



lapping solution/ case studies

October 2024



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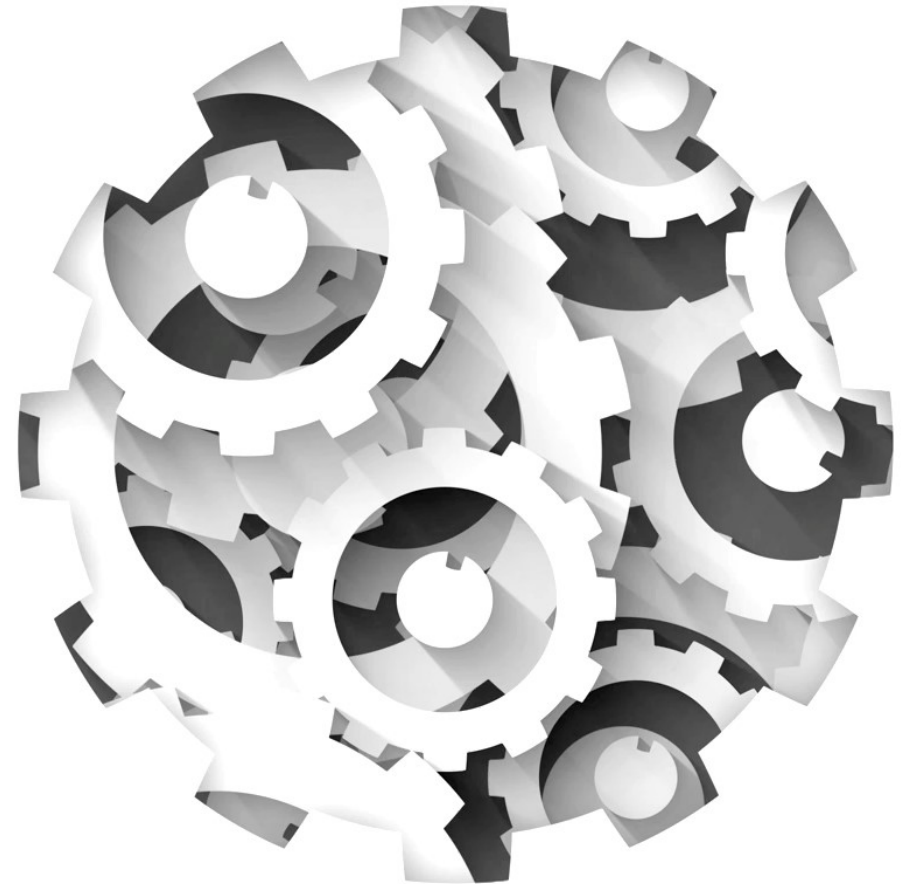
agenda

- introduction
- lapping
- case studies
 - Steering block
 - Steering sleeve
- lapping ↔ honing
- go live
- conclusion



5 years experience

- engineering
- quotation
- lapping trials
- support
- consulting
- training





lapping - machine SVL2115 vertical lapping machine

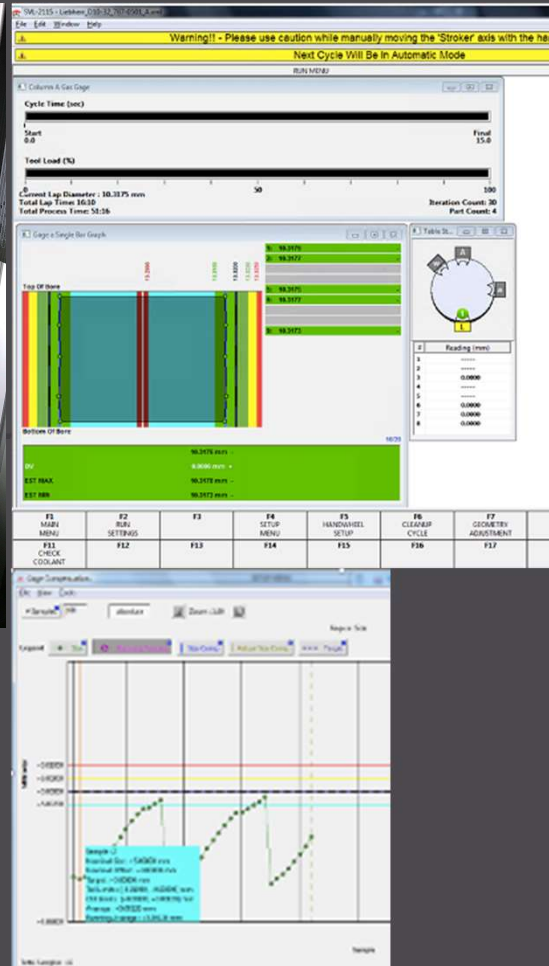




Tooling

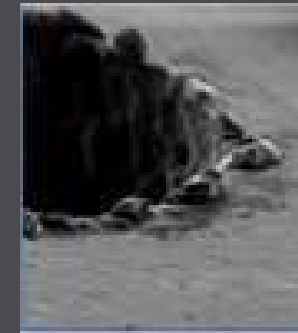
Main components

1. part fixture
2. washing
3. laptool at spindle
4. retrator
5. expander
6. paste applicator
7. paste
8. air gaging
9. software

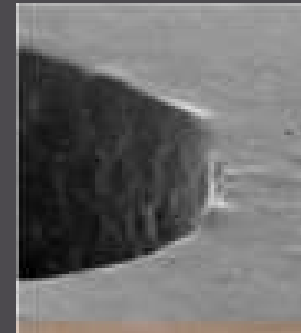


Advantage/ characteristics

- micro deburring of cross sections
- matte surface structure $Ra < 0.04$
- geometry improvement
- time saving process
- 100% process control, safe process

