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SIX SIGMA PROJECT
at
Deepa Engineering Works, Pune

Company Information

About the company

- Deepa Engineering Works is a leading manufacturer of all types of turned and thread rolled components in Pune. We specialize in manufacturing all type of Piston Rods and CNC turned components for our esteemed customers.
- We provide our customers with the value proposition of high volume, high precision and low cost components that are tailored to their needs. This is ensured by leveraging our manufacturing facility to rigorous quality standards. Deepa Engineering works is a ISO 9001:2015 certified manufacturer.

Production of piston rods:

- The company produces around 13,20,000 piston rods annually.
- This generates around 30% of the companies annual income and is the highest revenue generating SKU.
- The company supplies 8000 – 10000 piston rods per week to the customer.

Look at the product

Problem Definition

- **Current Scenario**
  - When a non-conformity like cavities in the metal, more than required weight and size out of tolerance limit is found in the piston rod, the process of debugging starts at each machine. Employees check each step to find the root cause. The whole process takes from 8 hours to 1 and a half day.

- **Problem Definition**
  - Higher debugging time to find root cause of non-conformity increases the Non-Value Added time (NVA).

- **Key Process Indication (KPI)**
  - Time taken to find the root cause (Hours)

SIPOC

Suppliers	Inputs	Process	Output	Customer
1. Raw Material Supplier.	**1**. Steel Rods.	**1**. Receiving Inspection.	**1**. Good Quality Steel Rods.	**1**. Traub Machining & CNC Machining.
2. Traub Machining & CNC Machining.	**2**. Good Quality Steel Rods.	**2**. Machining.	**2**. Semi-Finished Product.	**2**. Step Grinding.
3. Step Grinding.	**3**. Semi Finished product	**3**. Machining of Step Dia.	**3**. Semi Finished product with step diameter 9.05±0.02mm.	**3**. Thread Rolling.
4. Thread Rolling.	**4**. Semi Finished product with step diameter 9.05±0.02mm.	**4**. Threading of M10x1.25-6g.	**4**. Semi Finished product with Step and Threads.	**4**. Centreless Grinding.
5. Centreless Grinding.	**5**. Semi Finished product with Step and Threads.	**5**. Rough pass of centreless grinding.	**5**. Roughly Finished Product.	**5**. Swiss Super Finishing’
6. Swiss Super Finishing.	**6**. Roughly Finished Product.	**6**. Final Pass of grinding process in which final dimension are achieved.	**6**. Fully Finished Product with dimensions as per customer drawing.	**6**. Final Inspection.
7. Final Inspection.	**7**. Fully Finished Product with dimensions as per drawing.	**7**. Final Inspection of all dimensions.	**7**. Finished Products with conforming dimensions.	**7**. Packing & Dispatch.
8. Packing & Dispatch	**8**. Finished Products with conforming dimensions.	**8**. Packing of products in boxes and dispatching.	**8**. Packed Products dispatched to Customer.	**8**. External Customer.

Root Cause

- Voice of customer over here is the business owner.

Voice of customer	Requirement	Critical to Quality
“Galat Dimension aata hai tab problem kaha hai who find karne me time lag jata hai.” **Translation**: “When there’s non-conformity in final product, it takes a lot of time to find out what caused the non-conformity.”	To easily find the cause of non-conformity.	Time required to find the root cause of the non-conformity should be less than 4 hours.

Root Cause Validation

- Why-Why analysis was done to check the root cause validation.

Root Cause	Why	Why	Why	Why
To many irregular seeming non conformities	No direct way to check where the non-conformity arises from	No data being captured to find pattern/ perform analysis.	No procedure to check non conformity in process/ machine	No data about capability of machine or no SOP to take measurement present

Project Charter

Project Theme				Justification
Assessing non-conformities and machine capability in current process.				SPC charts would help in pin pointing the machine which caused the non-conformity, which currently is not possible.
Goal statement				**Project scope**
Measure (KPI)	**Current Level**	**Goal / target**	**Target date**	If applied across the shop floor, this could reduced defective parts manufactured and can also check capability of individual machines.
Non-conformity per week	40	< 10	29/9/2019	

