

w1.1- What is Quality - Origins of Six Sigma - David Cook

What is Quality - SixSigmaIntro

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# WHAT IS QUALITY?

DAVID COOK

Kennesaw State University  
it can mean any number of things.

00:00:07 / 00:05:21 60

This image shows a video player window titled "What is Quality - SixSigmaIntro". The main video frame features a man in a yellow button-down shirt gesturing with his hands while speaking. To his right, the words "WHAT IS QUALITY?" are displayed in large, bold, blue capital letters. Below the video frame, a dark blue bar contains the name "DAVID COOK" in white capital letters. Underneath this bar, another dark blue bar displays "Kennesaw State University" and the phrase "it can mean any number of things." in white text. At the bottom of the window, there is a progress bar showing the video has been played for 7 seconds out of a total duration of 5 minutes and 21 seconds, with a frame rate of 60. The overall background of the video frame is light blue.

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**QUALITY:**

"the conformance to requirements  
realized through prevention  
& reduction of defects  
& nonconformances"

PHILIP CROSBY

"the conformance to requirements realized through

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**QUALITY:**  
**"DO IT RIGHT  
THE FIRST TIME!"**

**PHILIP CROSBY**

In essence, do it right the first time.

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SIX SIGMA

LEAN

Six Sigma is both a quality management philosophy

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**SIX SIGMA**  
a quality management philosophy  
and a methodology that focuses  
**on reducing variation, measuring**  
defects, and improving **the quality**  
of products, processes and services

**LEAN**  
**to maximize customer value**  
while minimizing waste

to maximize customer value while minimizing waste.

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# EVOLUTION OF SIX SIGMA

The diagram shows a sequence of four black silhouettes of humans, representing evolutionary stages, set against a light blue background. The first silhouette on the left is labeled 'Statistical Process Control' with a curved arrow pointing to it. The second silhouette is labeled 'Business Process Reengineering'. The third silhouette is labeled 'Total Quality Management (TQM)'. The fourth silhouette on the right is labeled 'Six Sigma'. A thin black line connects the text labels to their corresponding silhouettes.

Silhouette image used under license from <http://www.silhouettes.com> - right - bryanwright5

TQM grew into the methodology we know as Six Sigma.

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the forward production system,  
Image used under Creative Commons "Attribution" license. "Ford Assembly Line" by wikipedia  
was used to assemble cars.

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# LEAN & SIX SIGMA TOOLS

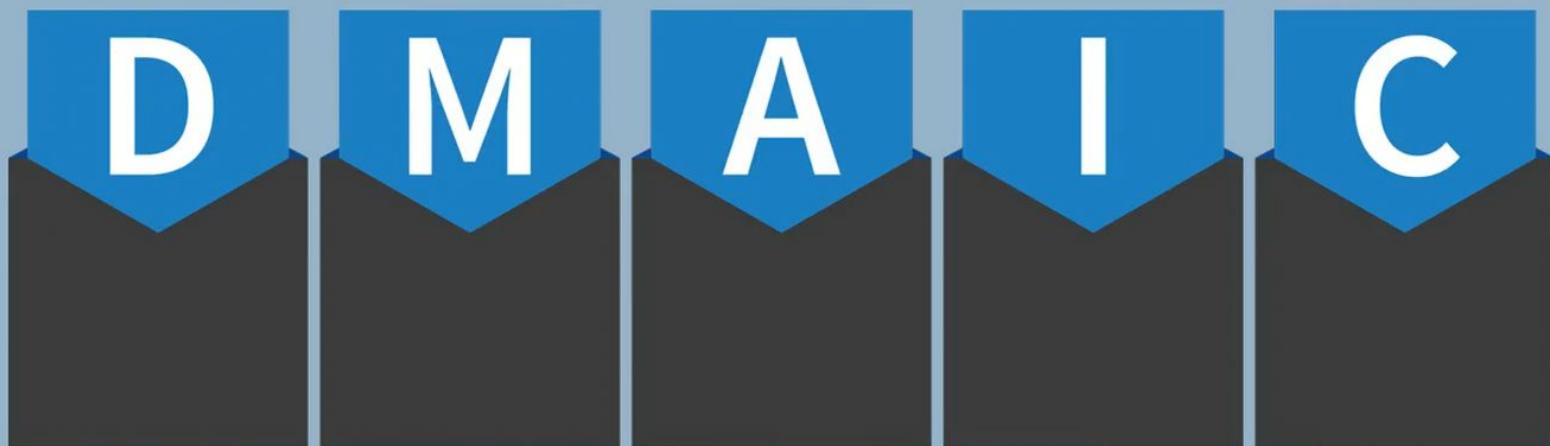
- > Eliminate waste and excess cost
- > Reduce variation and defects
- > Improve our processes and customer experience

Using Lean and Six Sigma tools,

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The DMAIC process is represented by five blue chevron-shaped boxes arranged horizontally. Each box contains a large white capital letter: D, M, A, I, and C. The boxes are set against a dark grey background.

The Six Sigma methodology is grounded in a process known as DMAIC.

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D M A I C

DEFINE MEASURE ANALYSE IMPROVE CONTROL

Measure, Analyze, Improve and Control.

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# 99% DEFECT FREE



**200,000 WRONG PRESCRIPTIONS/YEAR**  
too short or long landings at  
major airports each day,

00:02:59 / 00:05:21

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# 99% DEFECT FREE

## 66,810 DEFECTS per 1 MILLION OPPORTUNITIES

This is 66,810 defects for  
every one million opportunities.

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# 99.99966% DEFECT FREE

## 3.4 DEFECTS per 1 MILLION OPPORTUNITIES

This is 3.4 defects

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## Summary: What is Quality – Origins of Six Sigma

This excerpt from David Cook's talk discusses the definition of **Quality**, the origins of the concepts of **Lean** and **Six Sigma**, and the core goals of the Six Sigma methodology.

### 1. Defining Quality

- **Quality** is described as "the conformance to requirements realized through **prevention** and **reduction of defects and nonconformances**" (per Crosby: "Do it right the first time").
- Fundamentally, quality means serving the **needs of our customers** well.

## 2. Lean and Six Sigma

- The two most comprehensive and prevalent quality management philosophies are **Lean** and **Six Sigma**, which are meant to complement each other.
- **Six Sigma** is a philosophy and methodology that focuses on **reducing variation**, measuring defects, and improving the quality of products, processes, and services.
- **Lean's** purpose is to **maximize customer value** while minimizing **waste**.

### 3. Origins and Methodology

- Six Sigma evolved from **statistical process control** through business process re-engineering into the process improvement philosophy known as **Total Quality Management (TQM)**.
- Lean traces its origins to early productivity improvements (like the Ford production system), which served as the basis for the **Toyota Production System** and its **Just-In-Time** philosophy.
- The core methodology of Six Sigma is the **DMAIC process**, which stands for **Define, Measure, Analyze, Improve**, and **Control**.
- DMAIC requires a change in thinking: instead of being **problem-driven** (reactive), we need to be **customer-driven** (preventative).

#### 4. The Goal of Six Sigma (99.99966% Defect-Free)

The speaker illustrates the dramatic difference between a "good" 99% defect-free goal and the Six Sigma goal:

Quality Level	Defects per 1 Million Opportunities	Example (Consequence)
<b>3-Sigma (99% defect-free)</b>	<b>66,810</b>	200,000 wrong drug prescriptions per year; 5,000 incorrect surgical procedures every week.
<b>Six Sigma (99.99966% defect-free)</b>	<b>3.4</b>	68 wrong drug prescriptions per year; 1.7 incorrect surgical procedures every week.

