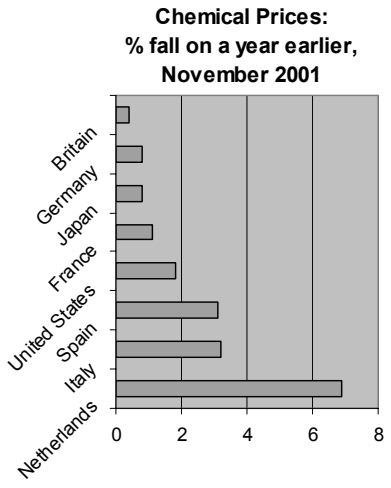
An Example of Profit Erosion

Chemical industry: Sales prices (in inflation adjusted $'s) declined ~1%/year for the past 20 years while costs kept rising

Source: *The Economist*, Jan. 19th 2002



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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Profit and Competition

- Profit is a necessity for survival in the market:
  - Profit is necessary for sustaining innovation – necessary for paying for product and process development, necessary for attracting capital
  - Profit is not the goal in itself but a measure of how well we innovate, manage and operate
- Economic reality is distinguished by competition from new commodities, new technologies, new sources of supply, new types of organization and competition that command a decisive cost or quality advantage

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Competitive Advantages Derive From

- **Lower Costs**
  - Fewer quality problems
  - Less costly defects
  - More efficient processes
  - Shorter delivery time
- **Product Differentiation**
  - Higher quality products
  - Superior value to the customers
  - Special features

⇨ ***Six Sigma will deliver lower costs and product differentiation***

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Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Higher Quality at Lower Costs?

- Higher quality at lower costs: Sounds like a contradiction, but isn't!
- It cost the same to produce scrap as producing good parts, sometimes much more
- Rework is expensive and scrap consumes unnecessary resources
- Dealing with unhappy customers is expensive
- It takes a lot of costly marketing and sales effort to sell a poor quality product – good quality is an advertisement in itself

Economics of Six Sigma

Inflated because of defects, scrap rework and delays; can be reduced with 6σ

Sales	$100
-Variable Costs	$ 60
=Contribution Margin	$40
-Fixed Costs	$30
=Profit	$10

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

The Bottom-line Effect of Six Sigma

Sales	$100
-Variable Costs	$ 60 - 5
=Contribution Margin	$40+5
-Fixed Costs	$30
=Profit	$10+5

A Cost reduction of (5/60)×100% = 8.3%

Produces A Profit Increase of (5/10)×100% = 50%

Any improvement in quality and efficiency goes right to the bottom-line!

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f Six Sigma

Happy and satisfied customers come back with more business. That increases the top line!

Sales	$120
-Variable Costs	$ 70
=Contribution Margin	$50
-Fixed Costs	$30
=Profit	$20

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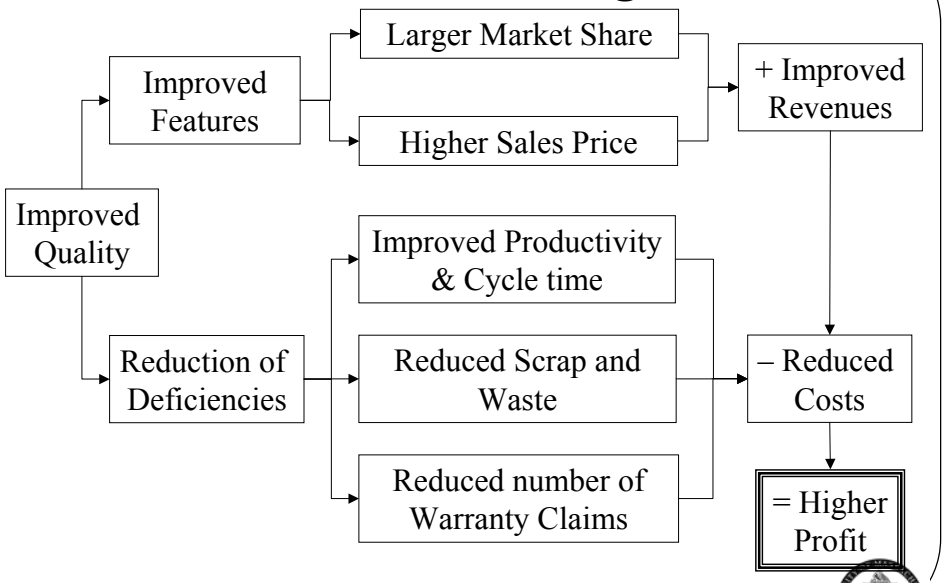
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Economics of Six Sigma



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Costs-of-Poor-Quality: COPQ

- **Definition:** The costs of poor quality are the costs that will go away if all products and services are produced to perfection
- Alternative definition **NOT** used: all costs related to attaining quality
- To organize the assessment, it is helpful to divide COPQ into major cost categories
- In each case individual categories will have to be created that are relevant to the specific company's operations

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Major Cost of Quality Categories

Cost categories:

1. **Internal costs**: cost incurred *before* product is shipped or the services completed
2. **External costs**: costs incurred *after* the product has been shipped or the service completed
3. **Appraisal costs**
4. **Prevention costs**