Project Plan			Team Members
Phase	**Start**	**End Date**	**Project Guide: Prof. Ismail Akbani**
Reason for improvement	28/8/2019	1/9/2019	**1. Jay Khedekar**
Understand the Requirements	1/9/2019	1/9/2019	**2. Jatin Sharma**
Explore Alternatives and select	1/9/2019	3/9/2019	**3. Atharva Bahirat**
Details the solutions and implement	7/9/2019	16/9/2019	
Result Check	17/9/2019	26/9/2019	
Sustenance	26/9/2019	29/9/2019	

Measure and Analysis Phase

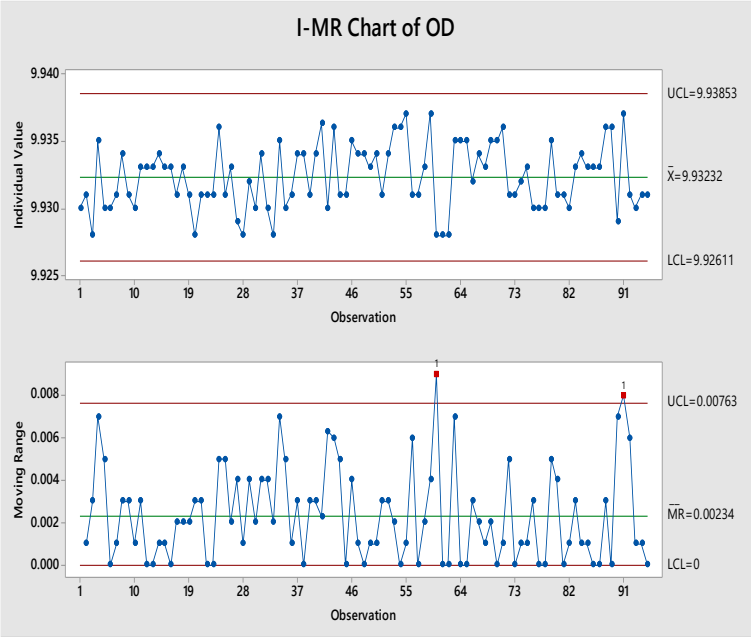
Measure

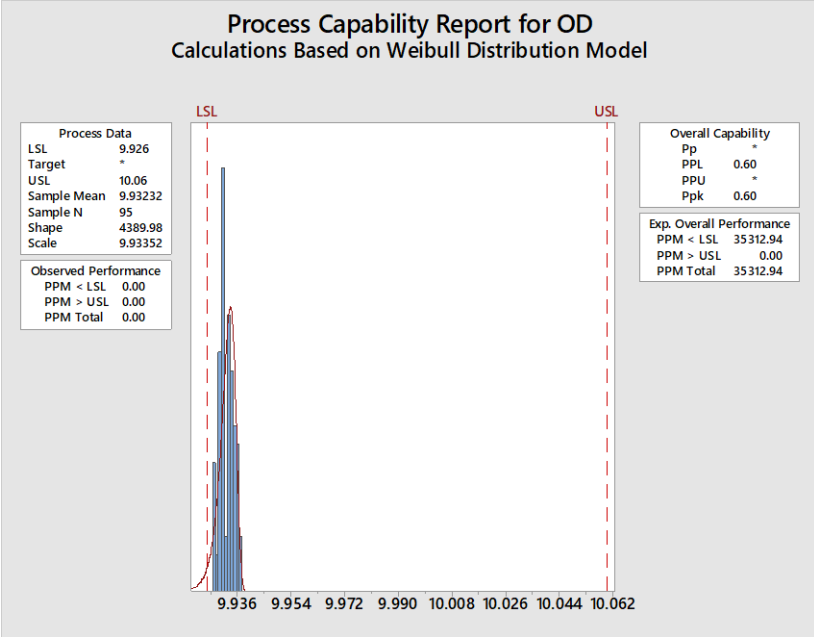
Traubing	OD Grind	MC2
179.28	9.93	6.965
179.35	9.931	6.967
179.35	9.928	6.966
179.36	9.935	6.967
179.4	9.93	6.968
179.48	9.93	6.999
179.04	9.931	6.97
179.48	9.934	6.971
179.45	9.931	6.975
179.57	9.93	6.96
179.41	9.933	6.965
179.51	9.933	6.964
179.51	9.933	6.961
179.51	9.934	6.967
179.41	9.933	6.967
179.52	9.933	6.968
179.52	9.931	6.968
179.51	9.933	6.967

