Lecture # 36

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Six Sigma

Six Sigma Defined: A quality discipline that focuses on product and service excellence to create a culture that demands perfection (on target, every time!)

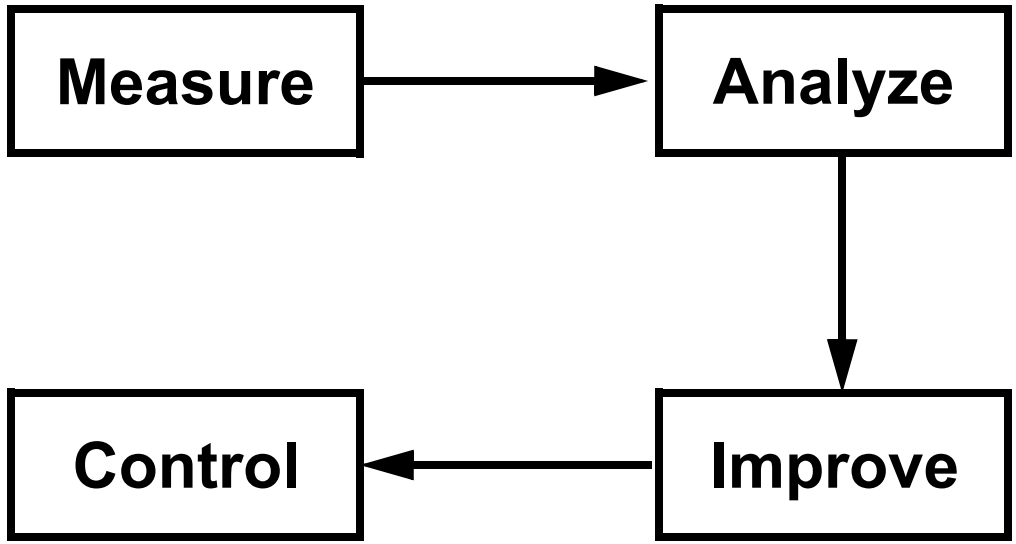
JWS comment: We will focus on what advocates of 6-sigma are saying and their point of view.

In many cases, the 6-sigma approach is no different from what we have discussed all semester.

Who is Using 6-Sigma as a Key Part of their Corporate Philosophy

Honeywell
Dupont
Dow Chemical
Ford Motor Co.
General Electric
Motorola
Raytheon
Sony
etc.

Steps of Six Sigma



Key Words

- Critical to Quality (CTQ)
- DMAIIC (Define, Measure, Analyze, Improve, Implement, Control)
- DFSS (Design for Six Sigma)
- DPMO (Defects Per Million Opportunities)
- Design of Experiments (DOE)
- Failure Mode Effects Analysis (FMEA)
- Gage Repeatability & Reproducibility (Gage R&R)
- Quality Function Deployment (QFD)
- Defect Per Unit (DPU)

