



fives

MARKET BACKGROUND

Date: 2/2023

Prepared by: Caitlin Barnhart



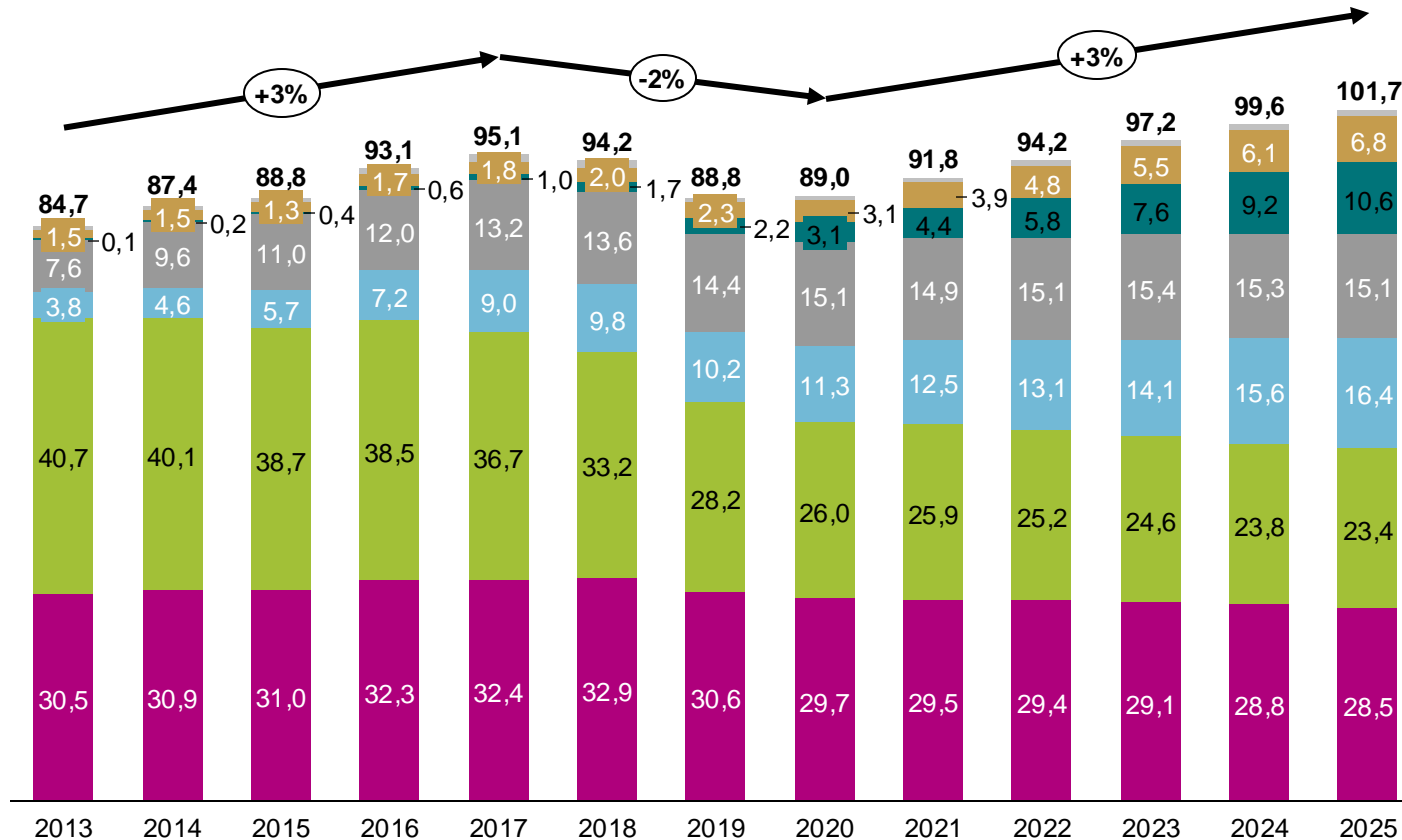
OVER THE NEXT YEARS, REDUCTION, AMT AND DHT WILL EXPERIENCE THE MOST IMPORTANT GROWTH WITH AROUND +16 MILLION TRANSMISSIONS PRODUCED IN THE WORLD