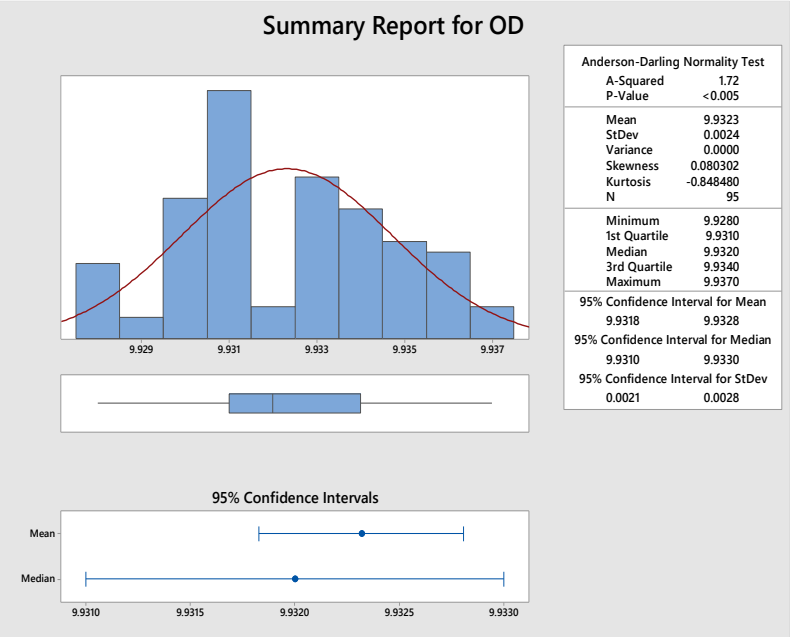
90 readings

Why did we take the following measurement?	While inspection visit on factory floor, we took out the processes which can contribute to error. These three process seemed to be most error prone places.
What analysis showed us?	Analysis opened up door to new problems which were happening on the shop floor but we had not anticipated. Process being skewed is one of them which made Process capability low.