Measurement System

Identify the CTQ's

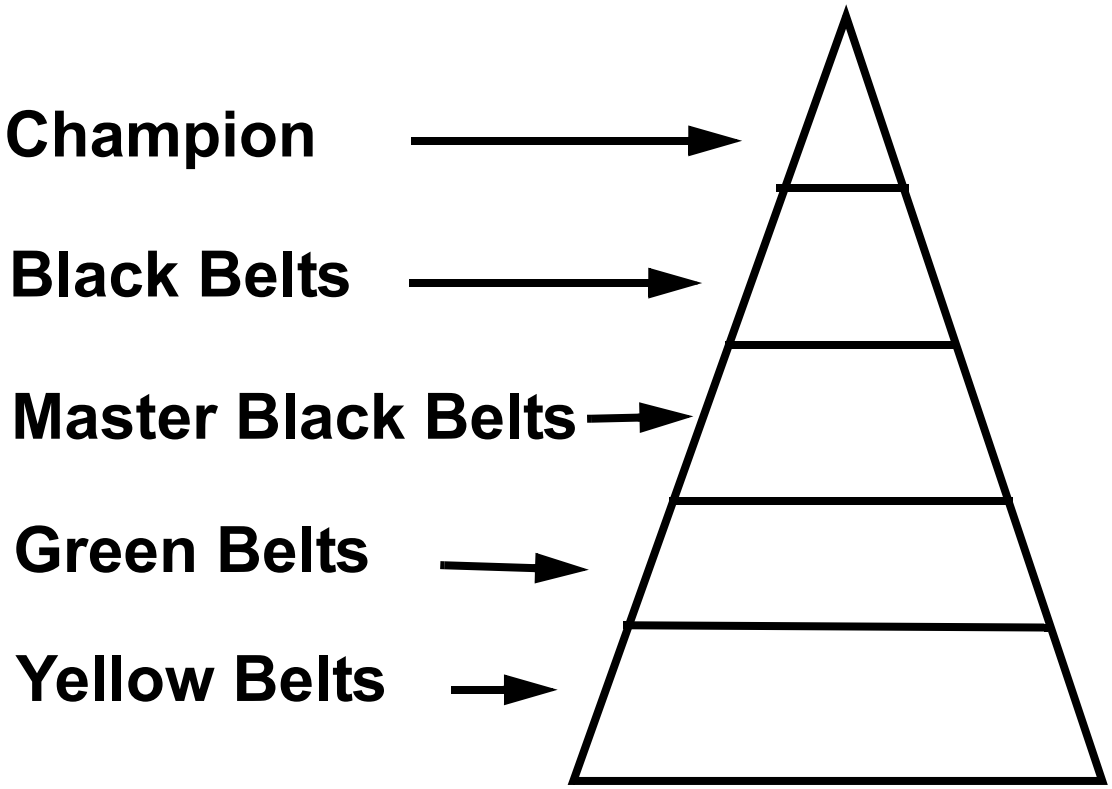
Define Defect Opportunities

Look for Defects in Products or Services

Arrive at DPMO

Convert DPMO to Sigma Level

Six Sigma Roles



Core Principles of Six Sigma

- **Focus on Customer Satisfaction**
- **Improve Profit through increased revenue and reduced costs**
- **Improve Performance Project-by-Project**

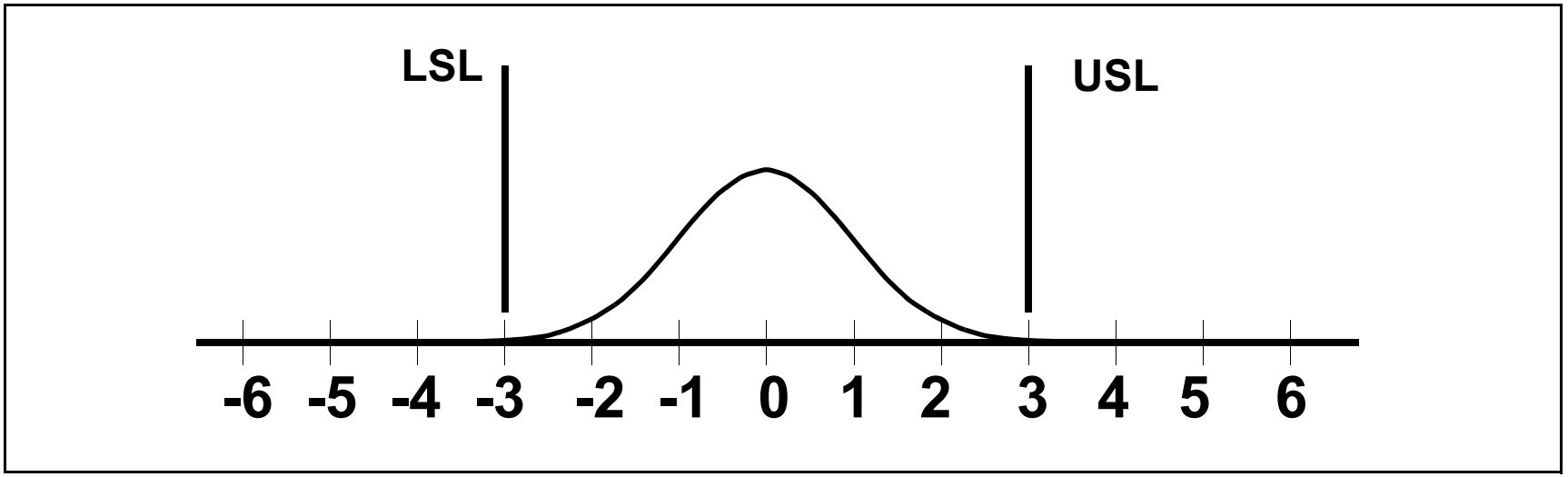
Prioritize:

- **projects based on their impact on business**
- **defects/errors based on what matters most to customer and their impact on the cost structure of the product or service**

Core Principles of Six Sigma (Cont.)