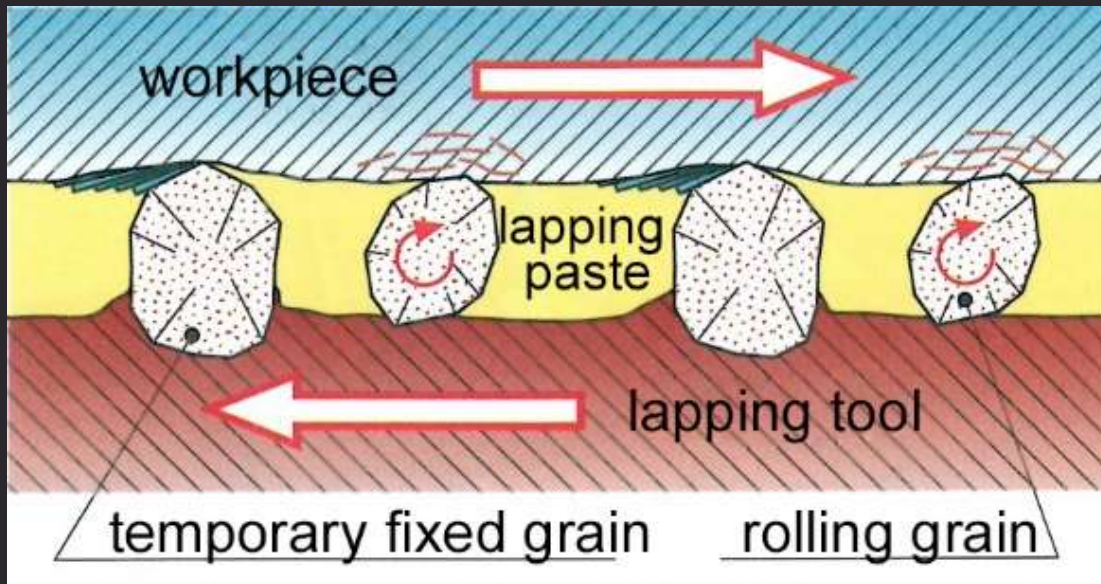


honed



lapped

Principle of lapping



1) Lapping compound:

Lapping compound consists of abrasive grains that are distributed in a liquid or paste.

2) Tool and workpiece:

The workpiece and the lapping tool slide over each other. The abrasive grains in the lapping compound roll between the surfaces and cause material removal.

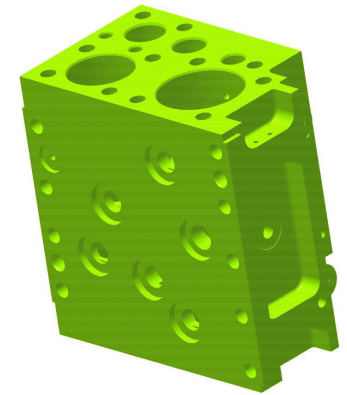
3) Movement:

Due to the "relative movement" between the lapping sleeve and the workpiece, the grains perform a rolling movement. The tips of the grains press into the material of the workpiece and create microcracks that lead to uniform material removal.



Case study: steering block





Customer request

Part dimension

Bore length: 80 mm
Ext. dimensions: 80 x 80 x 50 mm
Part weight: ca. 2 kg
Material: stainless steel ~60 HRC

* Sunnen standard, proposal to reach quality

Challenge

- Diameter form- and surface tolerances after lapping
- Only 5 parts available

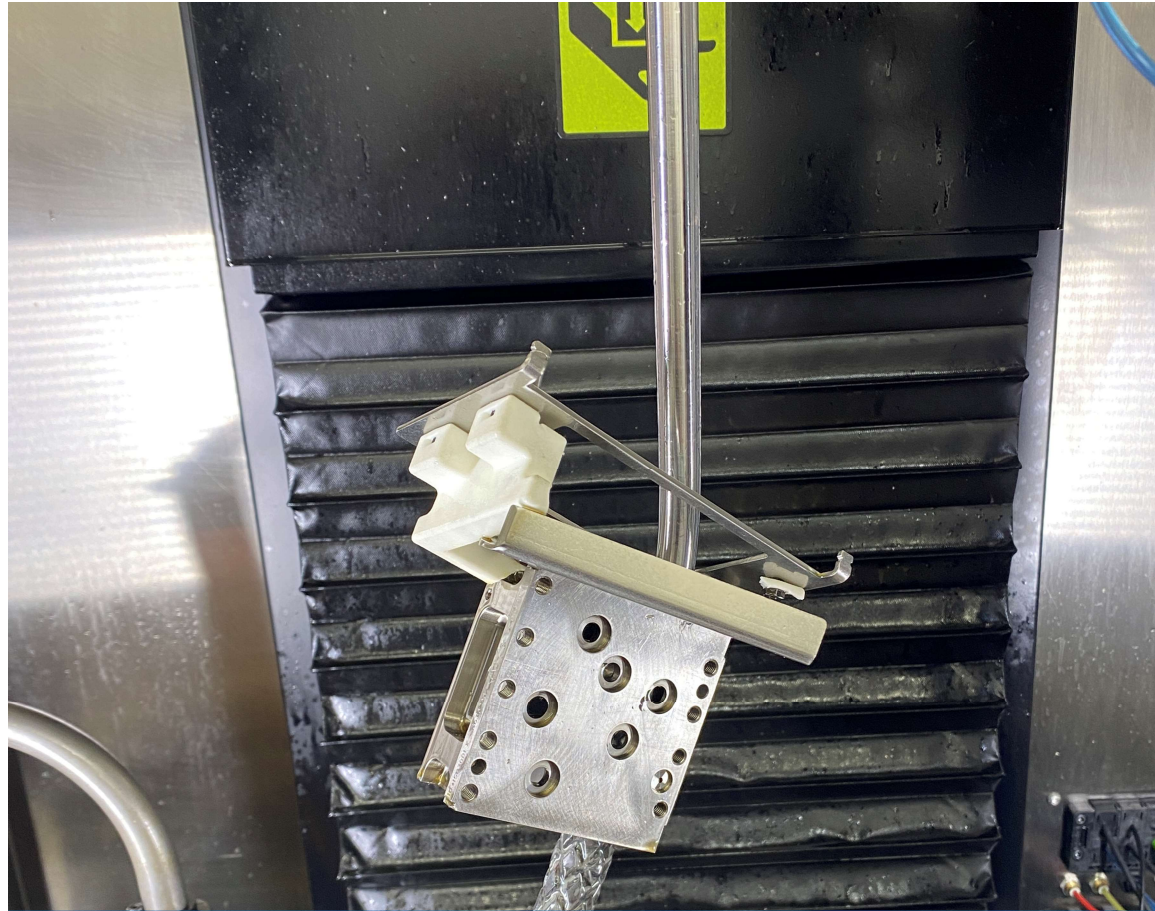
TOLERANCES	HONED*	LAPPED
removal	customer	0.008 – 0.014
diameter	20.49 +/- 0.004	20.5 +/- 0.001
cylinder /o/	< 4 µm	< 1 µm
axis straightness	< 3 µm	< 0.5
roundness	< 2 µm	< 0.5 µm
surface Ra	0.4 – 0.8	< 0.04 µm
cycle time		< 20 minutes



