GEARS - INCREASING DIMENSIONS DURING NITRADING PROCES

Process Capability Analyze and Solution for # 84D706978 Brake Adapter

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Abstract : # 84D706978 Brake Adapter has internal and external spline. The spline of the parts is grinded. During nitrading process show up different random values at dimensions over pins which requested often additional grinding on external spline which cause additional costs. The goal is using statistical method as MINITAB software and Six Sigma tools to determined exact dimension(value) over pins and eliminate any additional job.

Key words: Eliminate scrap and additional job cost reduction during serial production

Process capability

Analyze and solution of increasing dimension during nitriding process in UNIO

Description of production

Machining according to PFD(Process Flow Diagram).

Before nitriding performed grinding operation of teeth to reach required accuracy and surface finish. Characteristic dimension describing size of teeth is measurement over pins.

Nitriding process performed

According to PFD(Process Flow Diagram) no other machining should be performed after nitriding.

Observed problem

1. Sample Parts

After nitriding measured teeth over pins discovered teeth increased dimension. From this reason measurement over pins was over limit. Re-grind all the pieces was required.

Effect

By additional grinding the nitrided layer depth was decreased – approved by engineering, because the depth was still inside tolerance field

Increasing costs – additional grinding operation caused additional costs for samples, requested corrective action for cost reduction.

Proposed actions

Procedure for heat treatment, nitriding, marking and measurement

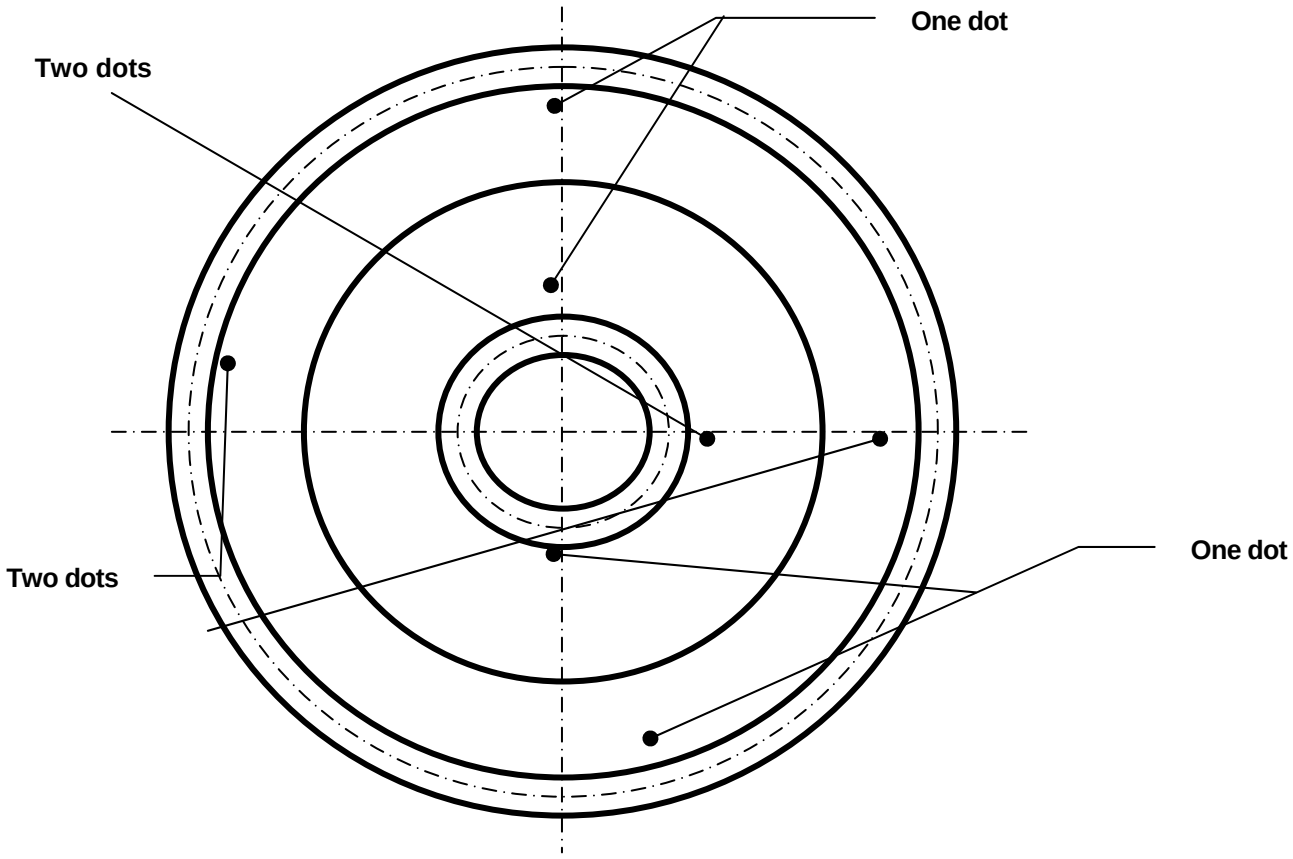
It was issued procedure for checking and collecting data for analyze of described phenomenon. Purpose of this procedure is to find reason of increasing dimension, find exact value of increasing and foreclose random influences to production process.[2]