- Manage the Organization as a system of connected processes
- Apply PDCA approach: Plan-Do-Check-Act
- Pursue near perfection
- Use the full range of statistical tools that are available for analyzing and solving problems
- Respect and build upon knowledge, experience and dedication of people throughout the organization

Quick Review



We know that common cause variation produces "natural tolerances" of ± 3σ. This is a capability of 99.73%. About 3 parts in 1000 will fall outside the specifications.

Interpreting Capability

Is 99.73% capability good enough? 3 bad parts out of 1000 -- isn't this ok?

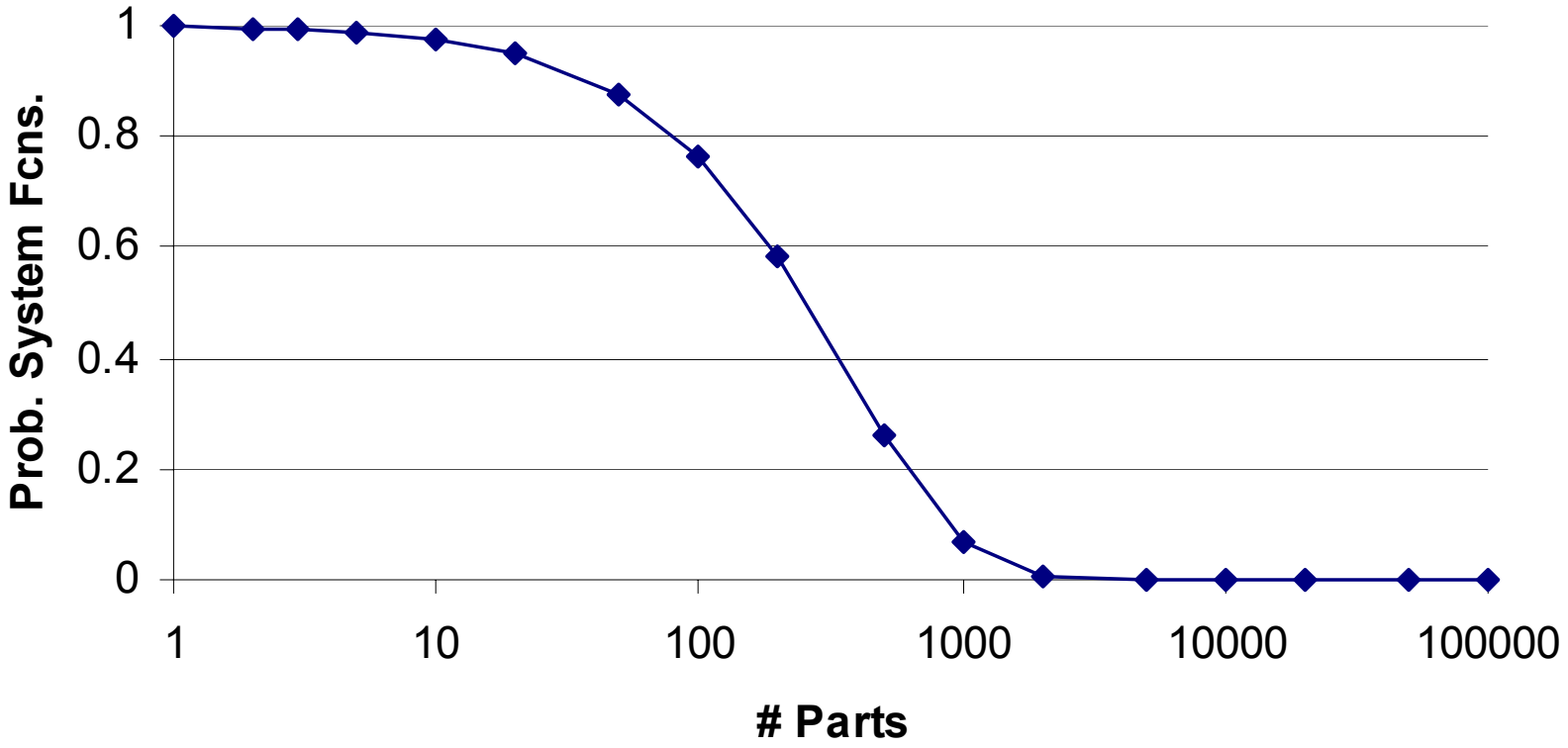
Consider a product with multiple parts -- all parts must work for product to function.