## w1.2- Six Sigma Foundations and Principles

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# What is Six Sigma

- An improvement method that aims to eliminate variation and defects in a wide array of processes. These reductions are realized through a focused effort on outputs critical to the customer, leading to a financial gain for the organization
- Grounded in the goal of 3.4 defects for every 1 million opportunities
- Pioneered by Motorola in the 1980's and embraced heavily by General Electric in the 1990's

In Juran's Trilogy, this falls in the third part, quality improvement.

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# Quality Framework of Six Sigma

- Unlike TQ, which is worker empowered, Six Sigma is owned **at the business leader champion** level of the organization.
- TQ is confined to functions or processes within the organization. Six Sigma seeks a broader cross **functional deployment**

TQ stands for total quality.

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## Overview of Six Sigma Definition

Six Sigma is both a **quality management** philosophy and a methodology that focuses on **reducing variation**, measuring **defects**, and improving quality of products, processes and services.

measuring defects and improving quality of products, processes and services.

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## Overview of Six Sigma

Event	Time	Impact	Era
Motorola Pioneered	Early 80's	A systematic approach to solving complex part and process problems and the launch of an effective process improvement	Goal

The beginnings of Six Sigma can be traced to Motorola.

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## Overview of Six Sigma

Six Sigma **evolves** from a “Quality Goal”  
to a **enterprise-wide** “strategy” for  
business management and improvement

an enterprise-wide strategy for  
business management and improvement.

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# Six Sigma Foundation

Bill Smith:

- Motorola – introduced six sigma as a measure of quality in 1986.
- Smith, with Mikel Harry developed the initial four-step six sigma stages: measure, analyze, improve, control to reduce defect levels.

Bill Smith with Mikel Harry developed the initial four step Six Sigma stages,

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# Six Sigma Foundation

## Mikel Harry

- Motorola
- With Richard Schroeder, founded Six Sigma Academy in 1994.
- Main architect of six sigma movement.

Mikel Harry with Richard Schroeder went on to found Six Sigma Academy in 1994.



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# Six Sigma Foundation

## Crosby's Four Absolutes

1. The definition of quality is *conformance to requirements.*
2. The system of quality is prevention.
3. The performance standard **is zero defects** (close to Six Sigma).
4. The measurement of quality is the price of **nonconformance.**

“Do it right the first time.”

traced to a group of highly knowledgeable individuals in quality.



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# Six Sigma Foundation

## Deming's 14 Points:

1. Create constancy of purpose toward improvement of product and service. Innovate, allocate resources **to long-term planning**. Put resources into research and education.
2. **Adopt the new philosophy**. Do not tolerate commonly accepted levels of errors and defects.

Dr. Deming is another quality guru who has made



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# Six Sigma Foundation

## Deming's 14 Points:

3. Cease dependence on mass inspection to achieve quality. Inspection does not improve quality.  
**Quality is built into a product** and cannot be inspected into it.
4. End the practice of awarding business on the basis of price tag alone. **Minimize total cost** by working with a single supplier.

Deming also strongly opposed inspecting quality in the product,



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# Six Sigma Foundation

## Deming's 14 Points:

5. Improve constantly and forever every process for planning, production, and service. Continually improve test methods and identify problems, from the very first planning stages right up to distribution to customers.
6. Institute training on the job. In Japan, managers start their careers with a long internship. They work in procurement, accounting, distribution, and sales.

continual improvement at a time when most industries looked to



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# Six Sigma Foundation

## Deming's 14 Points:

7. Adopt and institute leadership. The job of  
**management is not supervision**, but leadership.
8. Drive out fear. No one can perform unless he or  
she feels secure.

Deming also points to the difference  
between supervision and leadership,

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# Six Sigma Foundation

## Deming's 14 Points:

9. Break down barriers between staff areas. Create teams of members coming from all areas and sectors of the business to prevent and solve problems.
10. Eliminate slogans, exhortations, and targets for the workforce. Posters and slogans have never helped anyone to do a better job.

Dr. Deming also believed in keeping the message simple in the organization,



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# Six Sigma Foundation

## Deming's 14 Points:

11. Eliminate numerical quotas for the workforce and numerical goals for management.
12. Remove barriers that rob people of the pride of workmanship. Eliminate the annual rating or merit system.

numerical quotas for the workforce or numerical goals for the management.

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# Six Sigma Foundation

## Deming's 14 Points:

13. Institute a **vigorous program of education** and self-improvement for everyone.
14. Put everyone in the company to work to accomplish the transformation.

Finally, in line with his ideas of continuous improvement,

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# Six Sigma Foundation

## Dr. Genichi Taguchi

- Father of Quality Engineering
- Loss Function
- Robust Design

Taguchi was another quality guru who recognized the importance of

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# Six Sigma Foundation

Feigenbaum's Total Quality Control:

- *Total control of quality and control of total quality*
- **Apply quality to all stages** from design to delivery
- Share quality responsibilities among functions
- Quality is not only the manufacture of a product

Feigenbaum had some similar yet distinct insights

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# Six Sigma Foundation

Total Quality Control:

- ... is an effective system for integrating the **quality-development**, quality-maintenance, and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow for full customer satisfaction.

» Feigenbaum (1991)

In summation, Feigenbaum characterized



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# Six Sigma Foundation

Dr. Kaoro Ishikawa

- Known for Cause & Effect or Ishikawa Diagram

Other contributions found in various stages  
of the Six Sigma process come from Ishikawa,



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# Six Sigma Foundation

## Dr. Walter Shewhart

- Assignable and Chance causes
- Statistical Process Control
- PDCA

Once we have established the causes,

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# Six Sigma Foundation

## Juran's Trilogy

- Quality Planning
- Quality Control
- Quality Improvement

Another luminary in quality circles is Juran.



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## Six Sigma Foundations and Principles Summary

The provided transcript outlines the **Six Sigma** methodology, its relationship with **Total Quality (TQ)**, and the key contributions from major quality gurus who shaped its foundation.

### 1. Six Sigma as a Process Improvement Approach

- **Definition and Focus:** Six Sigma is a focused, five-step process improvement approach that falls under the **Quality Improvement** part of **Juran's Trilogy** (though it can also be part of Quality Planning).
- **Methodology:** It heavily relies on **statistical methods** and uses the **DMAIC** model (Define, Measure, Analyze, Improve, Control) to structure improvement projects.
- **Core Goal:** Six Sigma focuses on **reducing variation**, measuring defects, and improving the quality of high-level, **cross-functional processes**.
- **Origin:** The concept originated at **Motorola** in the early '80s and was introduced as a quality measure in 1986. **Mikel Harry** is considered the main architect of the Six Sigma movement.

## 2. Six Sigma vs. Total Quality (TQ)

The transcript compares Six Sigma with **Total Quality (TQ)**, which reflects **Deming's ideas** and the **Malcolm Baldrige criteria**. While the approaches differ, they work well together.

Feature	Total Quality (TQ)	Six Sigma
Focus	Culture change, empowering workers and teams.	High-level <b>cross-functional processes</b> .
Improvement Location	Within departments or functions.	Across the organization, with upper management involvement.
Implementation	Generally uses <b>simple tools</b> .	Relies on <b>experts</b> and complex statistical methods.
Goal	Broad improvement.	Outcomes measured in concrete company benefits (reducing variation/defects).