solution and
integration

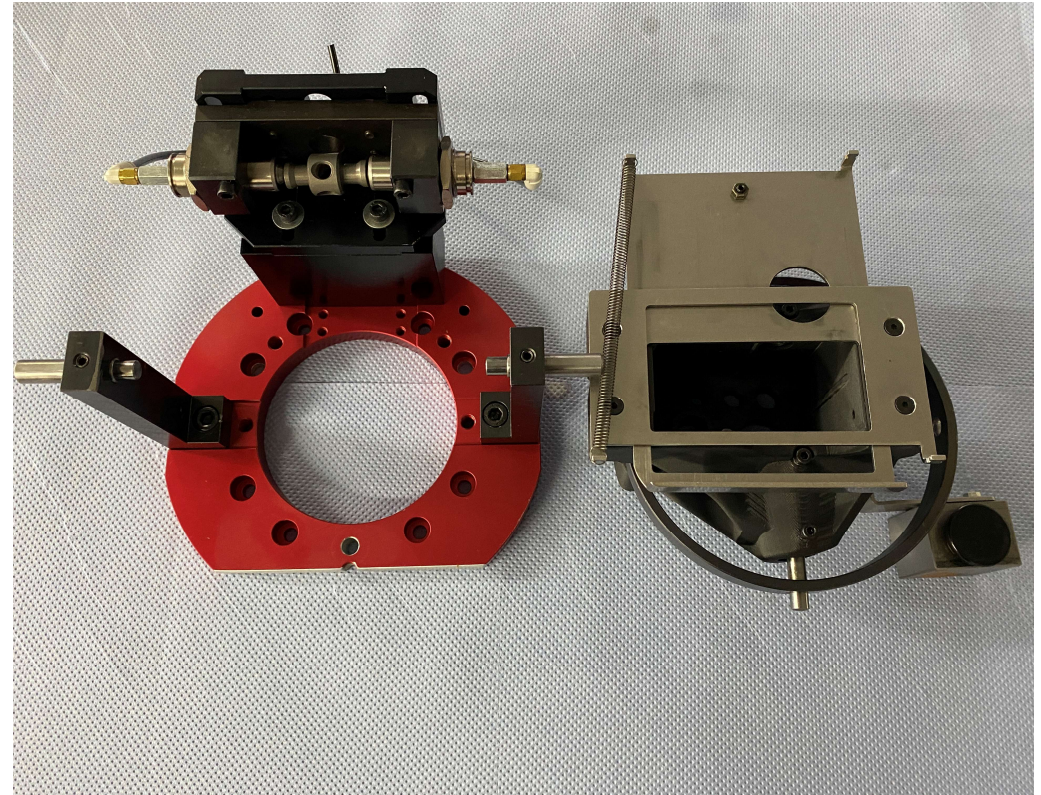


Ups...first
step



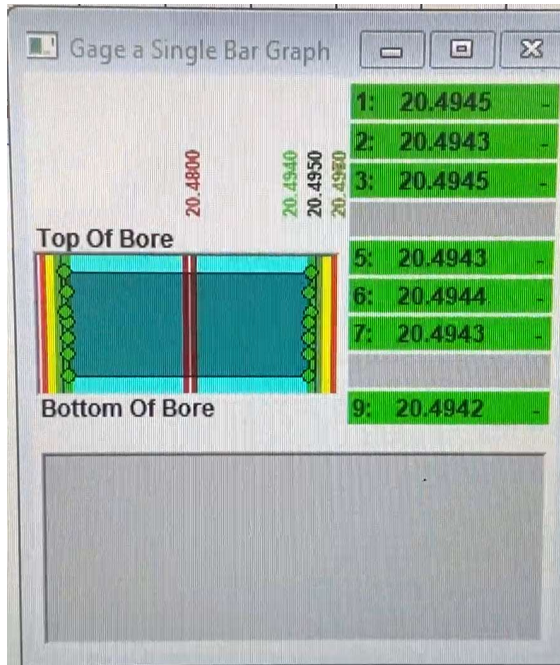
fixture redesign

learnings

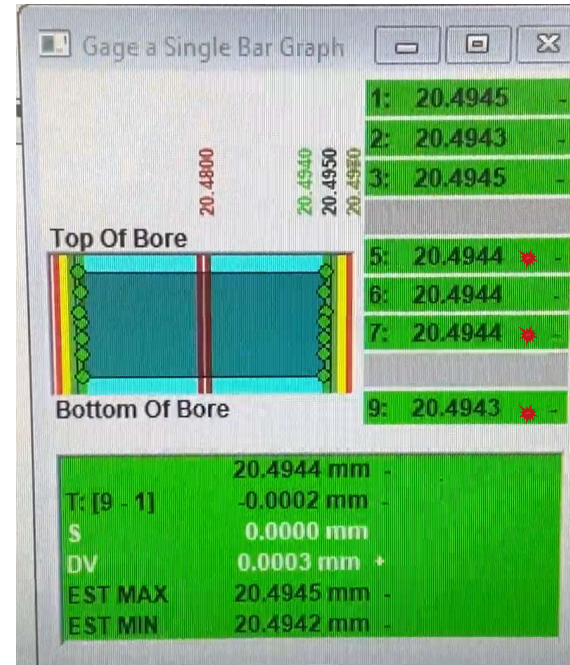




gage repeatability



first measurement



second measurement

- Estimated deviation: 0.3 μm
- Gage is very capable, 0.1 μm variation *

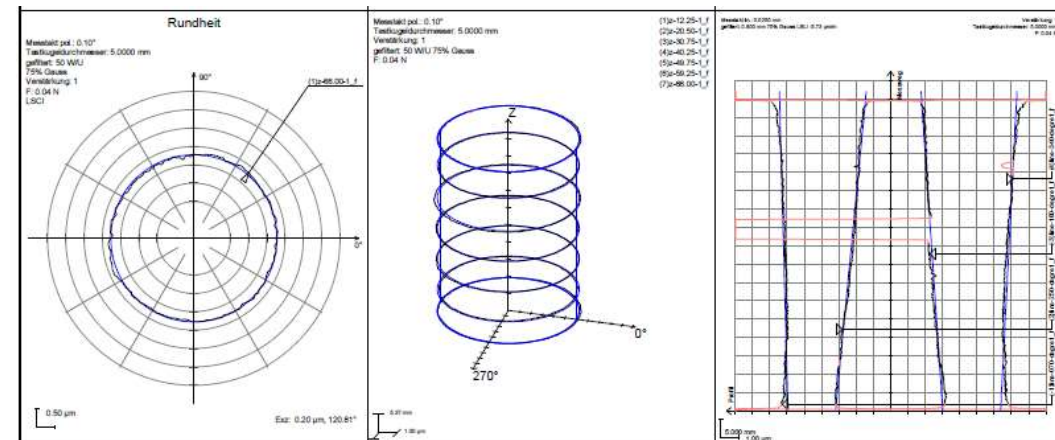


Process results

- ✓ size stability variation < 1 μm
- ✓ Cylindricity *lo/* 0.5 to 0.7 μm
- ✓ Line straightness 0.6 – 0.9 μm
- ✓ Axis straightness 0.2 – 0.4 μm

- ✓ Not one reject part produced

MarWin 13.20-16 SP 1		QE Mehrfachgrafik Aufgabe: "Multigrf"	04.06.2024 2 15:15:11 Prüfer: Robert Unterschrift:
Teil:	Zeichnungs-Nr.:	Bearbeitungsschritt:	
Bloc eassais lapping	-	lapped	
Part #194-1	CTC		
Kommentar: LAPC090002			
Ausgewertetes Element	Typ	Toleranz (μm)	Abweichung (μm)
Cylindricité-3D		1.00	0.55
Line-all-linear		1.00	0.75
line-070-degre1_f		1.00	0.61
line-250-degre1_f		1.00	0.43
line-160-degre1_f		1.00	0.51
line-340-degre1_f		1.00	0.75
Axis-straightness		1.00	0.21
Circularite		0.70	0.31
z-05.00-1_f		0.70	0.24
z-12.25-1_f		0.70	0.15
z-20.50-1_f		0.70	0.23
z-30.75-1_f		0.70	0.31
z-40.25-1_f		0.70	0.19
z-49.75-1_f		0.70	0.19
z-59.25-1_f		0.70	0.19
z-66.00-1_f		0.70	0.22