For a Series System

$$R_{system} = \prod_{i=1}^{n} R_i$$ **(Product Law of Reliabilities)**

where n is the number of components.

Interpreting Capability

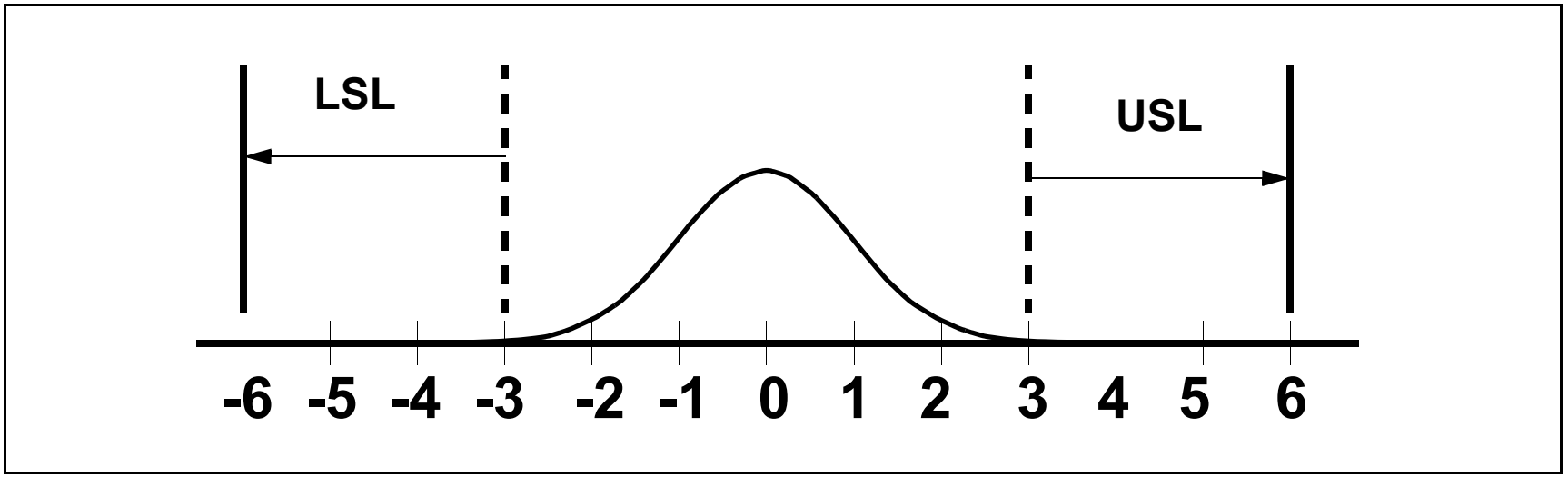


Overall product quality is really bad (individual capability is 99.73%) as number of products gets greater than 20.