OD Grinding





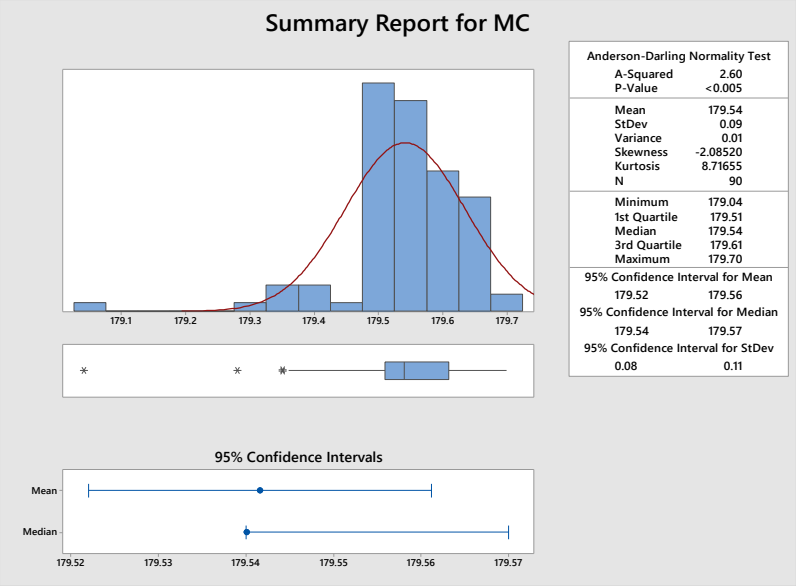


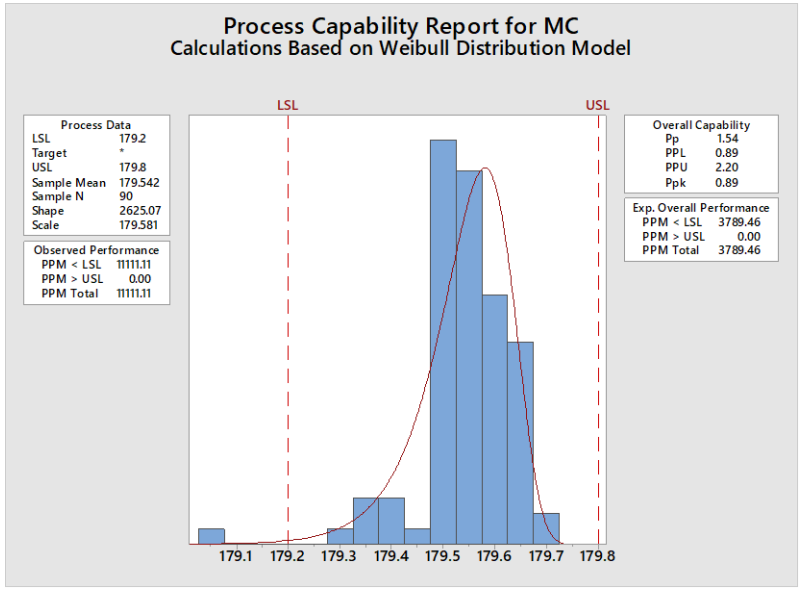
OD Grinding	
Standard Deviation	0.002394788
Specification	10 (+0.06, -0.074)
Data Distribution	Weibull
Cpk	0.6
Cp	-
Mean	9.932318947

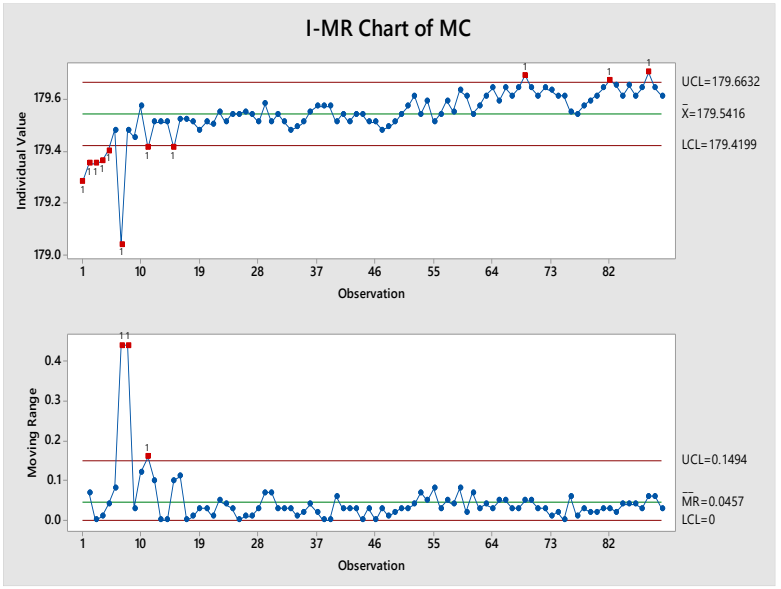
Abrasive process used to reduce the diameter to get it to the specified value by grinding.

OD Grinding

Traub Machining







Traubing	
Standard Deviation	0.093153531
Specification	179.5 ± 0.3
Data Distribution	Weibull Distribution
Cpk	0.89
Cp	1.54
Mean	179.5415556