- Advise: Initially, consider only internal and external failure costs

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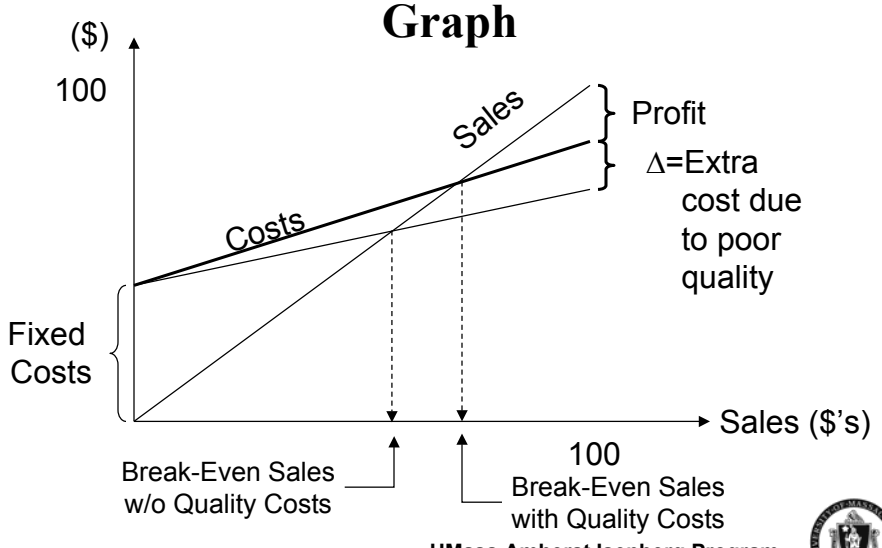
The Effect of an Increase in Cost of Poor Quality on the Cost-Profit-Volume Graph



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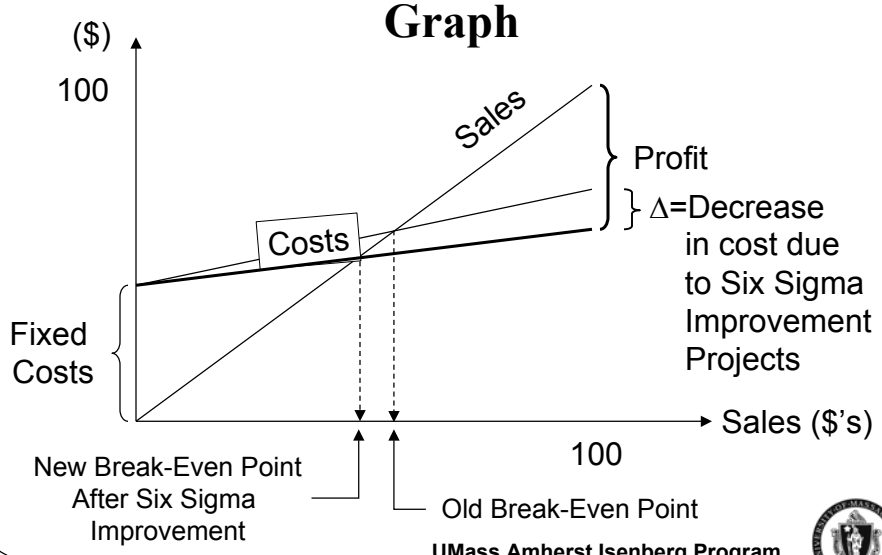
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

The Effect of a Decrease in Cost of Poor Quality on the Cost-Profit-Volume Graph



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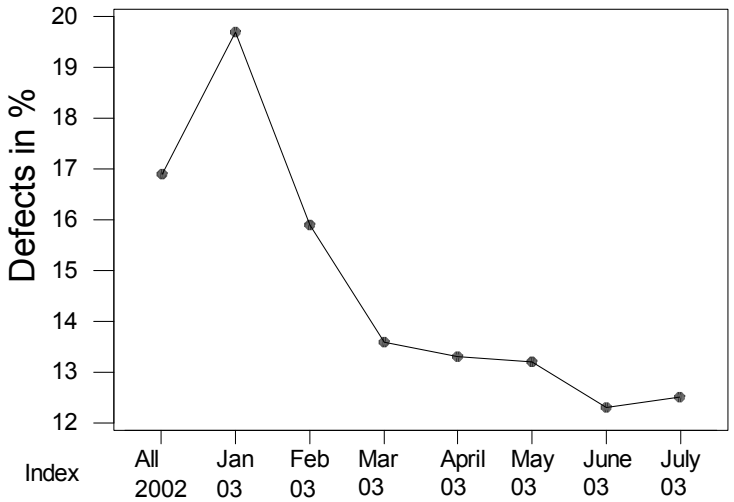
Six Sigma: A Fad?



Not to the CEO of this company!!!

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Innovation and Six Sigma

- In the past most companies had systems for managing day-to-day operations, but no formal systems for innovation and change
- Innovation used to be something mysterious, haphazard, a strike of genius
- Six Sigma is a systematic, analytic, (scientific) and purpose driven approach to process and product innovation and change
- Six Sigma and innovation needs to be made part of how we do regular day-to-day business
- Six Sigma must be institutionalized and become part of "how we work"

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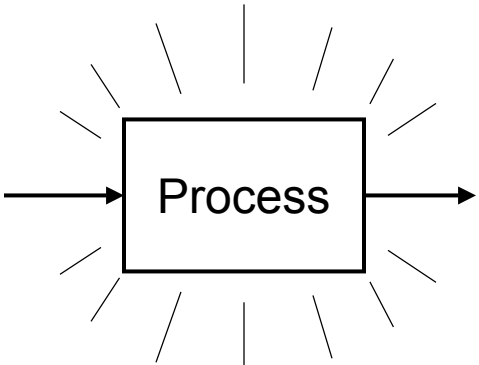
Fundamental Concept:
Every Process Produces Information That Can Be Used For Improvement



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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

What is Six Sigma?