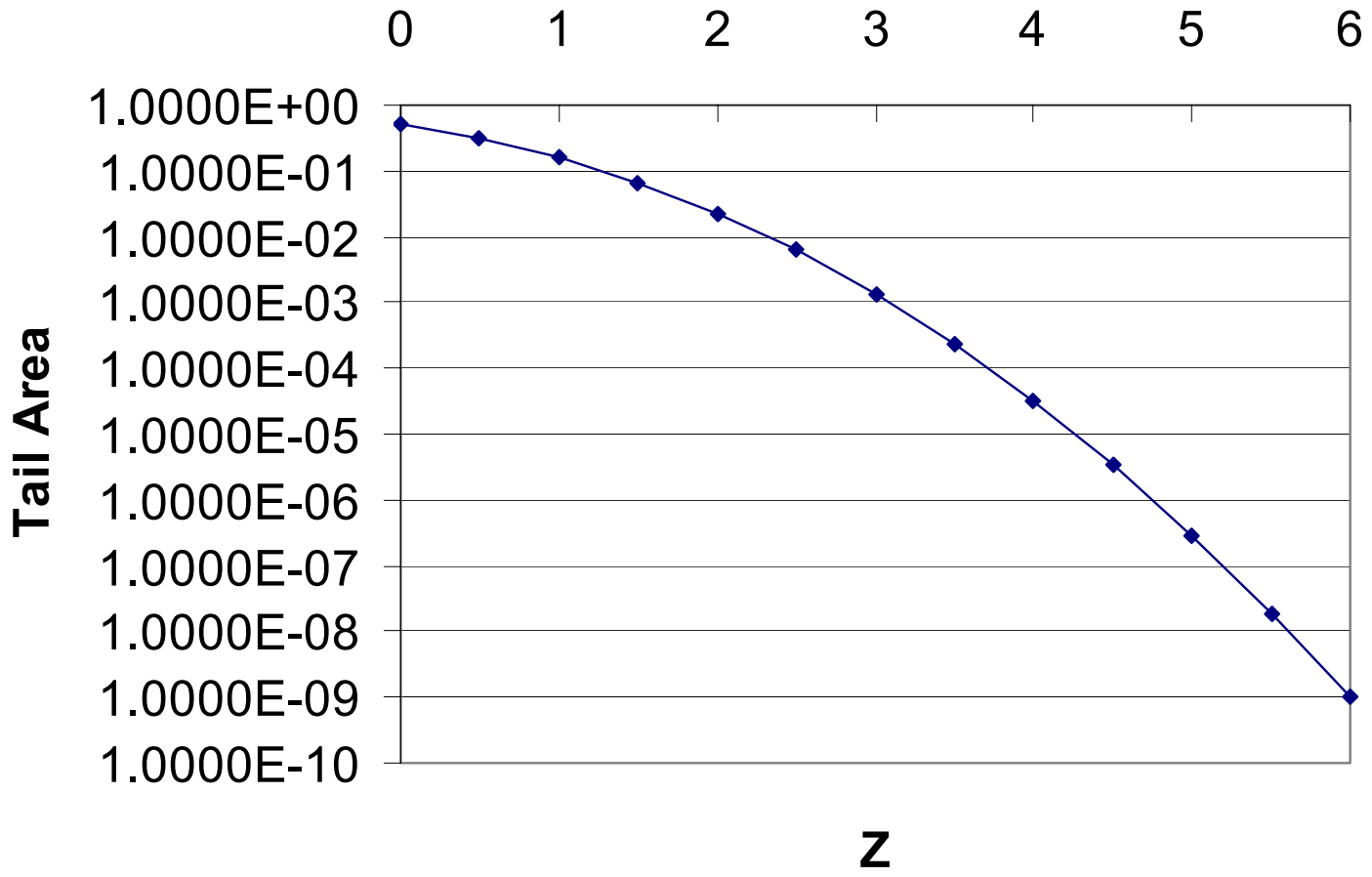
Moving Beyond ±3σ

So if our products contains anything more than just a few parts, then ±3σ (99.73%) just isn't good enough.