### 3. Contributions of Quality Gurus (Foundations)

The foundations of Six Sigma are built on the principles established by several key figures in quality management:

- **Philip Crosby:** Known for his **Four Absolutes for Quality**, which emphasize **conformance** to requirements and **prevention** of defects.
- **W. Edwards Deming:**
  - Famous for his **14 Points** for management, stressing **constancy of purpose** and continuous improvement.
  - Strongly opposed **inspecting quality into the product**, using **numerical quotas** for the workforce, and reliance on **merit systems** or annual ratings, which he felt created fear and inhibited collaboration.
  - Advocated for heavy investment in **education and self-improvement** of employees, viewing them as the most valuable asset.

- **Genichi Taguchi:** Recognized the importance of ensuring quality at the **engineering and design levels** of a process.
- **Armand V. Feigenbaum:** Characterized **Total Quality Control** as an effective system for integrating quality development, maintenance, and improvement at the most economical levels, extending quality efforts **beyond the manufacturing floor**.
- **Kaoru Ishikawa:** Contributed tools used in the analysis stage, such as the **Fishbone diagram** (Cause-and-Effect diagram) and the **Five Whys**.
- **Walter Shewhart:** Took the ideas forward by identifying **assignable and chance causes** of variation, which are monitored via **Statistical Process Control (SPC)** and confirmed through the **PDCA cycle** (Plan, Do, Check, Act).
- **Joseph M. Juran:** His most significant contribution is **Juran's Trilogy**, which divides quality management into three key areas: **Quality Planning, Quality Control, and Quality Improvement**.

### w1.3- Purpose of Six Sigma

w1.3- Purpose of Six Sigma.mp4

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## Key Concepts of Six Sigma

- Frame in terms of customer expectations and strategic business objectives.
- Sponsors drive change, cultivate resources, and champion projects.
- Based on quantifiable measures that can be traced back to how well the business serves its customers.

things that are of high importance to the organization.

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## Key Concepts of Six Sigma

- Metrics identified early and aligned with the aims of the business while incentivizing and maintaining accountability
- Accompanied by training and team deployment practices
- Utilizes Green Belts, Black Belts and Master Black Belts to execute various measurement, analysis, improvement and control tools.

Six Sigma also emphasizes

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## Key Concepts of Six Sigma

**Change**  
**Leadership Process**  
The PEOPLE PROCESS

**LEAN**  
ELIMINATES WASTE

**Six Sigma**  
REDUCES VARIATION

**Project Management**  
ENSURES SUCCESS

All tool drawers and the tools inside are very complementary. **Six Sigma and Lean serve as**

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## Critical Success Factors

### Lean Six Sigma

- Embraced at all levels of the organization
- Strong customer focus and welcome change
- Teamwork and training
- Strong systems, procedures, and infrastructure
  - Facilitating effective communication and collaboration
- Subject matter experts

In order for six  
Sigma and Lean to co



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## 6. Defect Levels and the 1.5 Sigma Shift

The difference in defect reporting is due to a specific factor used by Motorola to account for real-world process variation over time.

- This is true because **Motorola allowed for 1.5 sigma shift in the mean**. This shift accounts for the fact that a process mean tends to drift by up to 1.5 standard deviations in the long term, resulting in a higher defect rate (3.4 defects per million opportunities at 6 Sigma) than calculated for the short term.

## "1.5 sigma shift"

In Six Sigma methodology, the  $1.5\sigma$  shift is a **convention** (or adjustment) used to account for the fact that processes can and do change or **drift** over the long term.

- **Long-Term vs. Short-Term:** When a process is carefully measured over a short period (short-term), it appears to have a better performance (fewer defects) because it is stable and centered. However, over a longer period (long-term), the process mean ( $\mu$ ) is observed to drift away from the target, leading to more defects.
- **Accounting for Drift:** The  $1.5\sigma$  shift is a safety factor. Instead of using the measured short-term standard deviation ( $\sigma$ ) directly to calculate the defect rate, Six Sigma practitioners assume the process mean will shift by **1.5** standard deviations away from the target over time.

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## Six Sigma PPM

Sigma Level	PPM
$6\sigma$	3.4 PPM
$5\sigma$	233 PPM
$4\sigma$	6,210 PPM
$3\sigma$	66,810 PPM
$2\sigma$	308,770 PPM
$1\sigma$	691,462 PPM

In terms of Sigma level,

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## Six Sigma PPM

Sigma Level	Yield (%)
6σ	99.99966
5σ	99.977
4σ	99.38
3σ	93.3
2σ	69.1
1σ	30.9

As defect reduction improves,

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## Purpose of Six Sigma

The core purpose of Six Sigma is to serve as a strategic process improvement mechanism that drives meaningful change within an organization.

### Key Focus Areas and Principles

- **Strategic Alignment:** Six Sigma projects must always focus on issues of **high importance** to the organization, making the approach **strategic**.
- **Management Support:** Projects require support from the **highest levels of management** and are typically driven in a **top-down** manner, though project initiation can occur at any level.
- **Quantification and Metrics:** There is a heavy emphasis on **planning the project** and **quantifying the results**. **Metrics** are essential for tracking the project's impact and the health of the process being measured.
- **Personnel and Expertise:** The methodology relies on the existence of **highly skilled process improvement experts** (like Black Belts and Green Belts) to implement the changes.

## Critical Success Factors

For Six Sigma and Lean to coexist and successfully serve organizational interests, several factors must be present:

1. **Organizational Buy-in:** The value of the methodology must be **embraced at all levels** of the organization.
2. **Customer Focus & Change:** The organization must have a strong **customer focus** and be willing to **welcome change**.
3. **Teamwork and Training:** These are essential for project success.
4. **Strong Infrastructure:** Effective communication and collaboration require robust **systems, procedures, and infrastructure**.
5. **Subject Matter Experts (SMEs):** Experts in quality and Lean tools are needed to **analyze results** and devise effective means for measuring and quantifying improvement.

## Performance and Variation

The Six Sigma philosophy acknowledges that achieving 3.4 defects per one million opportunities (the true Six Sigma level) is difficult. However, substantial rewards can be realized through intermediate gains.

- **Sigma Shift:** When comparing short-term and long-term performance and variation, one should expect to see a 1.5 Sigma shift.
- **Defect Reduction:** Moving from one Sigma level to the next results in huge leaps in defect reduction and a corresponding improvement in percent yield.

## w1.4- Six Sigma Methodology

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# D M A I C

Define      Measure      Analyze      Improve      Control

measure, analyze,  
improve, and control.

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## Define Phase

- In the define phase, project goals are set and boundaries established. These are aligned with your organization's:
  - Business goals
  - Customer needs
  - The process that requires improvement

In the defined phase,  
project goals are set and



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# Measure Phase

- In the measure phase
  - We pinpoint the location or source of problems by building a factual understanding of existing process conditions.
  - We establish a baseline capability level

The measure phase establishes



# Analyze Phase

- In the measure phase, we produce a baseline performance of the process.
- The baseline assessment makes it possible to pinpoint the location or source of problems by building a factual understanding of existing process conditions and problems
- In the analyze phase, we develop theories of root causes, confirm theories with data, and identify the root causes of the problem.