- A program for near elimination of defects from every product and process
- A disciplined quantitative approach for improvement of defined metrics aligned with the overall strategy
- Can be applied to all business processes: manufacturing, transactions, finance and services
- Focused on carefully selected Projects
- *In a nutshell: Six Sigma is the application of scientific method to improve processes and products*

Six Sigma Genealogy

- A successful program spearheaded by companies such as General Electric and Allied Signal (Honeywell)
- Originated at Motorola as their quality improvement program
- Different from traditional TQM and ISO 9000; really about systematic innovation in general, not just quality control

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

DMAIC: A Simple Problem Solving Discipline

- Define: Select relevant problems to work on
  - » Stating a problem in measurable and actionable terms
- Measure: measuring the variation of the performance data of the problem
- Analyze: finding the sources of variation to the performance data
- Improve: eliminating or enhancing the highest drivers of the performance data variation
- Control: establishing controls to manage the gains of the problem solution

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The Six Sigma Strategy

Phase 0: Define
- Scope and Boundary
- Define Defects
- Develop Team Charter and Select Champions
- Estimated $ Impact
- Get Leadership approval

Phase 1: Measure
- Map the process and Identify Inputs and Outputs
- Make Cause and Effects Matrix
- Establish Measurement System Capability
- Establish Process Capability Baseline

Phase 2: Analyze
- Perform Multi-vari Analysis
- Develop Input-output relations
- Identity Critical Process Inputs
- Develop FMEA

Phase 3: Improve
- Verify Critical Process Inputs
- Optimize Critical Process Inputs
- Reduce variability

Phase 4: Control
- Develop Control Plan
- Implement Control Plan
- Verify Long Term Capability
- Transfer to operations
- Continuously Improve the Process

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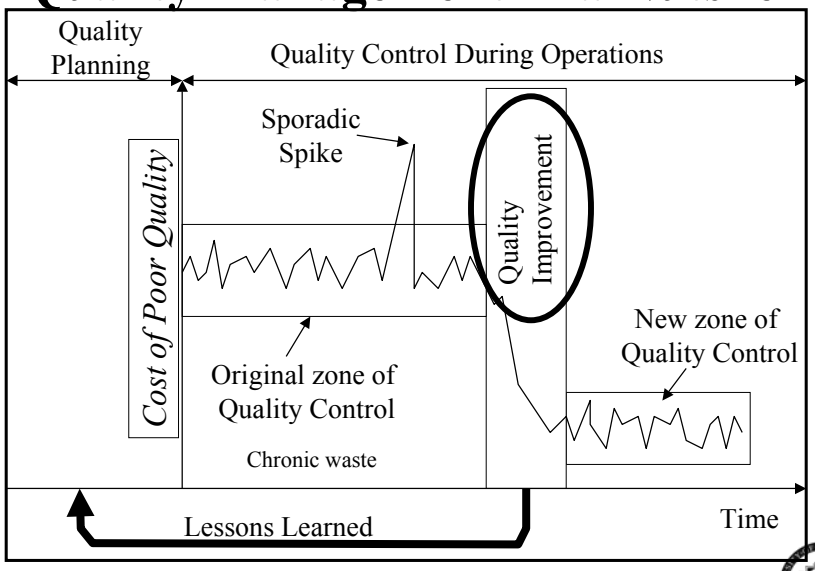
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Quality Management in a Nutshell



Adapted from Juran

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Case: Reducing Defects in Outboard Motors

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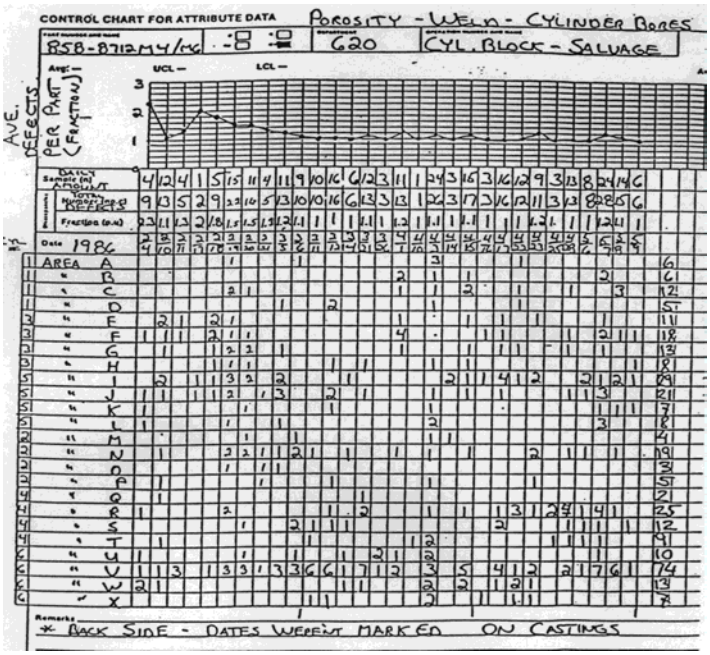
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu



An Example of an Observational Study From Industry: Mercury Marine

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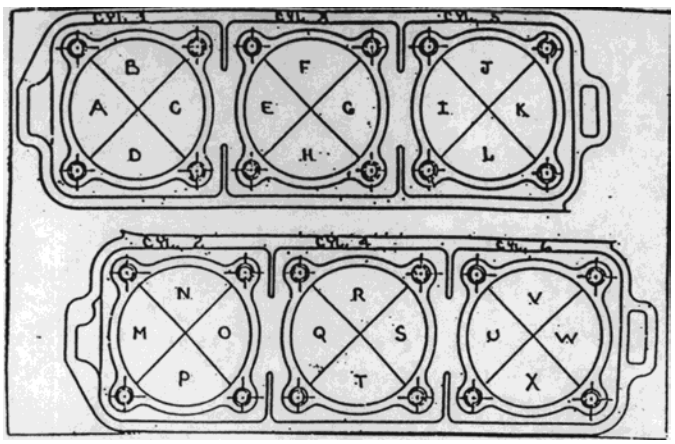
Location Identification Sheet for Casting Defects