We need to consider higher capabilities for ind. parts



Capability Behavior

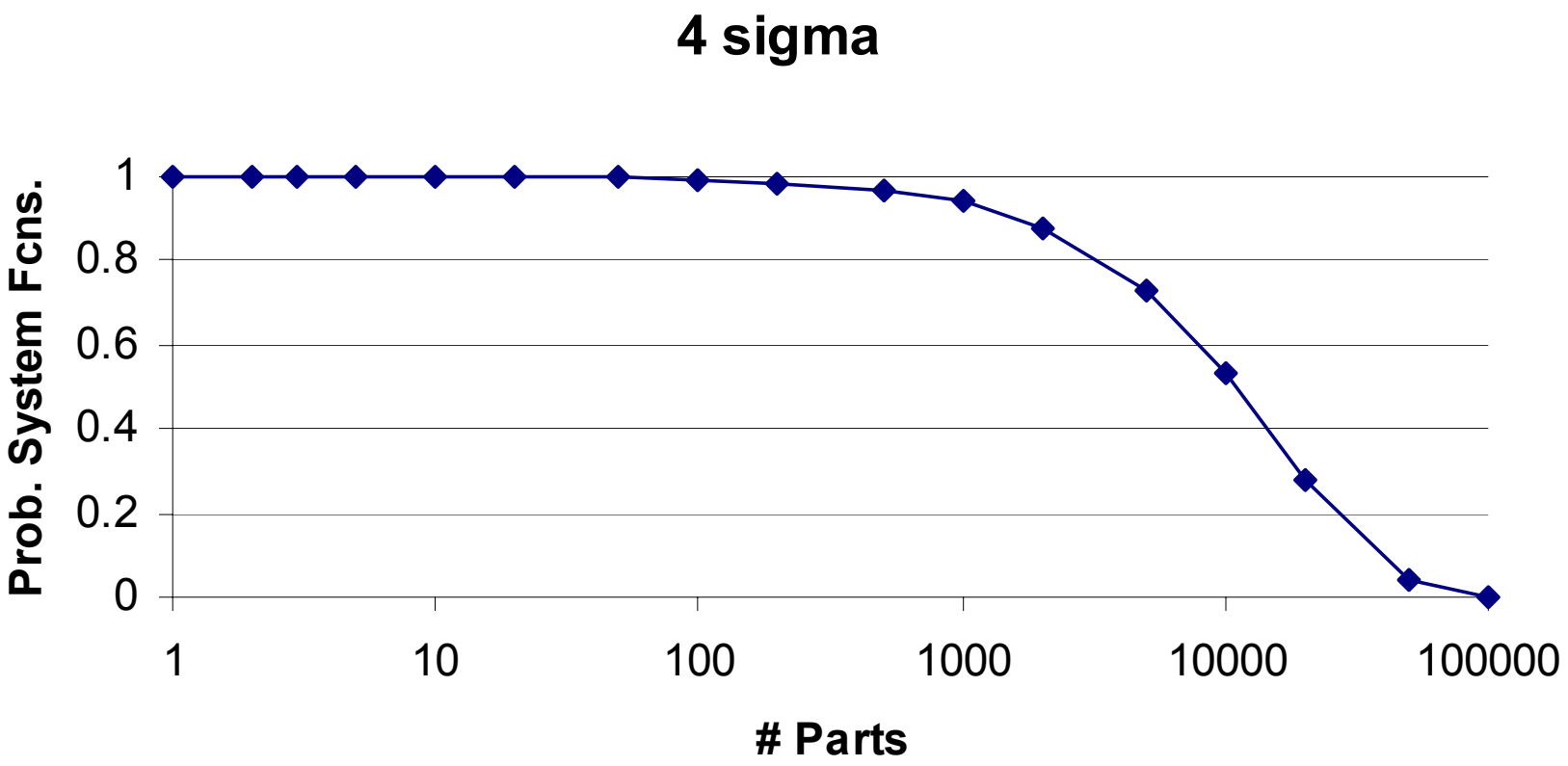


Capability Behavior

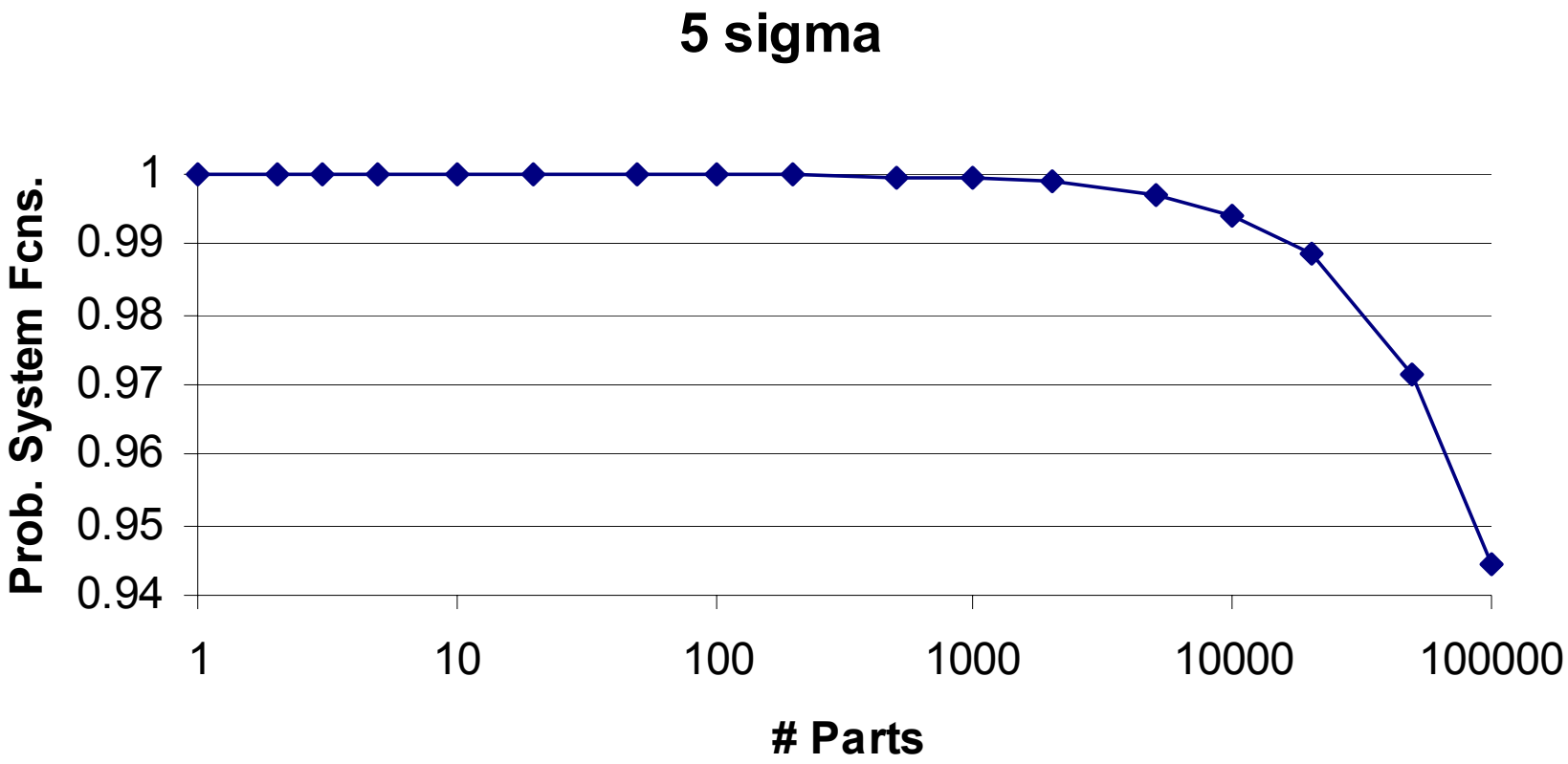
Z	Capability	~ Defective
1	68.26894805%	3/10
1.5	86.63855424%	15/100
2	95.44998759%	5/100
2.5	98.75806403%	1/100
3	99.73000656%	3/1000
3.5	99.95346533%	5/10000
4	99.99366279%	60 ppm
4.5	99.99931984%	7 ppm
5	99.99994258%	600 ppb
5.5	99.99999619%	40 ppb
6	99.99999980%	2 ppb