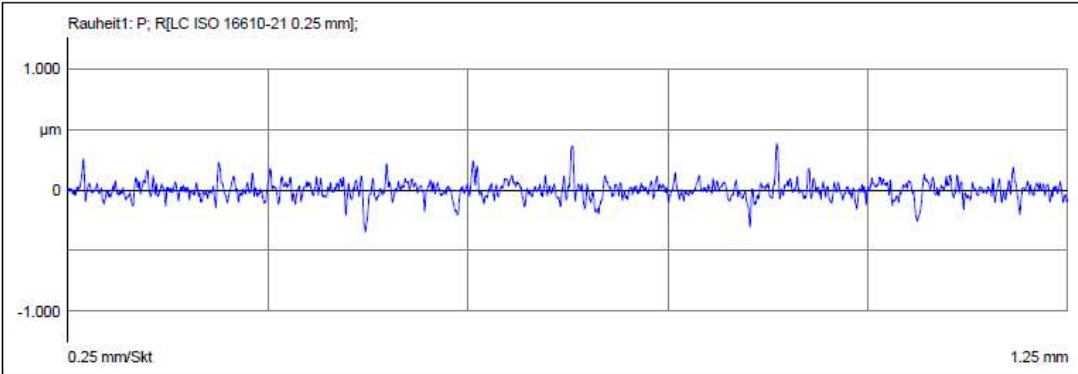


steering block



Process results

- ✓ Surface between Ra 0.04 -0.06
- ✓ Harmonic structure ratio Rz / Ra

		MarWin 13.20-16 SP 1	QE Rauheit Aufgabe: "Rauheit"	26.04.2024 1 15:47:45 Prüfer: Robert Unterschrift:
Teil: Bloc	Zeichnungs-Nr.: Keine 0	Bearbeitungsschritt: Lapped		
Part # 192-5_entrance		CTC		
SVL2115				
Kommentar: LAPC090002				
Messgerät: MarTalk Vorschubgerät: SD26 Taster: BFW A 10-45-2/90		Lt: 1.75 mm Ls: 2.50 µm VB: +/-250.0 µm Vt: 0.10 mm/s Punkte: 3498		
Rauheit1: P; R[LC ISO 16610-21 0.25 mm]; 				
Rauheitskennwerte - Rauheit1: P; R[LC ISO 16610-21 0.25 mm];				
Ra	0,052 µm	0,000		0,100
Rz	0,532 µm	0,000		1,000

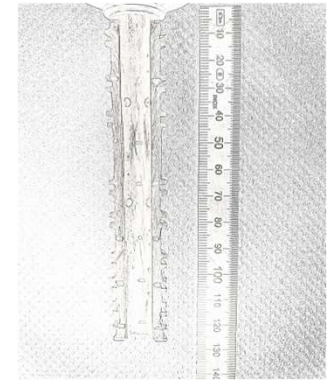


case study: steering sleeve





Customer request



Part dimension

Bore length: 110 mm
 Part length: 120 mm
 Material: stainless steel > 56 HRC

* Not Sunnen standard, varies in form and size

Challenge

- Diameter- form and surface tolerances after lapping
- Honed parts with big variation
- Long term test

TOLERANCES	HONED*	LAPPED
removal	customer	0.010 – 0.015
diameter	Ø10 +0/ 0.004	Ø10.01 +0.004 (min 0.010 stock removal)
cylinder /o/	4 - 12 µm	< 2.5 µm
axis straightness	3 - 10 µm	< 0.5
roundness	2 – 4 µm	< 0.5 µm
surface Ra	0.1 – 0.3	< 0.1 µm
cycle time		< 20 minutes !!