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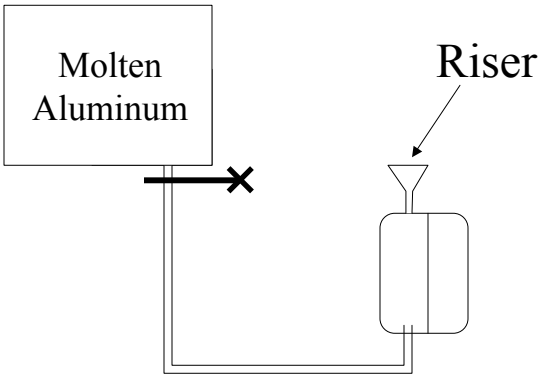
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Die Casting



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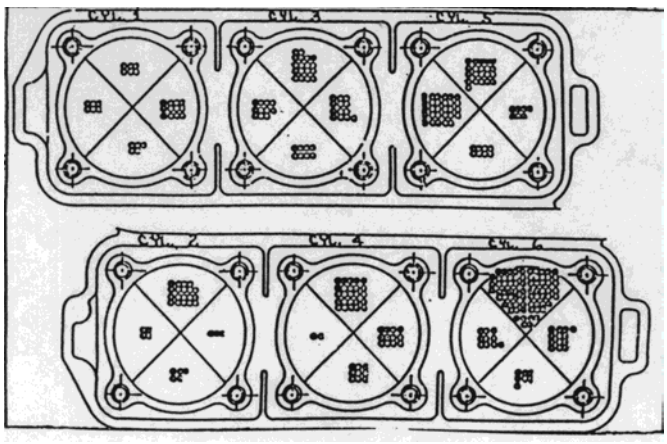
Defect Map For Casting Defects



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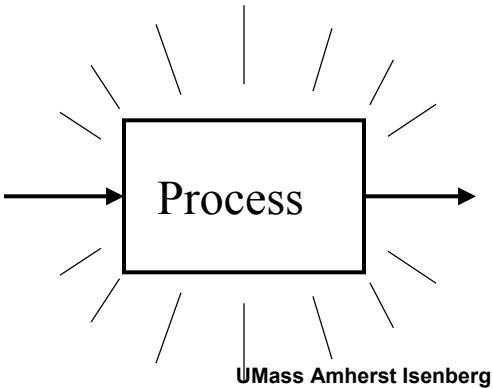
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Every Process Produces Information That Can Be Used For Improvement



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Other Applications: GE Examples

- Approving credit card application process
- Lending money to corporate customers
- Installation of turbines
- Servicing aircraft engines
- Overhauling locomotives
- Answering service call for appliances
- Underwrite insurance policies
- Developing software for a new CAT product

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Case: Improving the Design of a Product

An Example of Quality Improvement: A Ball Bearing Life Test Experiment*

		–	+
H:	Heat treatment	Standard	Modified
O:	Outer ring osculation	Standard	Modified
C:	Cage design	Standard	Modified

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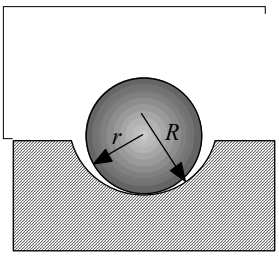
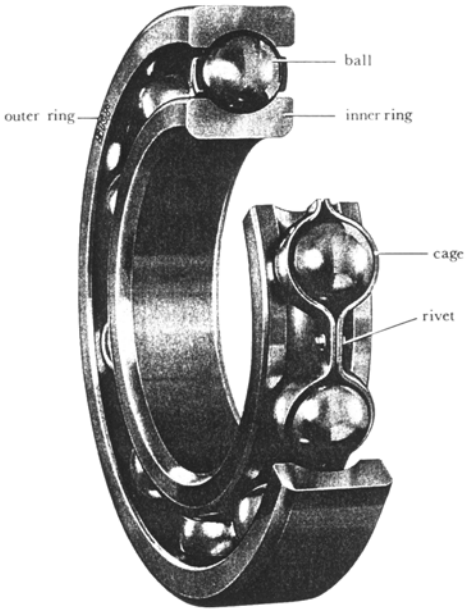
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu



Osculation= r/R



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The Design Matrix

	H	*O*	*C*	*Life*
1	–	–	–	17
2	+	–	–	26
3	–	+	–	25
4	+	+	–	85
5	–	–	+	19
6	+	–	+	16
7	–	+	+	21
8	+	+	+	128