*** Numbers from EXCEL**

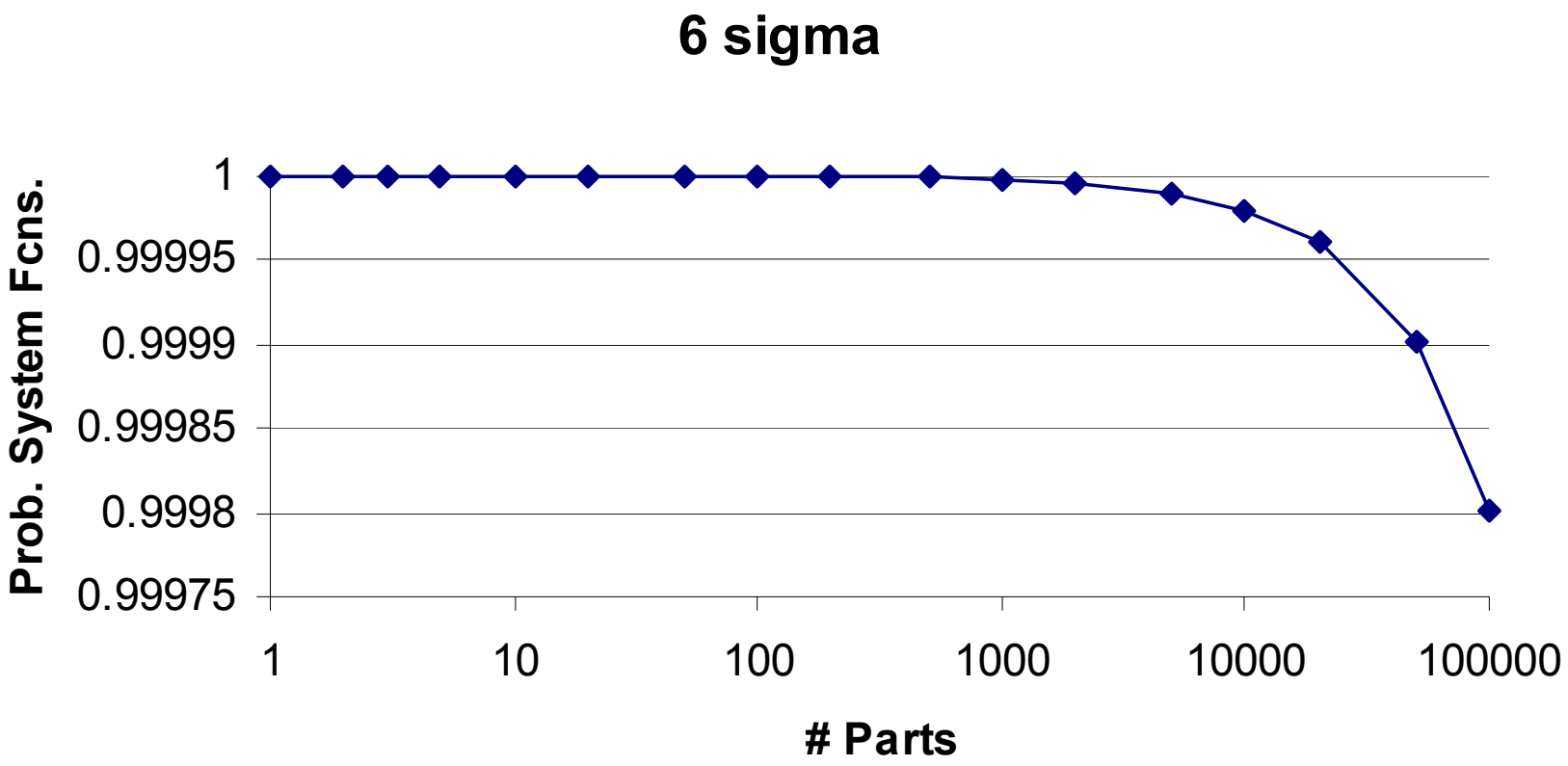
Effect of Capability on System Qual.