solution and
integration

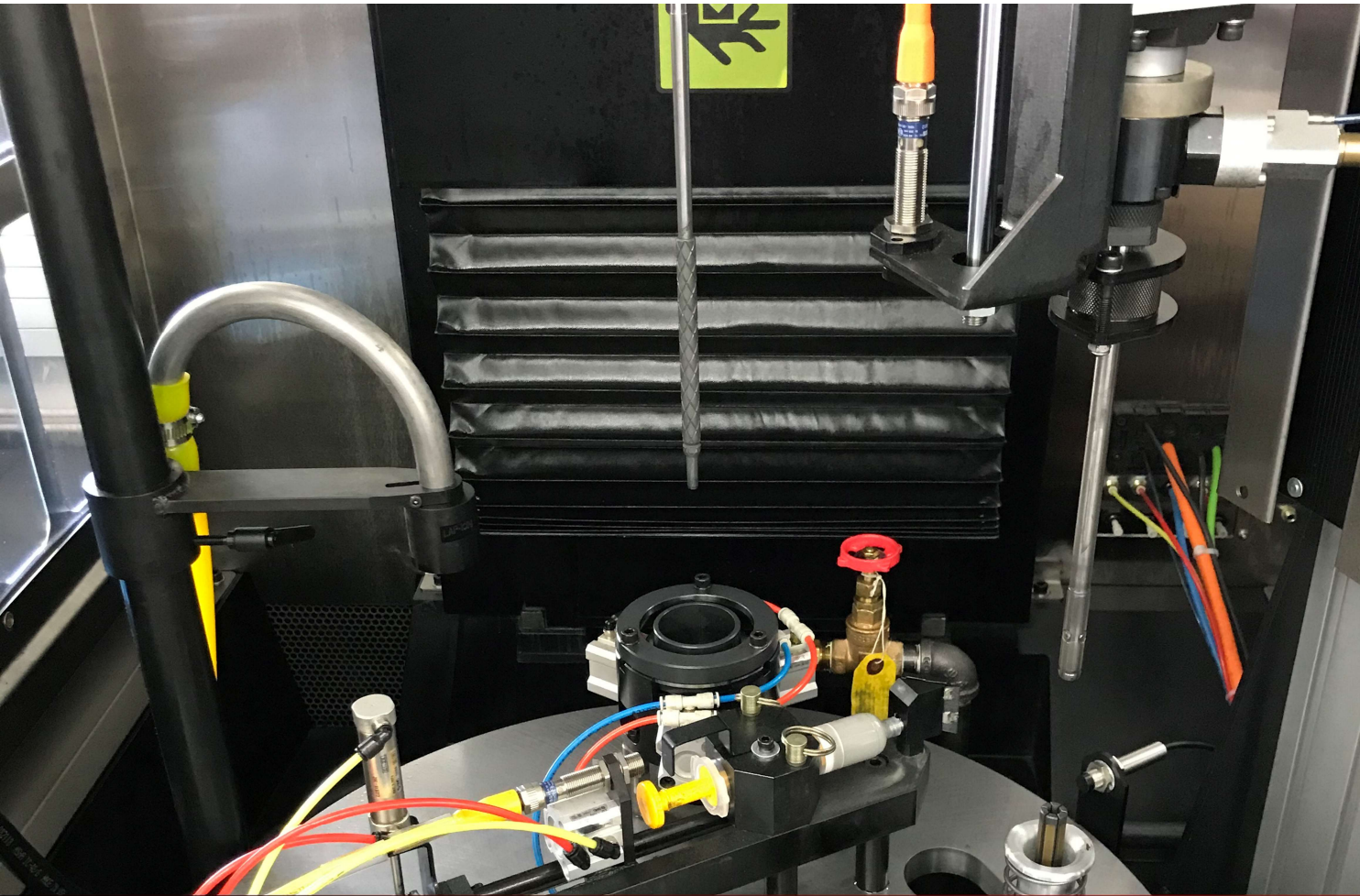




- Situation



- long term test



Ups...first step

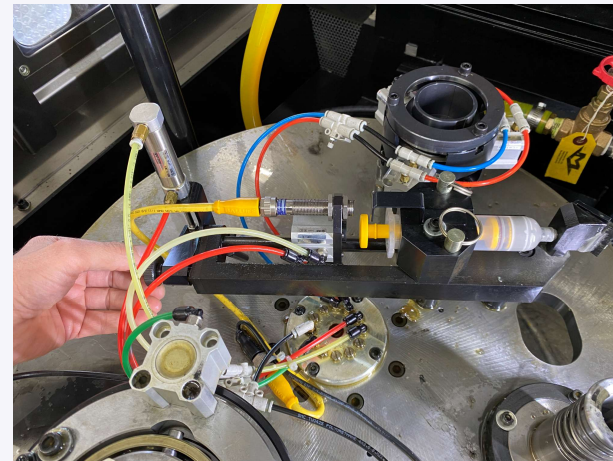
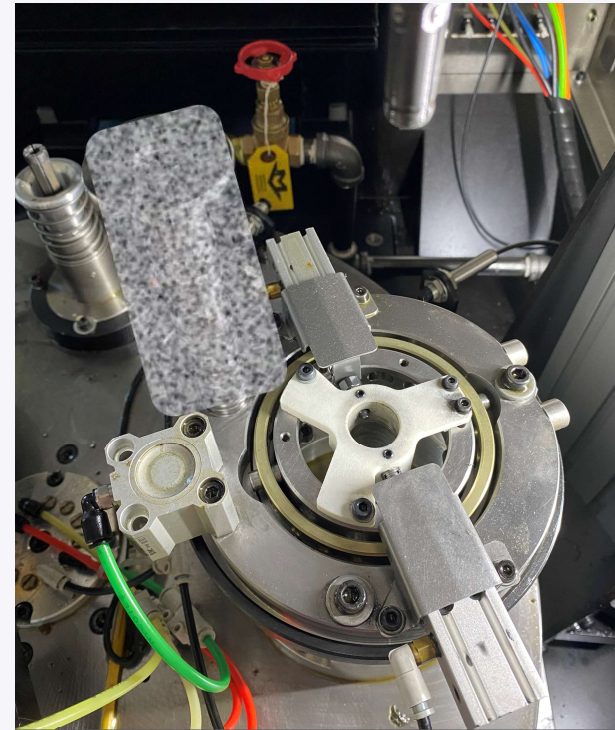