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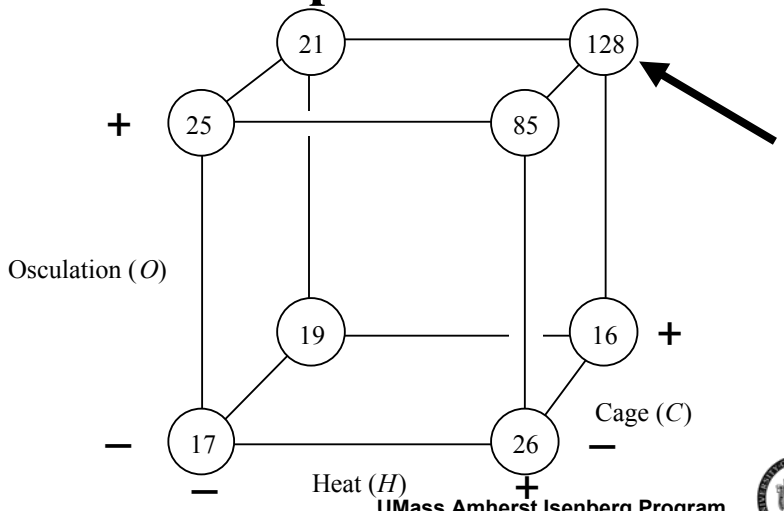
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Results of Ball Bearing Experiment



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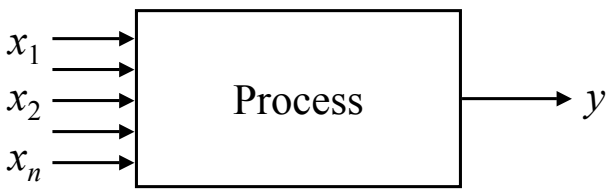
Six Sigma



$$y = f(x_1, x_2, \ldots, x_n)$$

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Isenberg School of Management
University Massachusetts-Amherst
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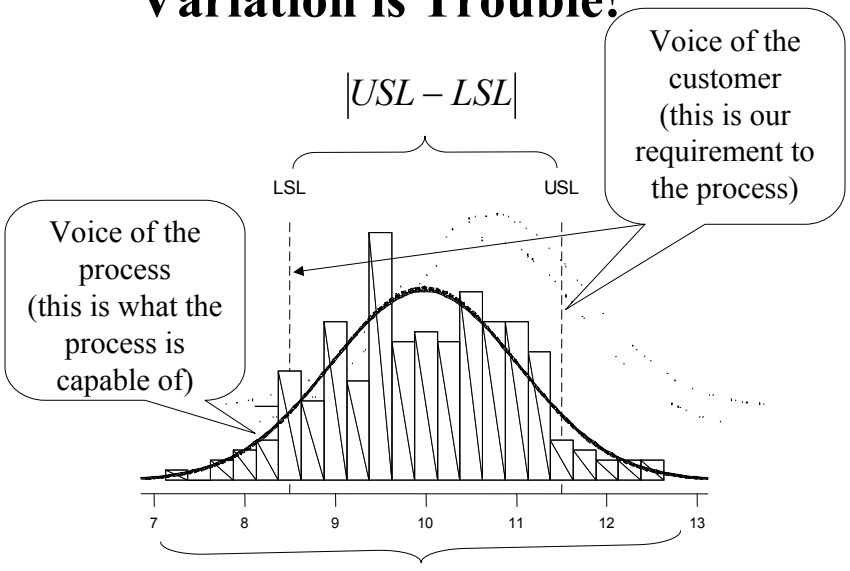
Variation is Trouble!



$$\pm 3\sigma = 6\sigma$$

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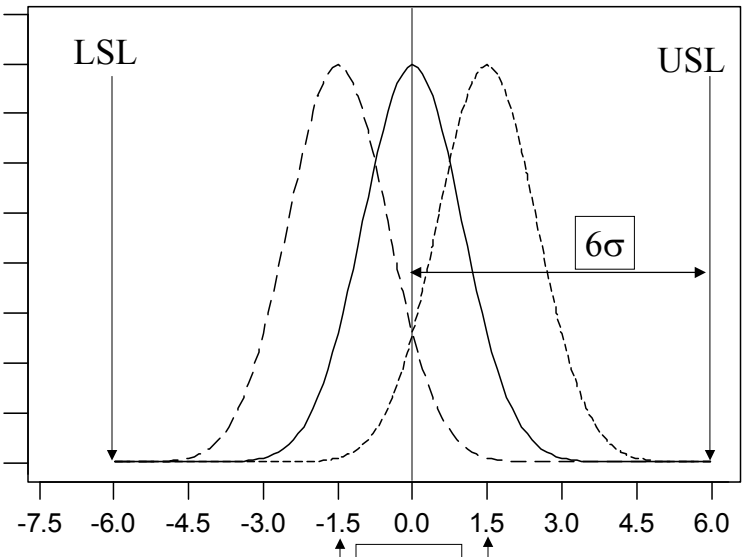
A Sigma Process



See Appendix for details

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Universal Applicability

- Methods and ideas are universally applicable:
  - Manufacturing
  - Service and hospitality industry
  - Banking and financial services
  - Business support processes
  - Software and hardware
  - Etc.

Quality Improvement

J. M. Juran: *"All quality improvement takes place project by project and in no other way!"*

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Project Selection: Prioritization Methods

- All projects MUST be Important!
- Two methods for prioritizing projects:
  1. Relating projects to the strategic initiatives / goals
  2. Relating projects to predetermined criteria
- First prioritize projects based on their impact across all initiatives
- Second prioritize projects based on their expected impact on key business metrics

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Organization

Leadership:

- Champions
- Master Black Belts/consultant (MBB)
- Black Belts (BB)
- Green Belts (GB)

Key to Success: Select successful people, Not just "warm bodies"!!!