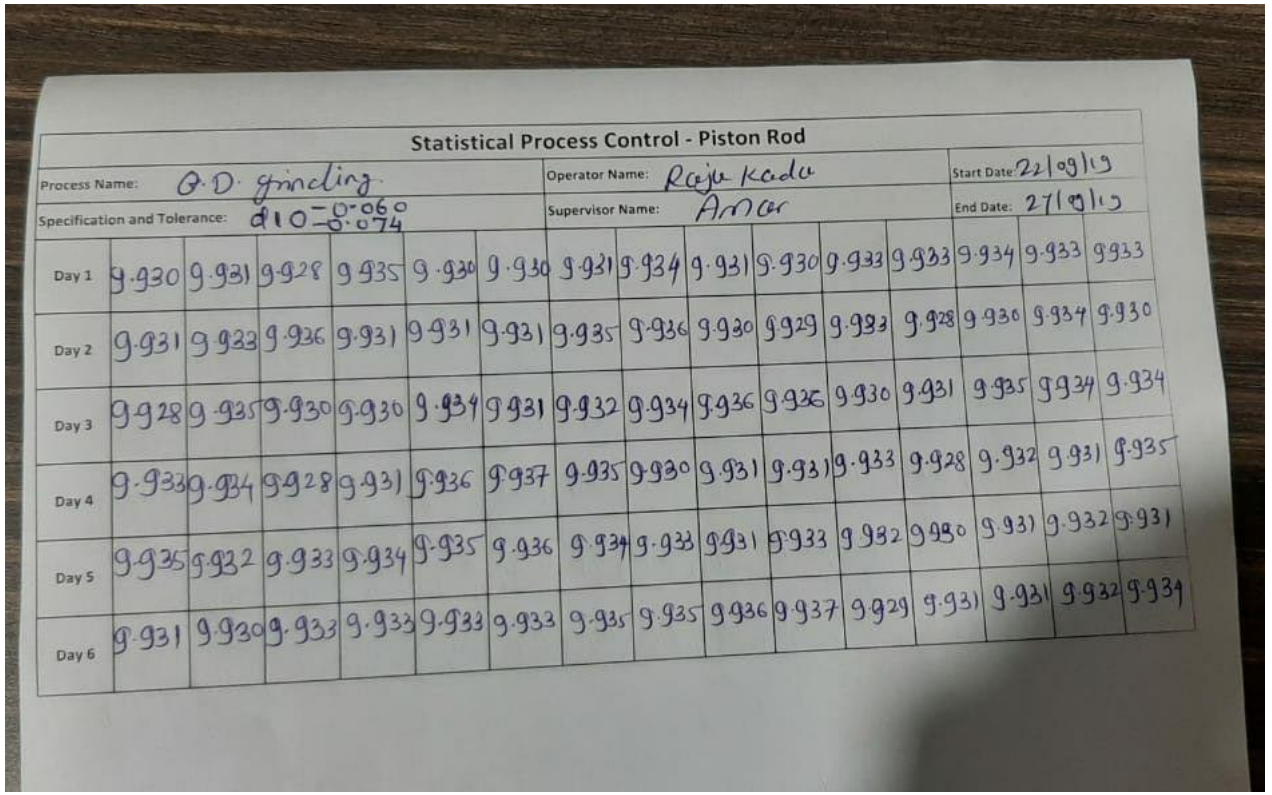
Traub is an automated lathe machine used to get the metal bar to specified length. Most suitable for mass production of suitable part.

Solution & Implementation

Solution

Process	Problems	Solutions Provided
OD Grinding	Employees taking incorrect reading	Suggestion for ring gauge was given from our side. Which was then improvised to air ring gauge. Implemented X bar – R chart and set fixed spots to take readings.
Traub Machining	Frequently giving out of control limits parts. Multiple readings above/ below central line.	Implemented Control chart for continuous monitoring.

Implementation



Statistical Process Control - Piston Rod

Process Name: O.D. grinding
Specification and Tolerance: ø10 -0.060 -0.074
Operator Name: Raju Kadu
Supervisor Name: Amar
Start Date: 22/09/19
End Date: 27/09/19

Day 1	9.930	9.931	9.928	9.935	9.930	9.930	9.931	9.934	9.931	9.930	9.933	9.933	9.934	9.933	9933	
Day 2	9.931	9.933	9.936	9.931	9.931	9.931	9.935	9.936	9.930	9929	9.933	9.928	9.930	9.934	9.930	
Day 3	9.928	9.935	9.930	9.930	9.934	9.931	9.932	9.934	9.936	9.936	9.930	9.931	9.935	9934	9.934	
Day 4	9.933	9.934	9928	9.931	9.936	9.937	9.935	9.930	9.931	9.931	9.933	9.928	9.932	9.931	9.935	
Day 5	9.935	9.932	9.933	9.934	9.935	9.936	9.934	9.933	9931	9933	9.932	9930	9.931	9.932	9.931	
Day 6	9.931	9.930	9.933	9.933	9.933	9.933	9.935	9.935	9.936	9.937	9.929	9.931	9.931	9.932	9.934	

Benefits

- Reduction in cost incurred due to defects.
- Better view of the quality of product produced.
- Reduction in time to identify error causing process/ activity.
- Help in keeping check on machine performance in long term with long term trend charts.

Thank You