2. Serial Production

For serial production the "Procedure for heat treatment, nitriding, marking and measurement of brake adapters " has been applied. During production of lot of 21 pieces, the same phenomenon of increasing dimension has been observed.[2]

Purpose of this procedure is to find reason of increasing dimension, find exact value of increasing and foreclose random influences to production process.[2]

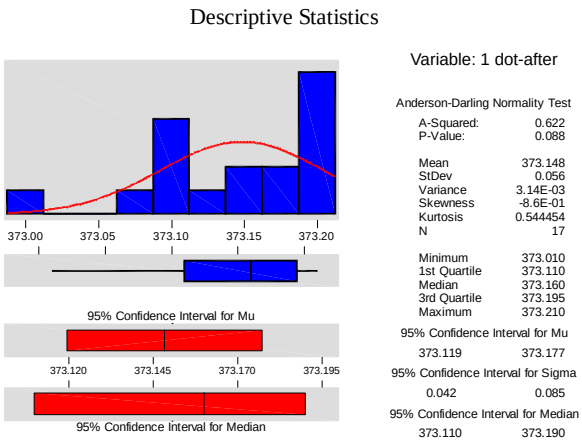
1. All parts should be marked according to picture from the same side by punching close tooth space of external and internal teeth, which the measurement over/between pins, is provided in, so that possible easy identified the place for repetition of measurement.
2. Measurement will be provided on two places turned approximately about 90 degrees. One place is marked by one dot and second place is marked by two dots, always closed to teeth space what the measurement is provided between.
3. Marking to be done before nitriding operation
4. Measurement to be done after grinding before nitriding. All measured values to be written down to table including operator name.
5. Second measurement will be done after nitriding in the same places marked by dots. Values to be again written down to table.
6. Gage R&R to be done for this measurement by assistance SQE.
7. Sketch of location (layout) and supporting parts inside furnace for quenching and tempering, for annealing and also for nitriding should be done and introduced to SQE. This sketch should exactly identify which part number was where and how was supported.
8. All temperatures and times inside furnaces should be recorded.



Analyze of collected data, dimension over pins at tolerance field of 372.872 – 373.126 mm

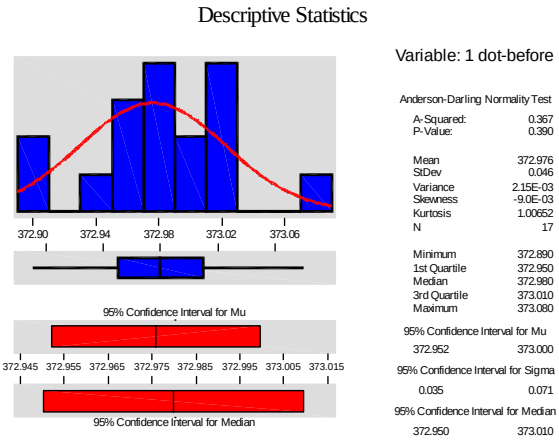
Part number	Measurement before nitriding			Measurement after nitriding		
	1 dot	2 dots	Operator	1 dot	2 dots	Operator
1	372.95	372.96	1	373.11	373.14	1
2	372.96	372.96	1	373.12	373.12	1
3	373.02	373.01	1	373.21	373.21	1
4	373.01	373.01	1	373.19	373.19	1
7	372.89	372.89	1	373.11	373.11	1
9	372.98	372.99	1	373.19	373.18	1
10	372.97	372.97	1	373.18	373.17	1
11	373.01	373.01	1	373.21	373.21	1
12	372.98	372.97	1	373.11	373.12	1
13	373.08	373.07	1	373.21	373.21	1
14	372.97	372.98	1	373.16	373.16	1
15	373.01	373.02	1	373.18	373.19	1
16	372.94	372.95	1	373.11	373.11	1
17	372.99	373.00	1	373.14	373.14	1
18	372.99	372.99	1	373.20	373.20	1
19	372.89	372.88	1	373.01	373.00	1
21	372.95	372.96	1	373.08	373.10	1

Normality test [1]