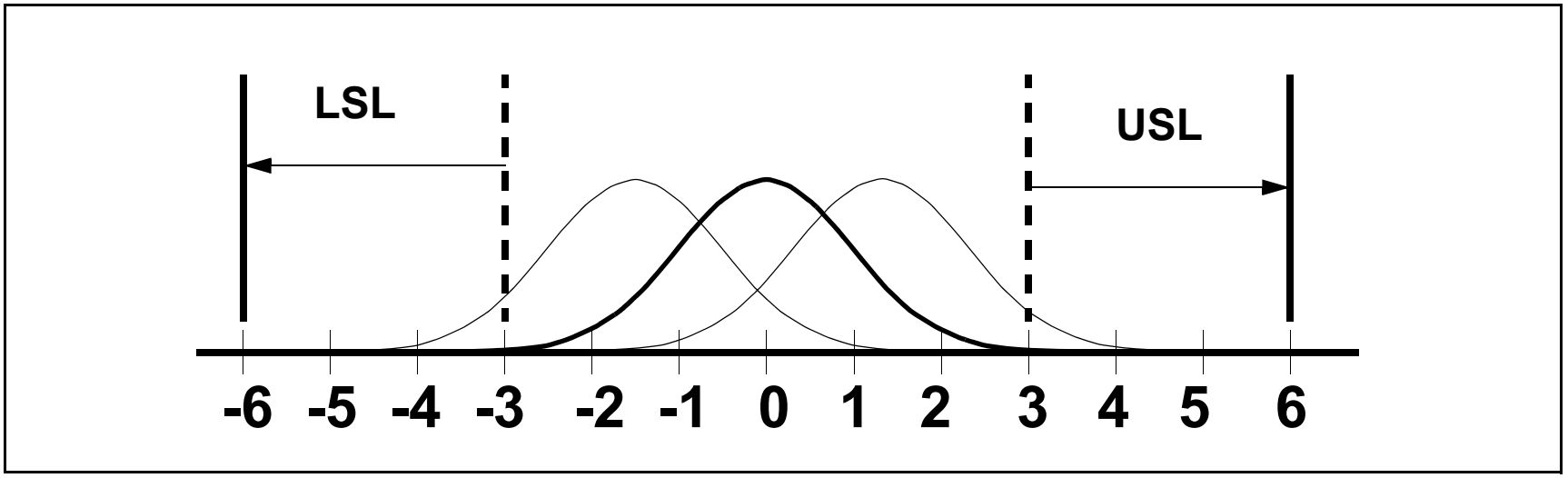
Effect of Capability on System Qual.



Effect of Capability on System Qual.



Robustness to Process Problems



If process mean shifts ± 1.5σ, process closest spec remains 4.5σ away

Resulting system capability is still pretty good: ~3ppm