Using the findings of  
the measure phase,



## Improve Phase

- In this phase, we are ready to develop, implement and evaluate solutions targeted at your verified cause.
- The goal is to demonstrate with data **that your solutions** solve the problem and lead to an improvement.

Now that we have  
ascertained the sources of



# Control Phase

- In the improve phase, the solution was piloted and plans made for full scale implementation.
- The control phase concentrates on ensuring the problem stays fixed. And the new methods can be further improved over time

The improvement phase is really



## Six Sigma Methodology: The DMAIC Model

The most common process methodology for Six Sigma is **DMAIC**, which is used primarily in manufacturing, service, and transactional settings. DMAIC is an acronym for five sequential phases: **Define, Measure, Analyze, Improve, and Control**.

### 1. Define Phase

- **Purpose:** To clearly outline the project's scope and objectives.
- **Key Action:** Set project goals and establish boundaries to ensure the project aligns with the organization's strategic aims.

## 2. Measure Phase

- **Purpose:** To establish a data baseline and understand the current process performance.
- **Key Action:** Establish the baseline and attempt to localize the "vital few Xs"—the primary factors or inputs driving the problems identified in the project.

## 3. Analyze Phase

- **Purpose:** To confirm the root causes of the problem using data.
- **Key Actions:**
  - Formulate conjectures (theories) about the root causes based on findings from the Measure phase.
  - **Confirm these theories** by collecting additional data.
  - **Crucial Step:** Ensure the process is **functioning as it should** before analyzing the problem; otherwise, the results may be invalid.

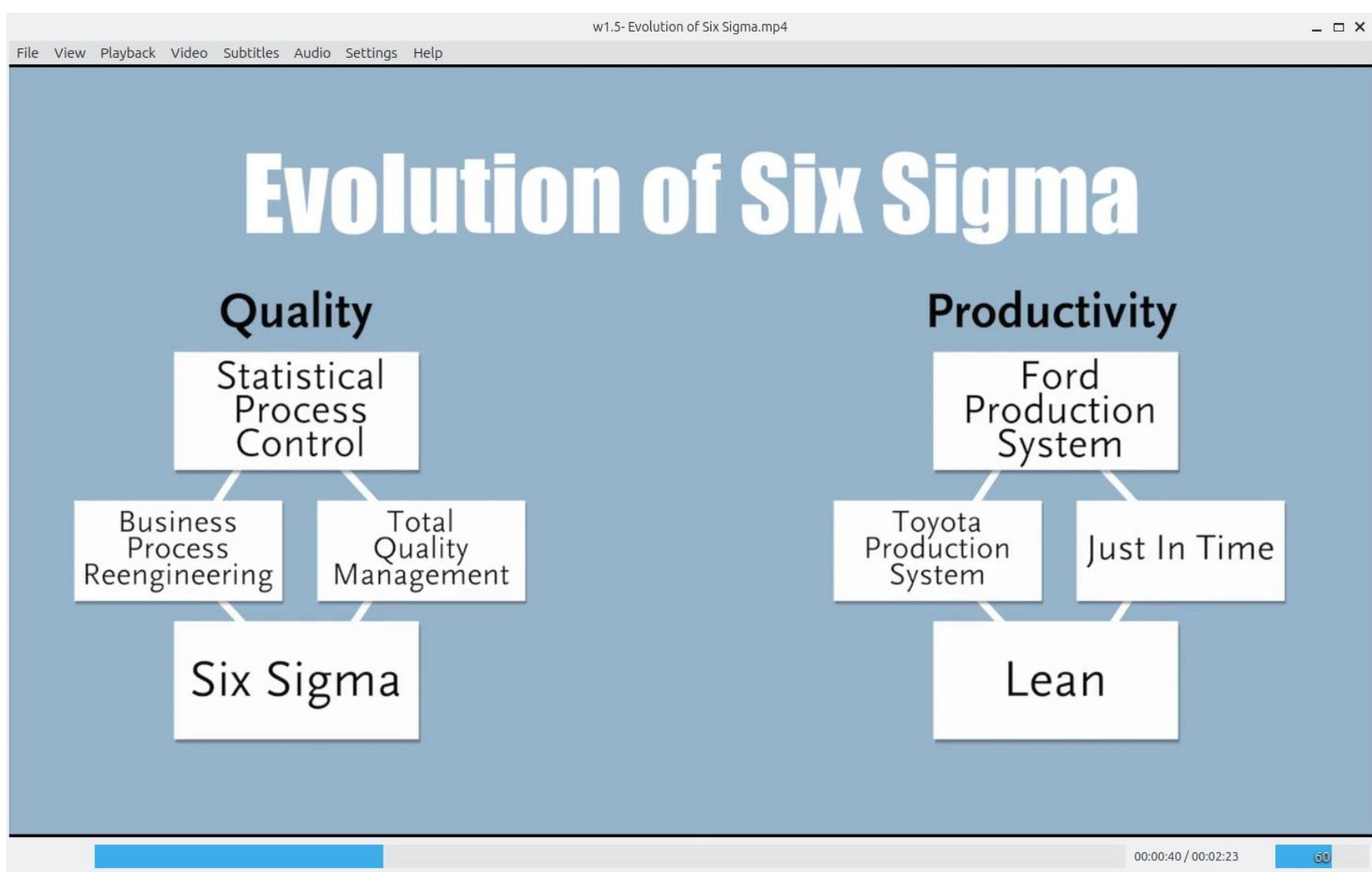
#### 4. Improve Phase

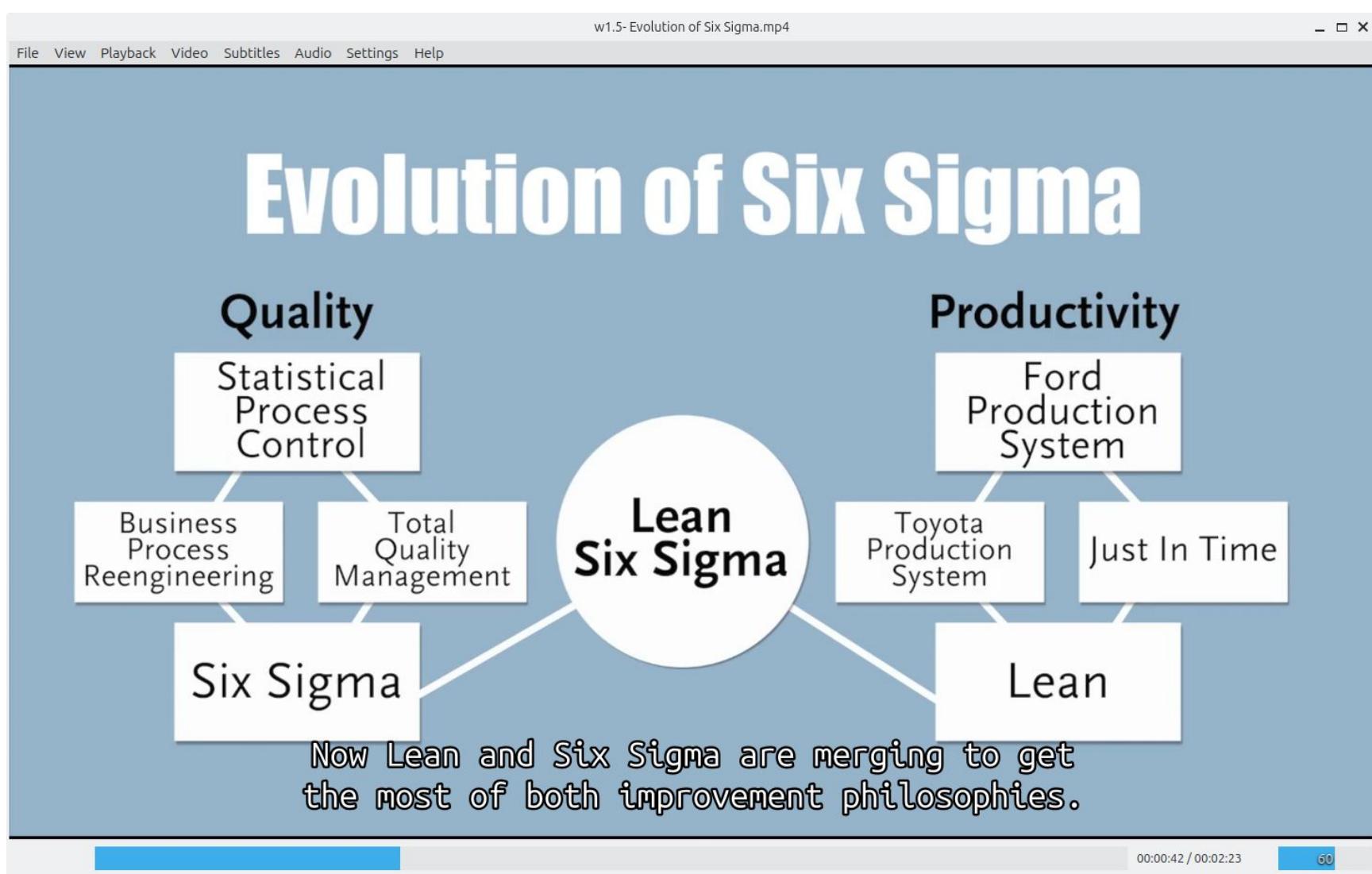
- **Purpose:** To develop, implement, and evaluate solutions aimed at the verified root causes.
- **Key Action:** Implement the proposed change as a **pilot** to demonstrate a **positive change** in the process's current state.