steering sleeve



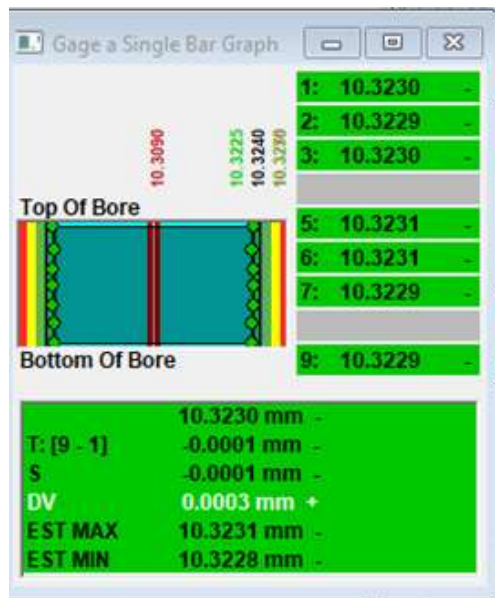
Re-engineering

- Fixture
- Lapping sleeve
- Paste
- Lap-applicator

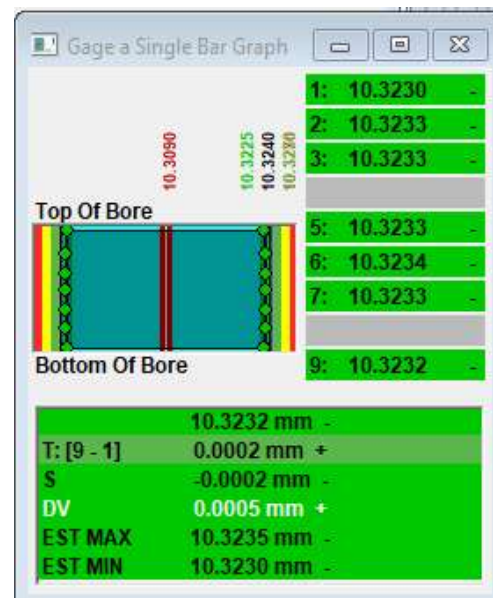




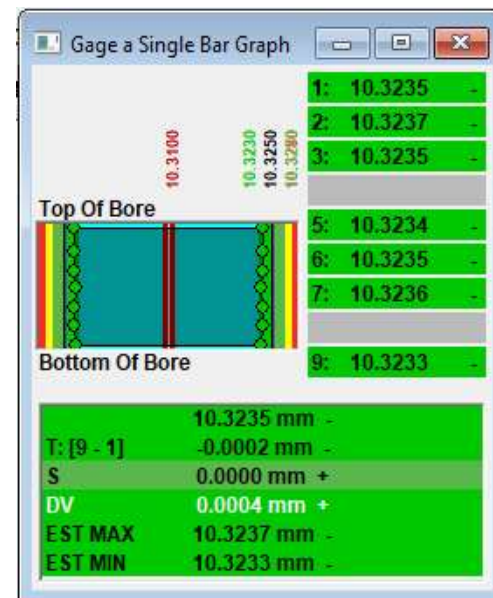
Ø-Diameter stability



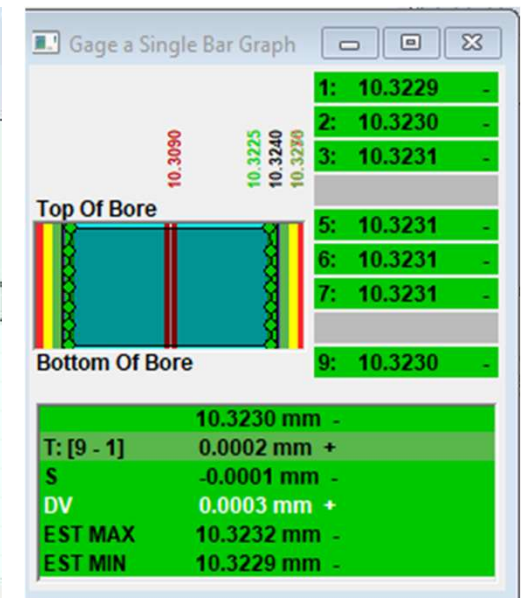
1) sample



2) sample



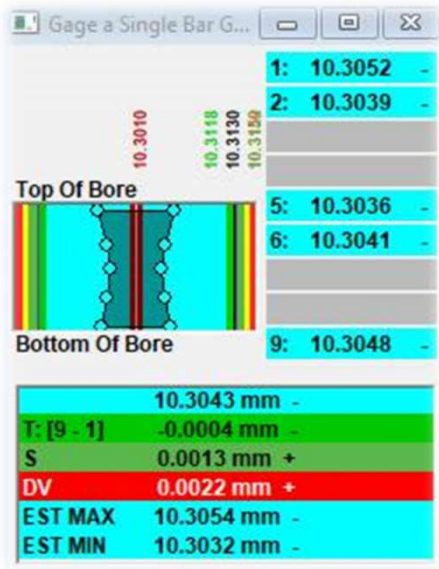
3) sample



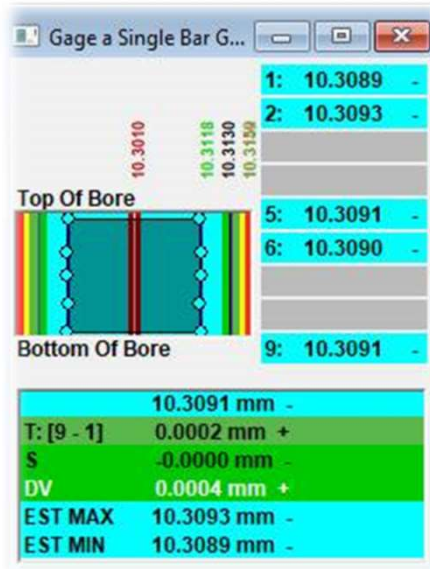
4) sample



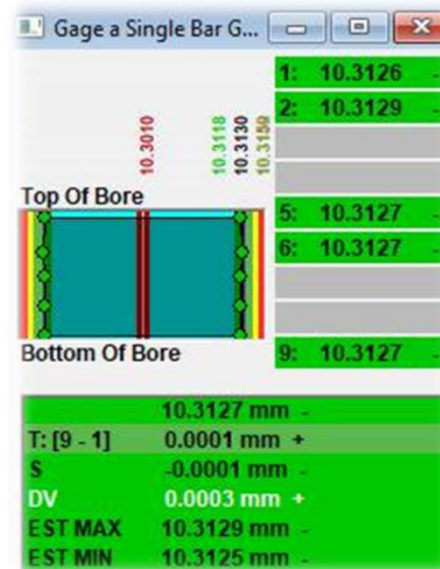
total cycle time, process



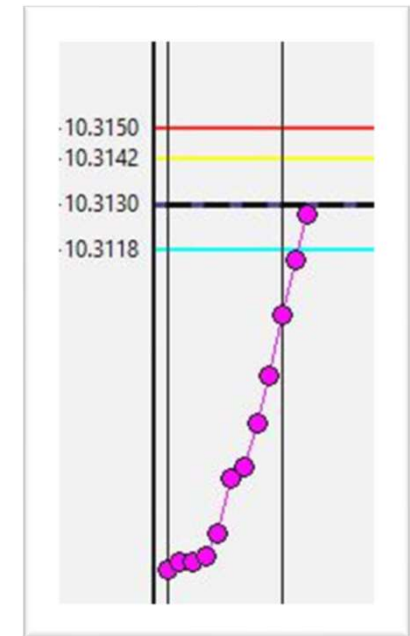
start



progress



end cycle



Cycle time < 20 minutes



Process results

- ✓ Cylindricity /o/ 1 – 2 μm *
- ✓ Axis straightness 0.5 – 1 μm *
- ✓ Roundness < 0.5 μm

* Depends on pre-honed quality

-		LAPPED		Unterschrift:
Part # 400/184		CTC		
Kommentar: LAPC090001, Nacharbeit				
<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm gefiltert: 50 W/U 50% Gauss Verstärkung: 2 F: 0.03 N LSCI</p> <p>Exz: 0.62 μm, 114.91°</p>	<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm gefiltert: 50 W/U 50% Gauss Verstärkung: 2 F: 0.03 N LSCI</p> <p>Exz: 0.23 μm, 75.97°</p>			
<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm gefiltert: 50 W/U 50% Gauss Verstärkung: 2 F: 0.03 N LSCI</p> <p>Exz: 0.34 μm, 12.71°</p>	<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm gefiltert: 50 W/U 50% Gauss Verstärkung: 2 F: 0.03 N LSCI</p> <p>Exz: 0.28 μm, 61.06°</p>			
<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm gefiltert: 50 W/U 50% Gauss Verstärkung: 2 F: 0.03 N LSCI</p> <p>Exz: 0.49 μm, 109.77°</p>	<p>Einzelpunktantastung</p> <p>(1) Jet-achse, achsengeradheit</p>			