Worldwide Transmission Production Evolution

of million cars produced, 2013 - 2025

- AMT Reduction DCT Automatic
- DHT CVT Manual

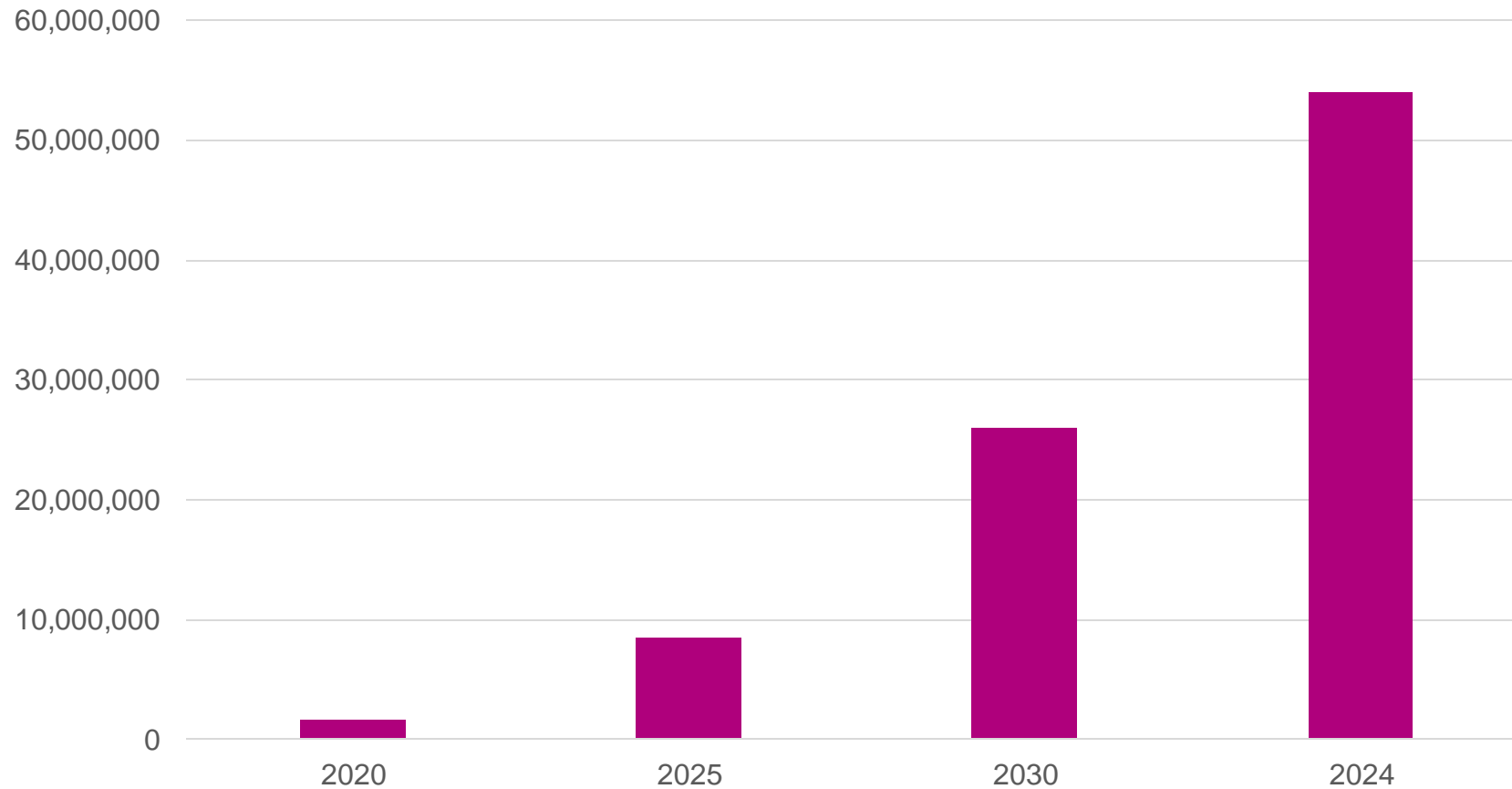


Equates to approx. 400 new grinding machines over 5 years



ELECTRIC VEHICLE OUTLOOK 2020

Projected EV Sales



500

Different EV models globally by 2022

Source: <https://about.bnef.com/electric-vehicle-outlook/>



fives

HISTORY

Date: 2/2023

Prepared by: Caitlin Barnhart

3L PLATFORM DEVELOPMENT

1979 - PROJECT INITIATED

1981 - FIRST MACHINE BUILT

1985 - CARRIAGE DRESSER FOR CBN

1987 - INTRODUCTION OF HYDROSTATIC WHEEL SPINDLE BEARINGS

1989 - INTRODUCTION OF 32 BIT CONTROLLER

1989 - **100** MACHINES SHIPPED

1990 - 125 M/S WHEEL SPEED CAPABILITY

1990 - HEADSTOCK MOUNTED DRESSER (11,000 RPM)