#### 5. Control Phase

- **Purpose:** To ensure that the improvements are sustained long-term and that the problem remains fixed.
- **Key Actions:**
  - Put mechanisms in place for **long-term effective change** on a larger scale.
  - Keep open the possibility for **future improvement** and the adoption of **best practices** in other, similar areas of the business.

## w1.5- Evolution of Six Sigma





w1.5- Evolution of Six Sigma.mp4

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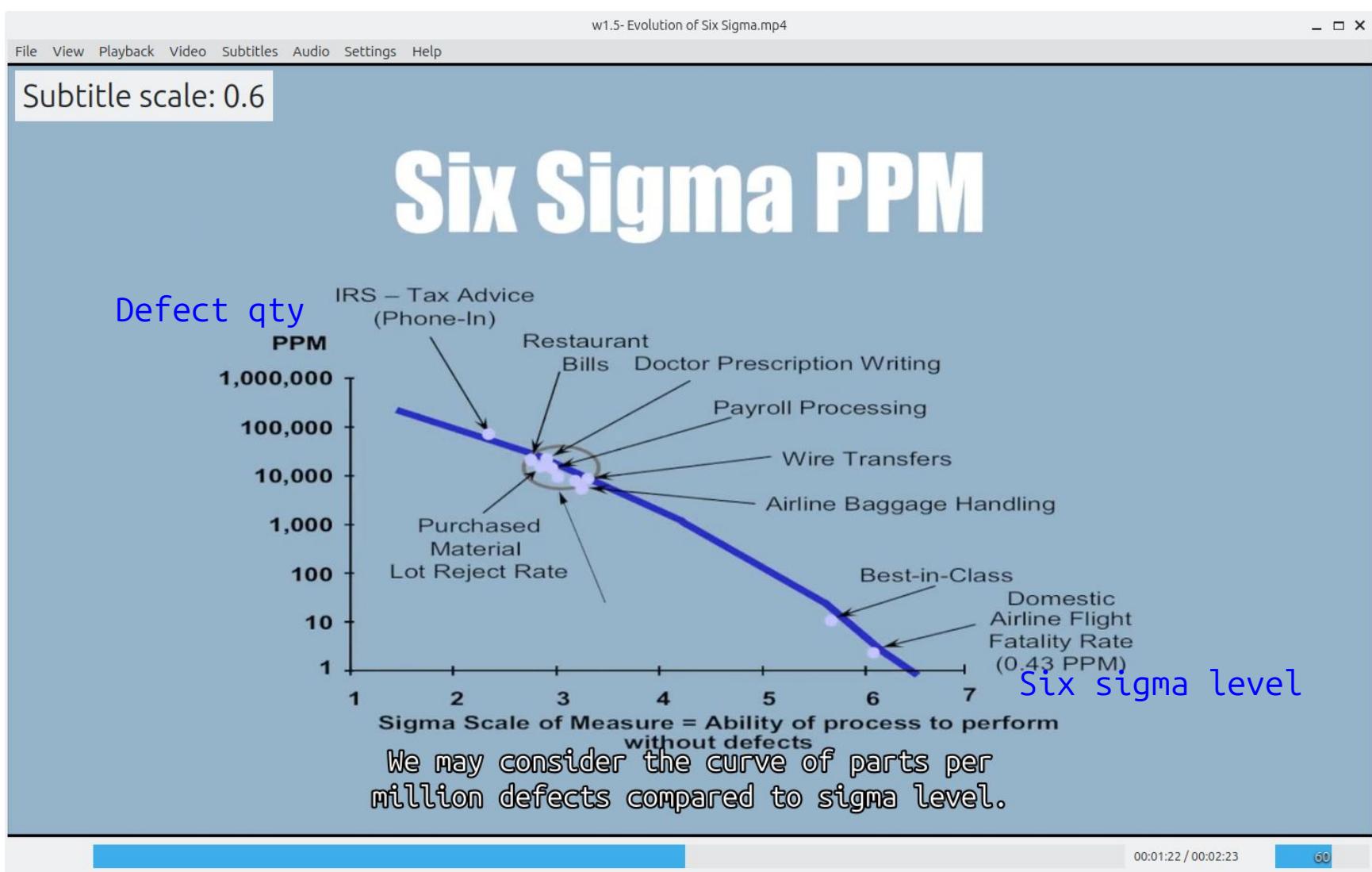
# Principles of Lean

Value  
Value Chain  
Flow  
Pull  
Perfection

The five principles of Lean include value,  
the value chain,

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w1.5- Evolution of Six Sigma.mp4

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# Lean and Six Sigma Tools

Eliminate waste

Remove excess cost

Reduce variation

Maximize customer experience



Together Lean and Six Sigma combines to produce a methodology

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## Evolution of Six Sigma and Lean

The transcript describes how **Lean** and **Six Sigma** evolved from separate improvement philosophies and how they have merged into a combined, strategic approach.

### 1. Evolution of Six Sigma (Quality Focus)

Six Sigma evolved primarily from a focus on quality control:

- **Statistical Process Control (SPC):** This was the starting point on the quality side.
- **Business Process Re-engineering (BPR):** This phase involved abandoning old processes to start fresh.
- **Total Quality Management (TQM):** A broader philosophy of process improvement that ultimately evolved into **Six Sigma**.
  - **Six Sigma** focuses on **reducing variation** to improve the quality of products and services.