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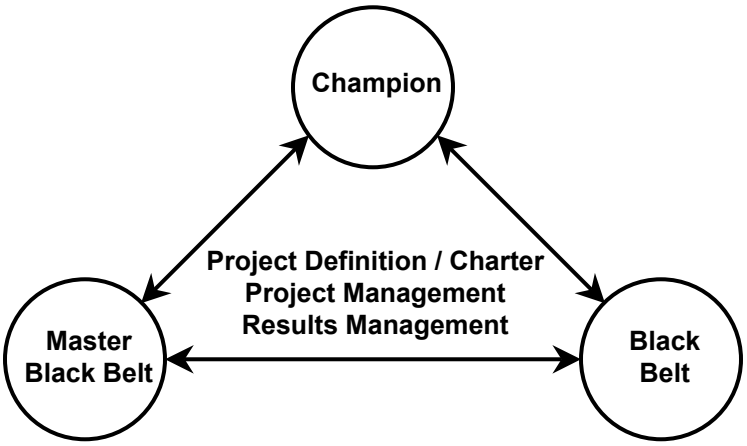
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

The Guiding Coalition



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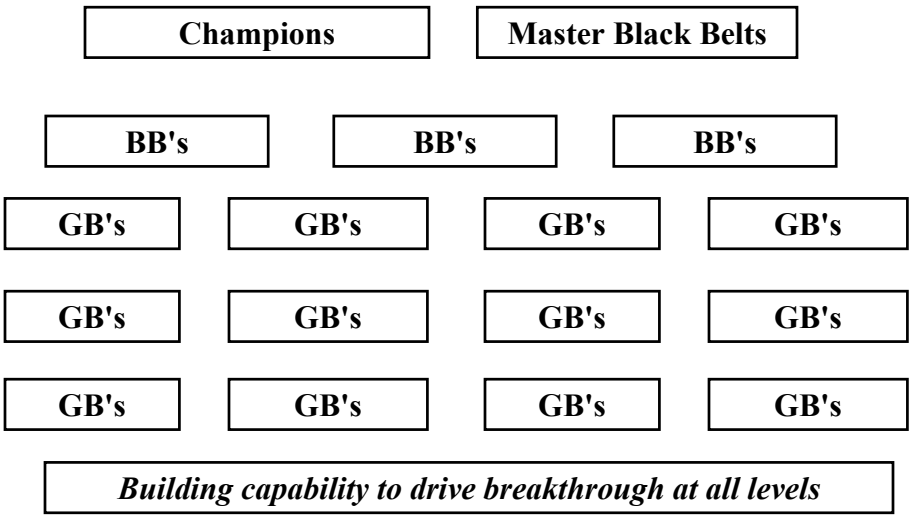
Organizational Structure:



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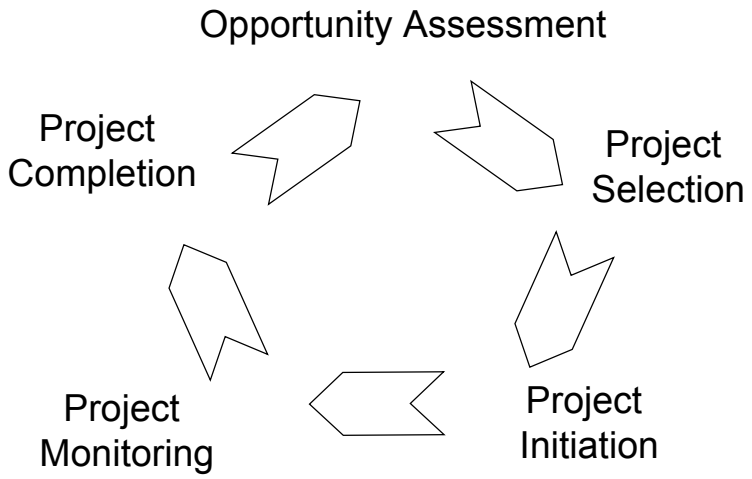
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Deploying Six Sigma: A Project Based Improvement Approach



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How to Get Started?

- Establish A Sense of Urgency
- Create a Guiding Coalition
- Evaluate strategic goals and "low hanging fruit" opportunities
- Develop team charters and select teams
- Just-in-time GB/BB training
- Manage projects for success: First wave *must* be a success
- Prepare for second wave …

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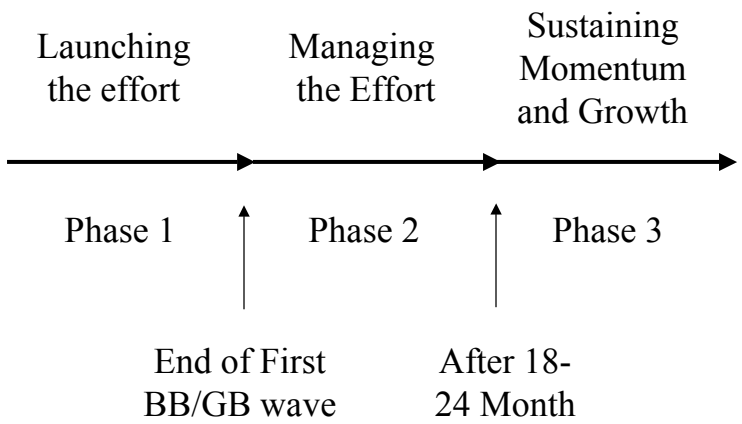
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Institutionalizing Six Sigma: *The Three Phases*



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Reasons for Success

- The Success at Motorola, GE and AlliedSignal has been attributed to:
  - Strong leadership (Jack Welch, Larry Bossidy and Bob Galvin personally involved)
  - Initial focus on operations
  - Aggressive project selection (potential savings in cost of poor quality > $50,000/year)
  - Training the right people

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Leadership Keys to Success: Summary