1991 - INTRODUCTION OF CNC TRUFORM DRESSER

1992 - **200** MACHINES SHIPPED

1994 - **300** MACHINES SHIPPED

1996 - **400** MACHINES SHIPPED

1997 - PC BASED 6400 CONTROL INTRODUCED

1997 - LINEAR MOTOR OPTION INTRODUCED

1998 - **500** MACHINES SHIPPED

1998 - 180 M/S WHEEL SPEED CAPABILITY

2000 - **600** MACHINES SHIPPED

2002 - **700** MACHINES SHIPPED

2005 – Infinitely variable position B-axis developed

2010 – Single PC (multi-core) 6400 control introduced

2012 – Linear rails replace traditional vee & flat

2015 - **800** MACHINES SHIPPED

2017 – 3L modernisation program commenced

2018 – Siemens control variant introduced

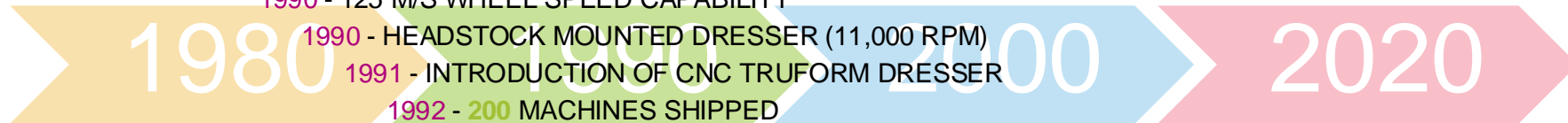
2019 – 3Lve development completed

2020 – Development focus on new generation transmission and E-drive



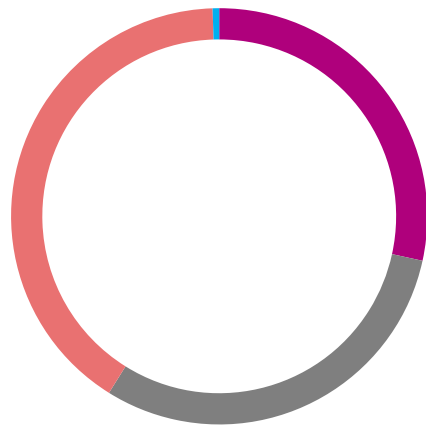
LANDIS

SINCE 1890



3L MACHINE PLATFORM

Breakdown of 3L sales
by geographical area



- The Americas
- Asia and Oceania
- Europe
- Africa and the Middle East

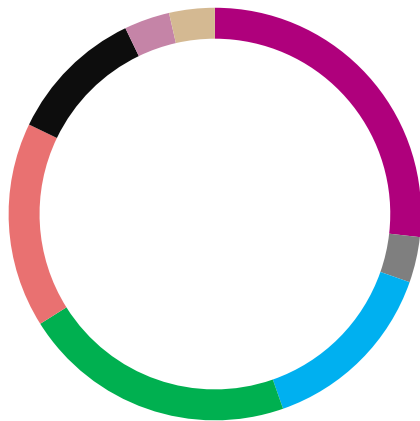
More than
800 machines | sold worldwide

Over **40** years
of development and
experience

90% | of machines still in
production today thanks
to Fives' full life support

MACHINES WITH B-AXIS

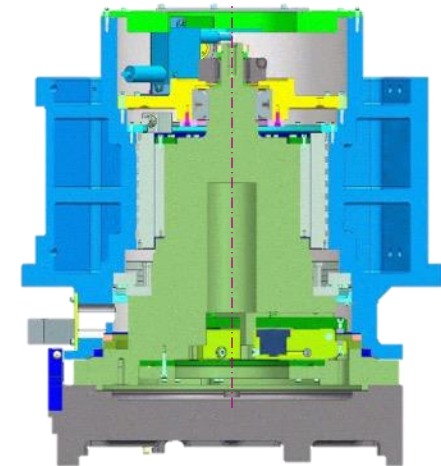