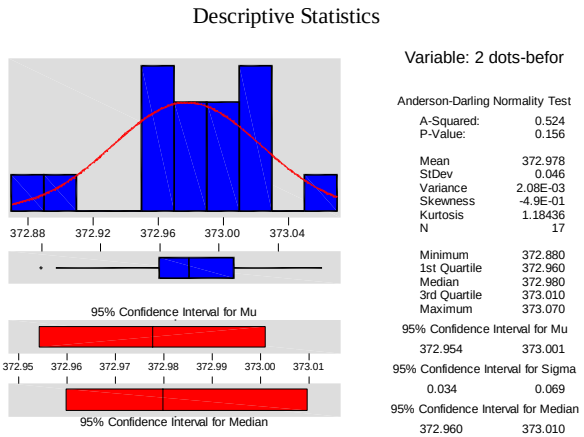
Variable: 1 dot-after

Anderson-Darling Normality Test	
A-Squared:	0.622
P-Value:	0.088
Mean	373.148
StDev	0.056
Variance	3.14E-03
Skewness	-8.6E-01
Kurtosis	0.544454
N	17
Minimum	373.010
1st Quartile	373.110
Median	373.160
3rd Quartile	373.195
Maximum	373.210
95% Confidence Interval for Mu	
373.119	373.177
95% Confidence Interval for Sigma	
0.042	0.085
95% Confidence Interval for Median	
373.110	373.190



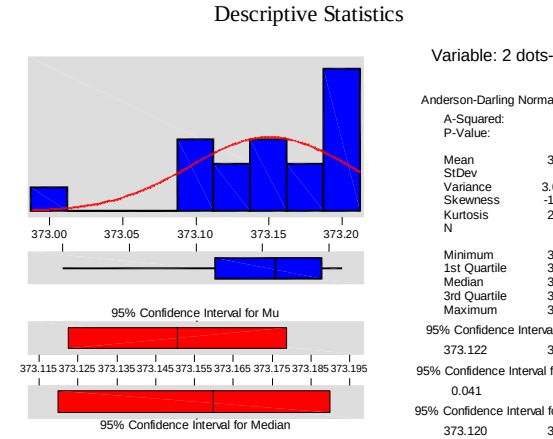
Variable: 1 dot-before

Anderson-Darling Normality Test	
A-Squared:	0.367
P-Value:	0.390
Mean	372.976
StDev	0.046
Variance	2.15E-03
Skewness	-9.0E-03
Kurtosis	1.00652
N	17
Minimum	372.890
1st Quartile	372.950
Median	372.980
3rd Quartile	373.010
Maximum	373.080
95% Confidence Interval for Mu	
372.952	373.000
95% Confidence Interval for Sigma	
0.035	0.071
95% Confidence Interval for Median	
372.950	373.010



Variable: 2 dots-befor

Anderson-Darling Normality Test	
A-Squared:	0.524
P-Value:	0.156
Mean	372.978
StDev	0.046
Variance	2.08E-03
Skewness	-4.9E-01
Kurtosis	1.18436
N	17
Minimum	372.880
1st Quartile	372.960
Median	372.980
3rd Quartile	373.010
Maximum	373.070
95% Confidence Interval for Mu	
372.954	373.001
95% Confidence Interval for Sigma	
0.034	0.069
95% Confidence Interval for Median	
372.960	373.010

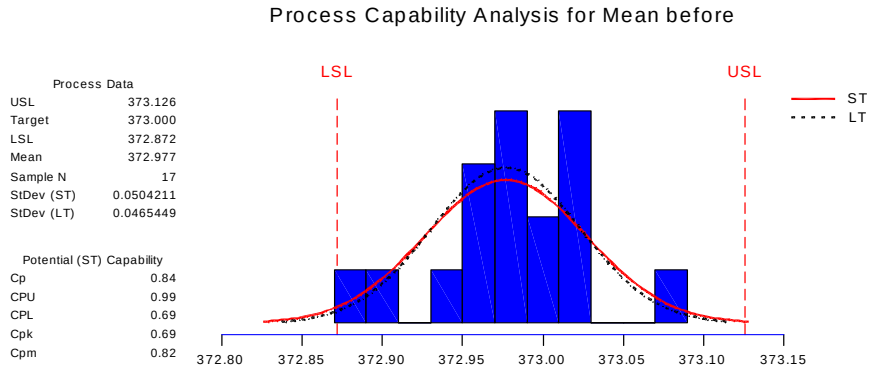


Variable: 2 dots-after

Anderson-Darling Normality Test	
A-Squared:	0.554
P-Value:	0.130
Mean	373.151
StDev	0.055
Variance	3.01E-03
Skewness	-1.21718
Kurtosis	2.15926
N	17
Minimum	373.000
1st Quartile	373.115
Median	373.160
3rd Quartile	373.195
Maximum	373.210
95% Confidence Interval for Mu	
373.122	373.179
95% Confidence Interval for Sigma	
0.041	0.083
95% Confidence Interval for Median	
373.120	373.190

Data was tested by Anderson-Darling test.