- The *Right* metrics
  - Productivity / Cycle time/ defects/Cost
  - Savings/Cash / Working Capital
- The *Right* projects
  - Metrics identify gaps in performance
  - Rigorously tracked and reviewed
- The *Right* people
  - Black Belts and Master Black Belts
  - Leaders and Champions
- The *Right* roadmap and tools
  - Step-by-step
  - Plan-train-apply-review format
- The *Right* support
  - Deployment roadmap
  - Infrastructure development

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Six Sigma: A Management Program for Competitive Advantage

- Six Sigma is not a set of statistical tools! It is a comprehensive management system!
- The system include: Road maps, project management, leadership roles, organization, change management, resistance to change, …
- Different from traditional TQM, ISO 9000, and EFQM
- Focused on innovation, cost reduction, streamlining, operational efficiency

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Conclusion

- Six Sigma: A disciplined approach
- Alignment of strategy, process and people to produce a leadership position in the market place
- Focus on significant measurable financial results
- Six Sigma provides powerful tools and methods to do the job. Large scale deployment of quality and statistical tools
- Data based, quantitative
- Results first — culture change will follow!
- Strong leadership: the key to success!

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Overview of the Rest of the Program

1. Introduction: What is Six Sigma? Done ✓
2. Assessment of readiness for Six Sigma
3. Organization for Six Sigma
4. Change management
5. Project management: Monitoring the effectives of your Six Sigma program
6. Early Wins: Case studies
7. Transition to Process Management
8. Alignment of Six Sigma with Strategy — Sustaining Success

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Appendix: What is Six Sigma Technically Speaking?

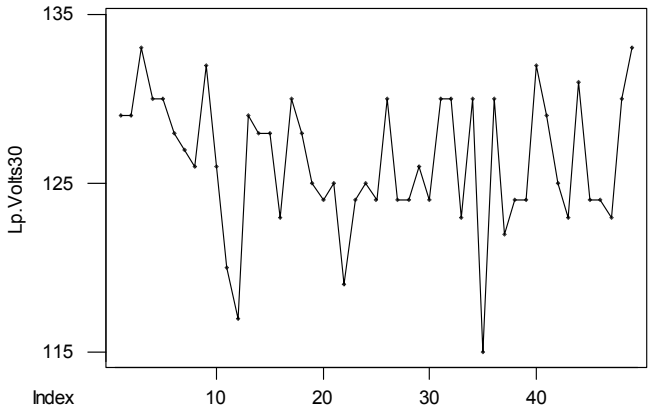
You don't really need to know these details to benefit from Six Sigma, but just in case you are curious…

Example: Voltage Readings

- Lamp study
- 49 observations
- Quality Characteristic: lamp voltages
- Data file:`ArcTubeVoltsCapability.MTW`
- LSL = 120
- USL = 135
- Note: these specifications are made up for illustrative purpose only

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Time Series Plot of the Data



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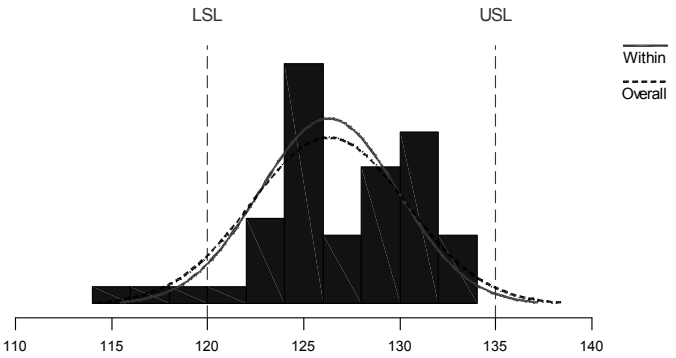
Process Capability Analysis for Lp.Volts30



Process Data	
USL	135.000
Target	*
LSL	120.000
Mean	126.306
Sample N	49
StDev (Within)	3.61998
StDev (Overall)	4.02719

Potential (Within) Capability	
Cp	0.69
CPU	0.80
CPL	0.58
Cpk	0.58
Cpm	*

Overall Capability	
Pp	0.62
PPU	0.72
PPL	0.52
Ppk	0.52

Observed Performance	
PPM < LSL	61224.49
PPM > USL	0.00
PPM Total	61224.49

Exp. "Within" Performance	
PPM < LSL	40751.23
PPM > USL	8160.90
PPM Total	48912.13

Exp. "Overall" Performance	
PPM < LSL	58687.38
PPM > USL	15432.94
PPM Total	74120.32

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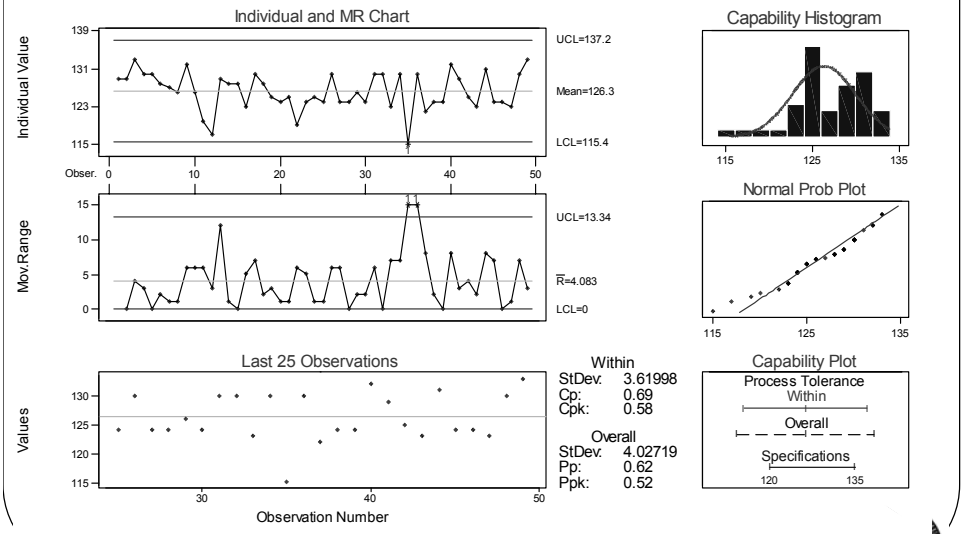
Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Process Capability Sixpack for Lp.Volts30