## 2. Evolution of Lean (Productivity Focus)

Lean evolved primarily from a focus on productivity:

- **Ford Production System:** Used initially to assemble cars.
- **Toyota Production System (TPS):** Developed by Toyota starting in 1973, using the Ford system as a basis.
- **Just In Time (JIT):** Production philosophies combined with TPS evolved into **Lean**.
  - **Lean** is essentially the **elimination of waste** to improve process speed and efficiency through continuous improvement.

### 3. The Merge: Lean Six Sigma

Today, **Lean and Six Sigma are merging** to combine the strengths of both philosophies:

- **Combined Goal:** The combined methodology is driven to **reduce variation** (Six Sigma) by attacking **waste and excessive cost** (Lean), all aimed at **maximizing the customer's experience**.
- **Mindset Shift:** This requires a fundamental shift in mindset: moving from **problem-driven** (reacting to issues) to **customer-driven** (searching for ways to **prevent** issues and dissatisfaction). The existence of waste and rework is viewed as an **opportunity** for prevention and reduction.

## **4. Lean's Core Principles**

The five principles of Lean that guide the waste elimination process are:

- 1. Value**
- 2. Value Chain (or Value Stream)**
- 3. Flow**
- 4. Pull**
- 5. Perfection**

## 5. Sigma Level and Risk

The transcript notes the importance of the **Sigma level**:

- The best-in-class organizations consistently operate in the realm of **Six Sigma** (3.4 defects per million opportunities).
- The **financial and customer perception risk** to a company can be staggering at lower Sigma levels, making high performance crucial.

w1.6- Value of Six Sigma

w1.6- Value of Six Sigma.mp4

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## Stakeholder Interaction

S	I	P	O	C
Supplier	Inputs	Processes	Outputs	Customers

- Project understanding
- Check and balance
- Identify Stakeholders
  - Profit
  - Growth
  - Additional Orders
  - Employee better and advancement

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w1.6- Value of Six Sigma.mp4

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## Six Sigma Impact on Quality and Profitability

- Improved Quality of Design and Conformance
  - Lower service costs
  - Increased margin and market shares
  - Higher profitability

conformance creates a cascade of impacts on customer perceived quality.

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w1.6- Value of Six Sigma.mp4

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## Requires a Change in Thinking

<u>99% defect-free</u>	<u>99.99966% defect-free</u>
At least 200,000 wrong drug prescriptions each year	68 wrong drug prescriptions each year
2 short or long landings at major airports each day	1 short or long landing at major airports each 5 years
5,000 incorrect surgical procedures every week	1.7 incorrect surgical procedures every week
20,000 lost articles of mail per hour	7 lost articles of mail per hour
Unsafe drinking water for almost 15 minutes each day	1 unsafe minute every 7 months
No electricity for almost 7 hours each month	No electricity for almost 7 hours every 5 years

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## ★ Value of Six Sigma

Six Sigma provides value by significantly improving process quality and efficiency, leading to widespread benefits across financial, customer, and societal levels.

### Applicability Beyond Manufacturing

While Six Sigma has a long history in manufacturing, it is highly applicable to **service industries** as well.

- **Universal Requirement:** Both manufacturing and service sectors have **customer requirements** that must be met.
- **Complexity:** Service processes tend to be more complicated, featuring numerous branching decision points.
- **Measurement:** Although manufacturing measurements are often tangible, service processes can also be effectively measured (e.g., cycle time, error rates). The speaker suggests that fundamentally, **all companies are service companies.**

## Quantification of Value

The value of Six Sigma is quantified through significant improvements, particularly in the reduction of defects, moving from the **3-Sigma level** to the **6-Sigma level**.

Area of Impact	3-Sigma Level (66,810 Defects/Million)	6-Sigma Level (3.4 Defects/Million)
<b>Drug Prescriptions</b>	200,000 wrong prescriptions/year	68 wrong prescriptions/year
<b>Airport Landings</b>	2 short or long landings/day	1 short or long landing/5 years
<b>Surgical Procedures</b>	5,000 incorrect procedures/week	1.7 incorrect procedures/week
<b>Lost Mail</b>	20,000 lost articles/hour	7 lost articles/hour
<b>Unsafe Drinking Water</b>	Almost 15 minutes unsafe/day	1 unsafe minute/7 months
<b>Electricity Loss</b>	Almost 7 hours no electricity/month	Almost 7 hours no electricity/5 years

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This represents a reduction from **66,810 defects** for every one million opportunities down to **3.4 defects** for every one million opportunities.

## Organizational and Societal Benefits

The benefits of Six Sigma are realized on multiple levels:

- **Organizational Output (Financial):** Improved quality design and conformance lead to:
  - **Lower service costs**
  - Increased **margin and market share**
  - Ultimately, **higher profitability** and **growth**
- **Stakeholders and Employees:** Benefits include profit, additional orders, and **employee betterment and advancement.**
- **Customer and Society:** The true value is seen in the **improved customer perceived quality**, and the ultimate benefit to the community and society as a whole through substantially reduced errors (as seen in the table above).

## Key Terms and Structure

- **Expertise Levels:** Six Sigma relies on a **high level of statistical** and process expertise, identified by different **colored belts** (e.g., Black, Green).
- **SIPOC:** **The SIPOC model** (Supplier, Inputs, Processes, Outputs, Customers) is a critical tool used to:
  - Ensure the **project scope is well understood**.
  - Act as a check for customer and stakeholder analysis.
  - Provide insight into the potential **benefit to the organization**.

## w1.7- Individual Contributors

w1.7- Individual Contributors.mp4

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DR. DAVID COOK

Kennesaw State University

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w1.7- Individual Contributors.mp4

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# Belbin Team Roles

- Helps balance types of team roles
- Action-oriented
- People-oriented
- Problem solving

each team member has clear responsibilities.



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## Teams and Roles in Six Sigma

A critical ingredient for success in the Six Sigma methodology is the creation of **strong teams**.

Teams foster **collaboration, synergies**, and the ability to quickly **adapt to change**. The combined effort of a team is far more beneficial than individual contributions alone, as teams can unlock access to all levels and disciplines within the organization.

### The Role of the Individual and Team Dynamics

While teams provide immense benefits, the **role and responsibilities of the individual** are also essential for the team's success. When a team performs optimally:

- Each member has **clear responsibilities**.
- Each role is aligned to **maximize the achievement of the goal**.

The individual team members are often described as the '**engine of change**', performing various tasks and support functions to advance the team's objectives. They often have a **specialization** in a specific area or a valuable **cross-functional skill set**.

## Identifying Team Roles (Belbin)

One method used to help identify each member's best contribution to the team is the **Belbin process**.

- A Belbin individual report identifies which combination of the **nine Belbin team roles** a person prefers and exhibits an aptitude toward.

## Effective Communication

**Effective communication** is equally important to the team's composition. Individual team members should be encouraged to:

- Speak **clearly and directly** and be **succinct**.
- **Actively listen** and avoid interrupting.
- **Share information** at all levels of the organization.

Team members should prioritize **active methods** (like one-on-one encounters) over passive methods to exchange information. Ultimately, an individual team member makes **teamwork a priority** to support specific projects and advance the team's objectives.

w1.8- Yellow and Green Belt.mp4

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other belt levels and exercise  
use of the terminology.