<p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm Verstärkung: 2 gefiltert: 50 W/U 50% Gauss F: 0.03 N</p> <p>Exz: 11.88 mm</p>	<p>(1)-007.5-1_f (2)-030.0-1_f (3)-065.0-1_f (4)-093.0-1_f (5)-118.0-1_f</p> <p>Messtakt pol.: 0.10° Tastkugeldurchmesser: 3.0000 mm Verstärkung: 2 gefiltert: 50 W/U 50% Gauss F: 0.03 N</p> <p>Exz: 11.88 mm</p>			
Ausgewertetes Element	Typ	Toleranz (μm)	Abweichung (μm)	
Rundheit-007.5	○	0.70	0.09	
Rundheit-030.0	○	0.50	0.14	
Rundheit-065.0	○	0.50	0.12	
Rundheit-093.0	○	0.50	0.22	
Rundheit-118.0	○	0.50	0.08	
Achsengeradheit	□	2.00	0.70	
Zylinder	▧	3.50	1.02	

Process results

- ✓ Surface between Ra 0.05 -0.07
- ✓ Harmonic structure ratio Rz / Ra in the range of 8-10
- ✓ Hardly any difference between top and bottom





honing

process difference

lapping

AUTOMATISCHER

Warning!! - Please use caution while manually moving the 'S' (partially visible)

Next Cycle Will Be In Automatic M (partially visible)

Column A Gas Gage

Cycle Time (sec)

Start 0.0

Tool Load (%)

Current Lap Diameter : 10.3175 mm
Total Lap Time: 16:10
Total Process Time: 51:16

Gage a Single Bar Graph

Top Of Bore

Bottom Of Bore

DV 10.3175 mm -
EST MAX 0.0006 mm +
EST MIN 10.3178 mm -

F1 ABSCHALTEN AUTOMATIK
F11

F2
F12

F3 ZYKLUS EINSTELLUNGEN
F13

F4
F14

F5 HANDWHEEL SETUP
F15

F6 CLEANUP CYCLE
F16

F7 GEOMETRY ADJUSTMENT
F17

Bohrungsdurchmesser (mm) 14.9976

Werkzeuglast (%)

Zykluszeit: 26 Zykluszähler: 4

Spindellast (%)

Messsystem a Einze...