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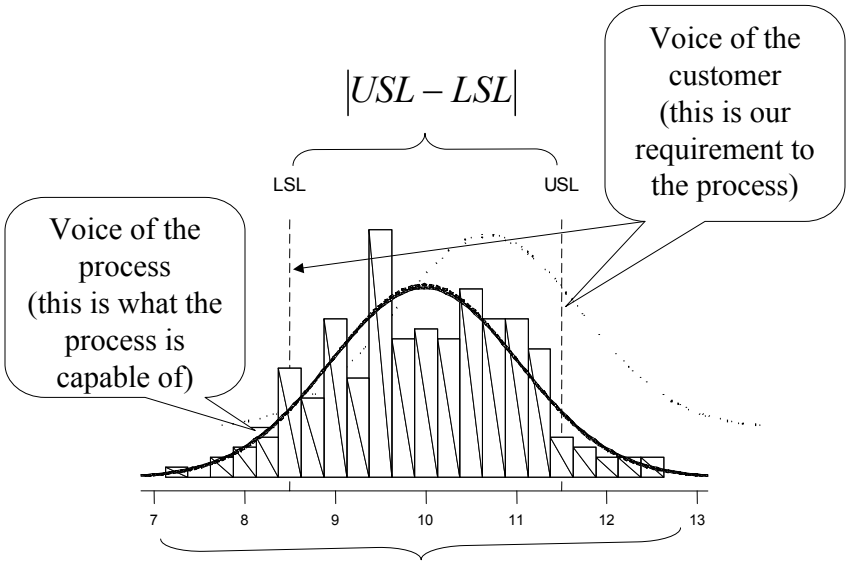

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Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu

Definition of Capability Index

$$C_p = \frac{|USL - LSL|}{6\sigma}$$

A Six Sigma Process: a $C_p = 2$

Six Sigma Concept of Process Capability

- For some processes, shifts in the process average sometimes occur
- Experience indicate that shifts in the mean of up to ±1.5σ are not unusual
- To allow for such shifts high values of C_p are needed
- If specification limits are ±6σ and if a shift in the mean of ±1.5σ occur (see next slide) then 3.4 parts per million will be outside the specification limits
- This is what Motorola defined as Six Sigma quality

Professor Søren Bisgaard
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University Massachusetts-Amherst
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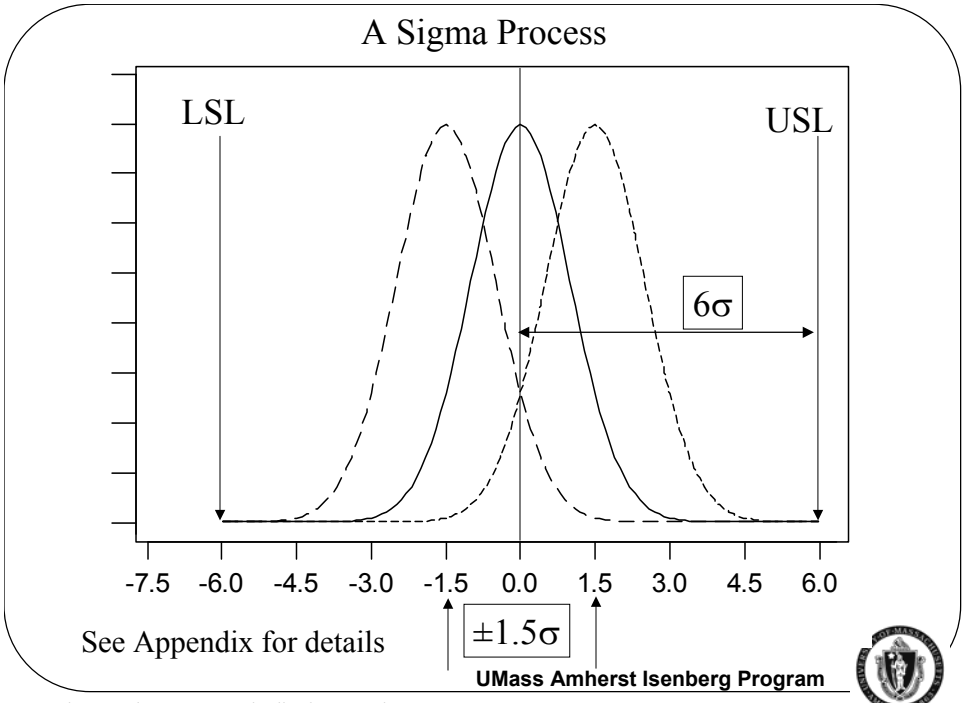

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Sigma Levels and Defects Levels

	Centered Process		Shifted Process	
Sigma	C_p	ppm	C_{pk}	ppm
3	1	2,700	0.5	66,803
4	1.33	63	0.833	6,200
5	1.67	0.57	1.167	233
6	2	0.002	1.5	3.4

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 1.62

Professor Søren Bisgaard
Isenberg School of Management
University Massachusetts-Amherst
Email: bisgaard@som.umass.edu