00:00:12 / 00:02:10 50

The image shows three men in a workshop setting. Two men on the left are looking at a cylindrical metal part held by the man on the right. The man on the right is gesturing with his hands while speaking. They are all wearing dark blue work jackets over light-colored shirts. The background shows industrial equipment and machinery. A subtitle at the bottom of the frame reads "other belt levels and exercise use of the terminology." The video player interface at the top includes a menu bar with File, View, Playback, Video, Subtitles, Audio, Settings, and Help, and a title bar for "w1.8- Yellow and Green Belt.mp4". The bottom of the screen shows a progress bar with a blue segment, the time "00:00:12 / 00:02:10", and a frame rate indicator "50".

w1.8- Yellow and Green Belt.mp4

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# Yellow Belt Training

Supervisors

Managers

Directors

Executives

Yellow belt training is  
targeted towards supervisors,

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## Six Sigma Belt Levels: Yellow and Green

The Six Sigma methodology uses a belt system to denote varying levels of training, expertise, and responsibility. The **Yellow Belt** and **Green Belt** roles represent two key levels of involvement.

### Yellow Belt

- **Fundamental Understanding:** A Yellow Belt has fundamental training in Six Sigma principles and understands the terminology, enabling them to converse with other belt levels.
- **Target Audience:** Training is typically aimed at **supervisors, managers, directors, and sometimes executives**.
- **Role and Focus:** Their responsibilities are often similar to those of **Champions or Stakeholders**. While their hands-on involvement with tools is diminished, they are essential for:
  - Moving the project forward.
  - Managing **resource issues**.
  - Overseeing **solution implementation**.

## Green Belt

- **Comprehensive Training:** Green Belt training covers all comprehensive elements of Six Sigma, but **with less emphasis on advanced statistical aspects** (like Design of Experiments) compared to Black Belts.
- **Project Responsibility:** They have nearly identical responsibilities to Black Belts regarding projects, but they typically work on **less complex or dynamic challenges**.
- **Job Status:** Unlike dedicated Black Belt professionals, Green Belts generally **retain their original job positions**. They use their new Six Sigma skills to improve their existing working environment and performance.
- **Scope and Duties:**
  - Their duties and responsibilities align closely with the Black Belt, but the **scope and frequency of these duties are primary differences**.
  - They are often viewed as Black Belts with **divided time** between Six Sigma and their primary job.
  - They typically **do not manage teams** and generally serve in a **support role**.

## w1.9- Roles and Responsibilities of Black Belts

w1.9- Roles and Responsibilities of Black Belts.mp4

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## Duties of Black Belts

- Engaged in six sigma projects on a full time basis
- Completed six sigma training and demonstrated this skills through successful project completion
- Are sometimes **individual contributors**, but mostly lead the efforts of other green belts and black belts.
- Could find themselves as a shared resource across multiple projects.
- Act as a SME to other green belts and black belts.  
*Among the Six Sigma belts, the Black Belt is probably the most active and valuable.*



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w1.9- Roles and Responsibilities of Black Belts.mp4

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## TEAM ROLES: *Black Belt*

- Facilitates meetings and reports
- Focuses on data and problem solving
- Serves as the contact point to organization.
- Maintains official records, reports of team actions
- Participates in discussions as needed
- Resolves problems as they arise. Involved in the removal of barriers

The typical Black Belt has led several projects, coached and



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w1.9- Roles and Responsibilities of Black Belts.mp4

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## DURING THE PROJECT: *The Team Leader*

- Lead the project
- Provide appropriate guidance
- Develop, update and execute the project plan
- Identify problems and addresses them
- Sets team meetings agendas
- Facilitates meetings and grooms others to assume this role
- Manage meeting logistics and administration
- Regularly meet with the Sponsor and Master Black Belt
- Recommend change when needed



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w1.9- Roles and Responsibilities of Black Belts.mp4

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## AFTER THE PROJECT: *The Team Leader*

- Complete project documentation and distribute to others in organization
- See that process owner receives all necessary documentation for monitoring the solution
- Identify, document, and communicate lessons learned
- As project ends, transition responsibility for implementing the solution to work area manager and staff

After the project the Black Belt will complete the project documentation and



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## Role of the Black Belt (BB)

The **Black Belt (BB)** is one of the most active and valuable roles in Six Sigma. They are experienced and well-trained professionals who serve as the **leader and driver of improvement projects**.

### Key Capabilities and Responsibilities

The Black Belt is a **well-rounded professional**, highly sought after for their capabilities in:

- **Project Management:** Leading and executing projects through the DMAIC process.
- **Statistical Analysis:** Applying statistical methods to analyze data and define problems.
- **Financial Analysis:** Understanding and quantifying the financial impact of projects.
- **Facilitation:** Leading and facilitating meetings and team dynamics.
- **Coaching and Mentoring:** Having coached and mentored various **Green Belts** and led several projects.
- **Problem Definition:** Understanding how to clearly define a problem to quickly drive toward a solution.

Depending on the organization, Black Belts can be **dedicated support resources** or professionals who integrate the role into their existing **line management role**.

## Black Belt Duties Across the Project Lifecycle

The Black Belt's responsibilities are divided into three phases:

### Before the Project

- **Planning & Review:** Review the project **charter** with the **Sponsor** to understand the problem's scope and importance.
- **Team & Logistics:** Meet with the **Coach (MBB)** to clarify roles and responsibilities. Draft a project plan, review and adjust it, investigate project history, and arrange meeting logistics.
- **Training:** Work closely with the Coach to identify and initiate necessary training for the team.

### During the Project

- **Leadership:** Lead the improvement project and **lead team meetings**.
- **Coaching & Teaching:** Provide appropriate teaching and coaching to the team.
- **Project Execution:** Develop, update, and **execute the project plan**.
- **Risk Management:** **Identify problems and risks** and proactively address them.
- **Communication:** Regularly meet with the **Sponsor** and the **Coach** and recommend changes as needed.

## w1.10- Role of Master Black Belts

w1.10- Role of Master Black Belts.mp4

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# Duties of Master Black Belts

- Engaged in six sigma projects on a full time basis
- Serve as a high level SME to other black belts
- More of a strategic focus and management toward project involvement
- Very proficient in quantitative skills and able to pass on knowledge to other black belts and green belts.

Typically, the Master Black Belt has

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w1.10- Role of Master Black Belts.mp4

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# TEAM ROLES: *Master Black Belt*

- *Highly knowledgeable of the scientific approach*
- Works with Black belt and Sponsor on charter
- Attends meetings but *maintains neutral position* to promote effective team synergies
- Assists black belt in task assignments
- *Teaches data collection and analysis*
- Encourages team to *seek causes before solutions*
- Helps Black belt to motivate and empower *reluctant participants*

The role of the  
Master Black Belt is



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w1.10- Role of Master Black Belts.mp4

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## BEFORE THE PROJECT: ***Master Black belt***

- Works with Black Belt to *define needed education and training*
- Works with Sponsor and Black belt to identify and recruit team members
- Works with **Sponsor and Black Belt** draft the charter
- Review Charter with Black Belt and team to design *project plan*

Before the project,  
the Master Black Belt



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w1.10- Role of Master Black Belts.mp4

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## DURING THE PROJECT: ***Master Black Belt***

- Consults with Black Belt on team progress and searches for ways to improve efficiency
- *Instructs team in six sigma tools.*
- *Helps team to remove barriers*
- Meets with team regularly to review progress

During the project, the Master Black Belt will work with



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w1.10- Role of Master Black Belts.mp4

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## BALANCING ROLES: Black Belt and Master Black Belt