From graphs we can see that P-value for each column was higher than 0.05, it means data has normal distribution.



Process Data	
USL	373.126
Target	373.000
LSL	372.872
Mean	372.977
Sample N	17
StDev (ST)	0.0504211
StDev (LT)	0.0465449

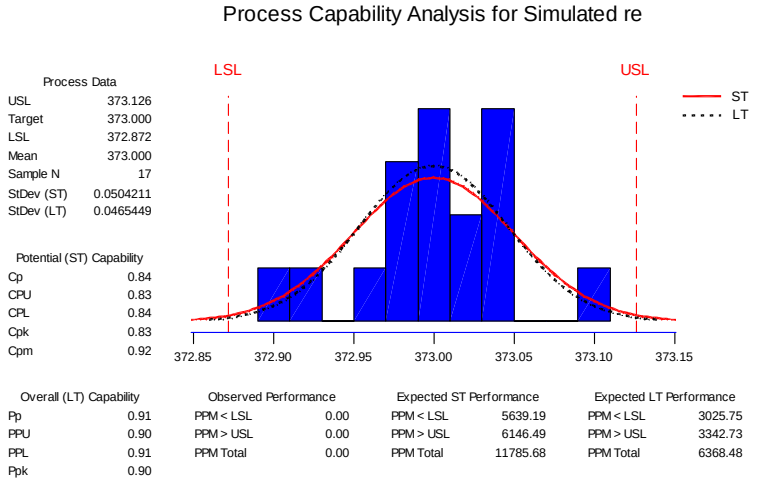
Potential (ST) Capability	
Cp	0.84
CPU	0.99
CPL	0.69
Cpk	0.69
Cpm	0.82

Overall (LT) Capability	
Pp	0.91
PPU	1.07
PPL	0.75
Ppk	0.75

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

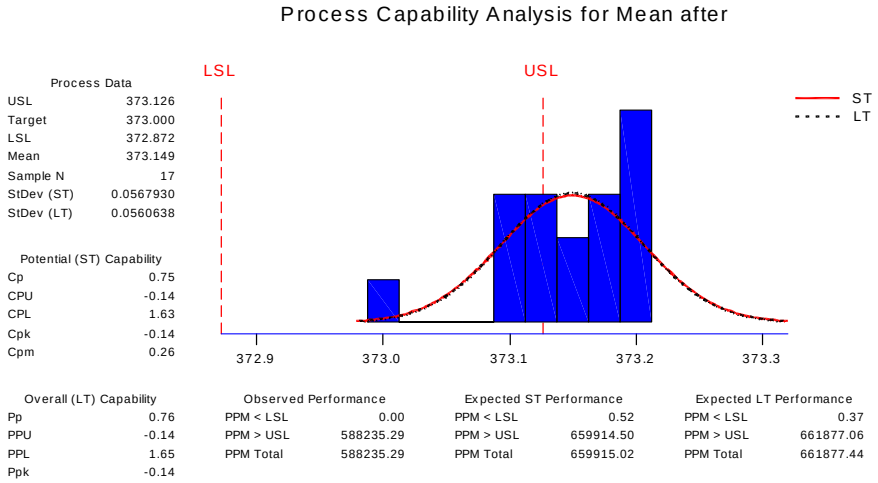
Expected ST Performance	
PPM < LSL	18864.12
PPM > USL	1539.30
PPM Total	20403.42

Expected LT Performance	
PPM < LSL	12198.12
PPM > USL	672.35
PPM Total	12870.47



Process capability [1]

1. The mean from 1 and 2 dots measurement before nitriding was calculated.
2. Process capability test was applied for this data. From the test we can see that process is not exactly centered, Cpk value is too low.
3. The mean from 1 and 2 dots measurement after nitriding was calculated
4. Process capability test was applied for this data. From this test we can see the process is absolutely out of center.



5. Mean value for measurement before nitriding is 372.977.
    - Mean value for measurement after nitriding is 373.149.
    - Target is 373.00 mm after nitriding.
    - 373.00 – 372.977 = 0.023 Difference of the measurement before nitriding from ideal target.
    - The increasing in nitriding is 373.149 – 372.977 = 0.172. This value should be taken from the target for grinding before nitriding operation.

- 373.149 – 373.00 = 0.149 This is the difference of the measurement after nitriding from target.

Result [1]

Before nitriding the teeth should be ground to target value 373 – 0.172 = 372.83.

The simulated results we can see on graph.

Target value for measurement over pins before nitriding is 372.83 mm

References:

[1] Mike J. Harry Ph.D., THE VISION OF SIX SIGMA A Roadmap for Break Through

[2] General Electric Company Six Sigma- Green Belt Training Course

[3] MINITAB Inc., 3081 Enterprise Drive, PA 16801-3008, USA 11.2 Release Software