1: 14.9982 +
2: 14.9977 -
5: 14.9979 -
6: 14.9983 +
7: 14.9981 +
9: 14.9978 -

14.9985
14.9985
14.9980
14.9985
15.0010

oberer Bohrungsebene
Bohrungsende

14.9980 mm +

14.9800 14.9980

Bohrungsdurchmesser (mm)

1 1
2
3
4
5

Gage Compensations

Legend

Sample 2
Nominal Size = +5.0000 mm
Nominal Offset = -0.0000 mm
Target = +5.0000 mm
To Limits = (+0.0000, +0.0000) mm
Cul Limits = (-0.0000, -0.0000) mm
Average = +5.0028 mm
Running Average = +5.0028 mm

Table S

Total Samples: 42

#	Reading (mm)
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000

F1 MAIN MENU
F11 CHECK COOLANT

F2 RUN SETTINGS
F12

F3
F13

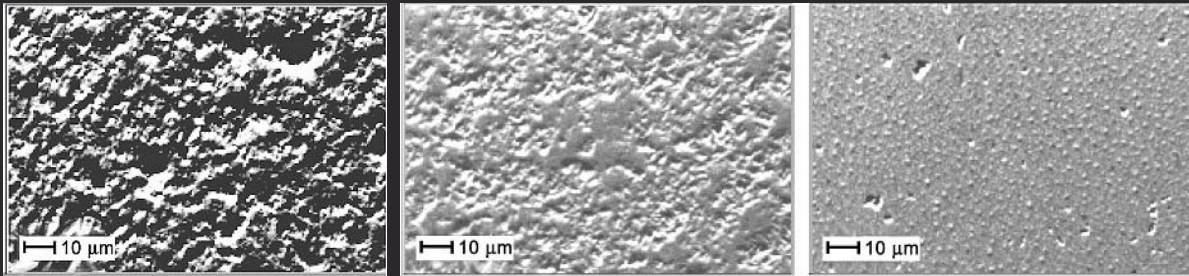
F4 SETUP MENU
F14

F5
F15

F6
F16

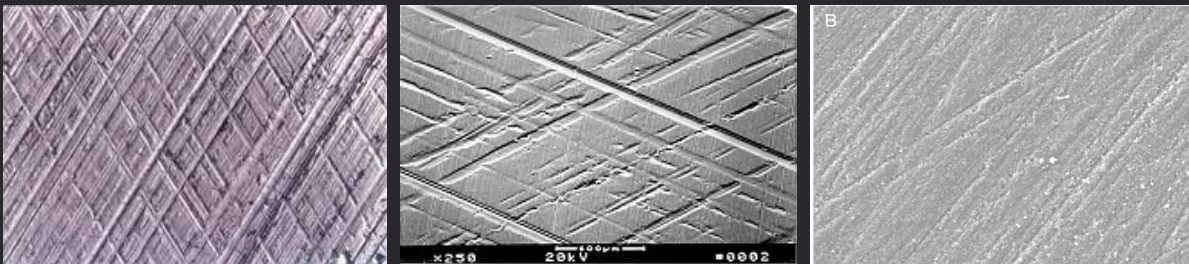
F7
F17

- Difference lapping \leftrightarrow honing



Lapping

Polished



Honing

Finished



Let's golf



Lapping $\leftarrow \rightarrow$ honing

golf course :

- ❖ white circle = size tolerance
- ❖ black dot = nominal size
- ❖ green stripe = form tolerance
- ❖ length = 150 m



Lapping

- start position
- fairway (ideal pre-honed)
- distance: 20 m +/- 2

Tools

- pitching wedge (paste), initial run
- putter (paste), final run



Process

- 10 – 20 steps
- Slow but safe

Navigation

- Air gage system in process
- GPS in “real time”

Honing

- start position
- distance: 150 m +/- 10

Tools, Iron-5
(stones A35, A45, J65...)



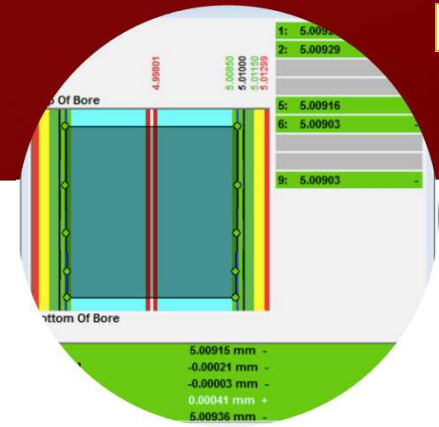
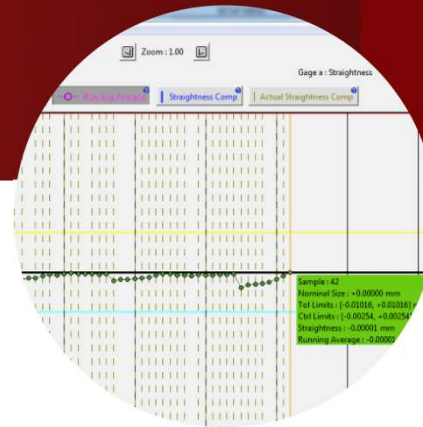
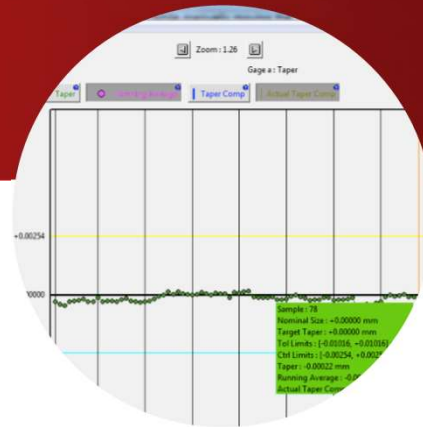
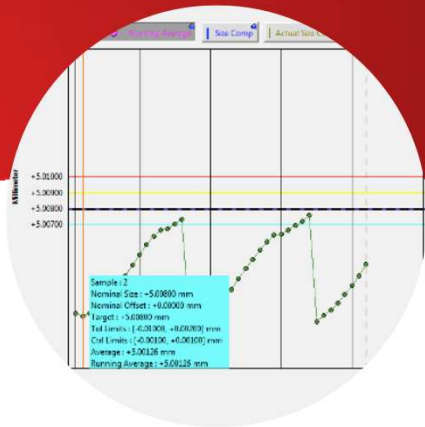
Process

- 1 strike
- Fast but risky

Navigation

- Air gage system post process
- GPS with Delay “not real time”

process control



RBO

RBO

diameter

Robert Buchmüller; 2024-10-07T10:26:19.553



Let's go live

Automation





Conclusion

 **Go to the customer**

 **Work with the customer**

hands on, persistent, critical, reactive, active
Implement and improve knowledge gained

 **Stay with the customer**

after sale is before sale
Tools and fixtures for further parts



Thank you
for your
attention

Robert Buchmüller