- Black Belt and Master Black Belt should set ground rules on how to best interact with the team
- *Master Black Belt* very active early in the project and later steps back as more of a consultant
- Black Belt and Master Black Belt should never give impression they are vying for control
- Roles between the Black and Master Black Belt will change throughout project
- Black Belt gradually assumes more control
- Black Belt may also choose to share larger portion of administration with team
- Team often benefits from “outside” views that a Master Black Belt offers

the shared responsibility



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w1.10- Role of Master Black Belts.mp4

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Other Master Black Belt Duties: *When Several Improvement Efforts Under Way*

- *Meet periodically to track projects*
- *Assess project mix with regard to organizational priorities*
- *Check for “synergies” across projects*
- *Manage the “pipeline” of projects*
- *Reinforce importance of projects*
- *Gather lessons learned about common factors for success and problems*

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## Role of the Master Black Belt (MBB)

The **Master Black Belt (MBB)** is the most **seasoned, educated, and capable** of all Six Sigma experts, acting primarily as a high-level mentor, strategic advisor, and coordinator. They have typically managed a minimum of **dozens of Black Belt level projects**.

### **Strategic and Mentoring Responsibilities**

- **Strategic Planning:** MBBs work with **senior executives, business managers, and high-level operations directors** to help assess and plan **strategic business objectives**.
- **Advisory Role:** They advise management on the **cost of poor quality** and consult on the best methods to approach systemic problems.
- **Mentorship & Certification:** They can **coordinate several projects simultaneously** and are responsible for **mentoring and certifying Black Belt and Green Belt candidates**.

## Role as a Coach and Facilitator

The MBB's core duty is to **know and teach the scientific approach** (DMAIC). They function as a coach, guiding the project leader (Black Belt) and the team.

Project Phase	MBB Key Actions
Before Project	Define needed <b>education and training</b> . Work with the Sponsor and Leader to <b>pick team members</b> and draft/review the project <b>charter</b> and project plan.
During Project	<b>Teach tools and skills</b> to the team. <b>Remove barriers</b> and get the team unstuck. Attend review meetings, encouraging the team to seek <b>causes before solutions</b> and helping to engage reluctant participants.
Relationship	The MBB is <b>active early in the project</b> , then <b>backs off</b> to let the Black Belt drive the agenda. They maintain a <b>neutral position</b> to foster team effectiveness and offer a <b>unique outsider's perspective</b> to resolve conflicts.

## Continuous Improvement and Oversight

The MBB is vital for institutionalizing Six Sigma success:

- **Oversight:** They spend most of their time **tracking project progress** and **assessing the effectiveness of teams**, working to resolve issues when team members struggle.
- **Synergies & Resources:** They look for **synergies among other projects** under their control. They can also allocate **additional resources** to reinforce a project's importance.
- **Lessons Learned:** They use outcomes from past projects to drive success on future projects, ensuring **lessons learned** are documented and applied to prevent costly missteps.

## w1.11- Role of Champions

w1.11-Role of Champions.mp4

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# Duties of Champions

- Managers of the allocation resources toward process improvement projects.
- Trained in the essentials of six sigma ( typically at the yellow belt level)
- Charge teams and identify processes for targeted improvement.
- **Serve as coordinator** at the beginning of the project
- Communicate project status updates between top management and black belts
- Ensure the availability of resources and training.



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w1.11-Role of Champions.mp4

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# Responsibilities of Champions

- Collaborates with master black belts on strategic direction of project
- Determines the criteria for project success
- Solves resource issues
- Oversees regular progress reviews
- Partners with the team on implementation of the solution
- Involved in team member selection process
- Maintain open and ongoing communication with the project leader.



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w1.11-Role of Champions.mp4

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## Duties of Sponsors

- Provides the imperatives, inspiration and direction of the business
- Originator of process improvement ideas
- Sets the tone and leadership approach toward the role of six sigma in the business and its successful deployment



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w1.11-Role of Champions.mp4

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## Responsibilities of *The Sponsor*

- Selects & defines project as *important, simple, defined start & finish, short cycle*
- Drafts a clear Charter; focused with *clear boundaries*, success is defined, *key measures*, & the scope of their authority
- **Select all members of the Team**
- Provide needed resources
- Offer *support & commitment*
- **Help overcome barriers**

The responsibilities of  
the sponsor include defining and

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w1.11- Role of Champions.mp4

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## Responsibilities of *The Sponsor*

- Participate in a final project review
- *Celebrate the project's conclusion*
- *Communicate results & ensure integration into daily work methods*
- Monitor changes & implement changes not under team's authority
- *Collect information about systems or barriers for future projects*

Sponsors are also critical at the close of the project.



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## Key Role and Position

The Champion acts as the **strategic link** between executive leadership and the Six Sigma project teams (Black Belts and Green Belts).  

- **Organizational Level:** They are typically **upper or middle managers** (e.g., Directors, Vice Presidents, or senior functional leaders) who have **profit-and-loss (P&L) responsibility** or direct oversight of the business area being improved.  
- **The Sponsor:** The Champion is often referred to as the **Project Sponsor**. Their leadership and visible commitment are vital for demonstrating that the organization is serious about its improvement efforts.  
- **Knowledge Requirement:** While they don't need to be statistical experts like a Black Belt, they must have a **deep understanding** of the Six Sigma philosophy, the DMAIC (Define, Measure, Analyze, Improve, Control) roadmap, and its strategic benefits to the business.

w1.11- Role of Champions.mp4

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## Duties of Process Owners

- Subject matter experts of a process
- Organizes process improvement initiatives and monitors progress on a regular basis
- Collaborates with black belts
- Typically possess a basic understanding of statistical tools
- At times, also serve as the champion.

Process owners are unique individuals, that can take on multiple roles in a team.

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## Role of Champions and Sponsors

In Six Sigma, Champions and Sponsors are critical high-level management figures who ensure the strategic relevance, funding, and success of improvement projects.

### 1. Champions

Champions are executives, directors, or managers **who are chartering, funding, or driving** the projects executed by Black Belts and Green Belts. They require a strong understanding of the Six Sigma methodology.

#### Key Responsibilities:

- **Strategic Oversight:** Determining the **strategic direction** of the project.
- **Success Definition:** Defining the **requirements for success**.
- **Resource Management:** **Resolving resource issues** for the team.
- **Project Monitoring:** Conducting **periodic progress reviews**.
- **Team Support:** Assisting in **team selection** and **solution implementation**.
- **Communication:** Communicating closely with the Black Belt.

## 2. Sponsors

Sponsors are similar to Champions but their scope of involvement **is typically less interactive**.

They operate at the highest levels of the organization to set the overall direction and communicate results.

### Key Responsibilities:

- **Chartering:** Defining and drafting the **project charter**.
- **Support:** Providing necessary **resources** and assisting in **removing barriers**.
- **Project Closure:**
  - Involved in the **final review** and helping the team **celebrate success**.
  - **Communicating the results** to the highest levels of the organization.
  - **Implementing changes** that are outside the team's authority.
  - Monitoring the change and keeping watch over systemic barriers for future projects.

### 3. Process Owners

A Process Owner is a **subject matter expert (SME)** for a specific, critical process under investigation.

- They are not Black Belts, but should **have a basic understanding of statistical tools.**
- They can take on multiple roles within a team (e.g., individual contributor or even Champion), but their unique value lies in their **deep process knowledge.**