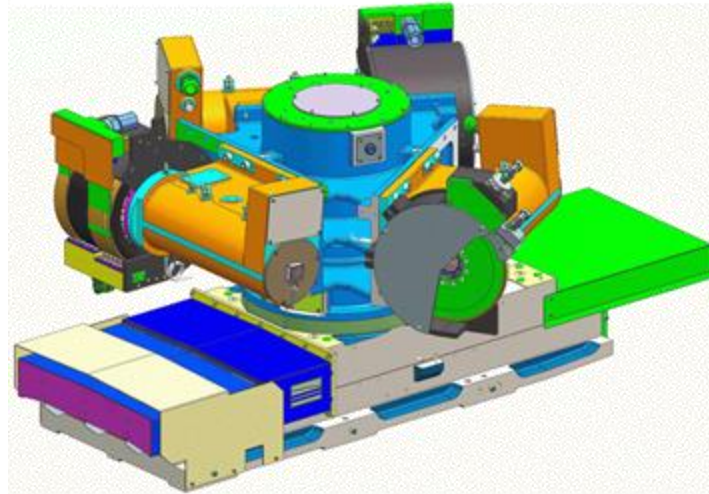
Breakdown of sales
by country



■ Germany ■ India ■ China ■ USA
■ Sweden ■ Poland ■ Mexico ■ UK

Over 50 machines

sold with B-Axes
Since 2010





fives

KEY FEATURES

Landis 3LVe

Date: 2/2023

Prepared by: Caitlin Barnhart

KEY ATTRIBUTES

- High stock removal – fast cycle time (Higher power and mechanical stiffness)
- Multiple spindles to allow combined processed (B-axis, up to 3 wheels)
- Plunge or peel processes
- Conventional, vitrified or electroplated CBN wheel options in the same setup
- Single-box solution for flexible production demands
- Higher power density (fewer machines, less floorspace)
- ID/OD possibility
- Customer specification compliant (major auto OEMs)



KEY DIFFERENTIATORS

- Up to 3-wheel spindles, each with power >50kW
- Grinding wheel width over 250mm
- Suitable for carbon fiber, high speed grinding wheels
- Infinitely variable B-axis positioning
- Automatic taper compensation
- Integral automation options minimizing non-grinding times
- Turnkey solution with automation, part cleaning, coolant system, etc.
- Combined ID grinding (option), e.g. for DCT shafts
- Flexible solutions for multiple part types with minimal changeover





fives

STIFF & RIGID BY DESIGN

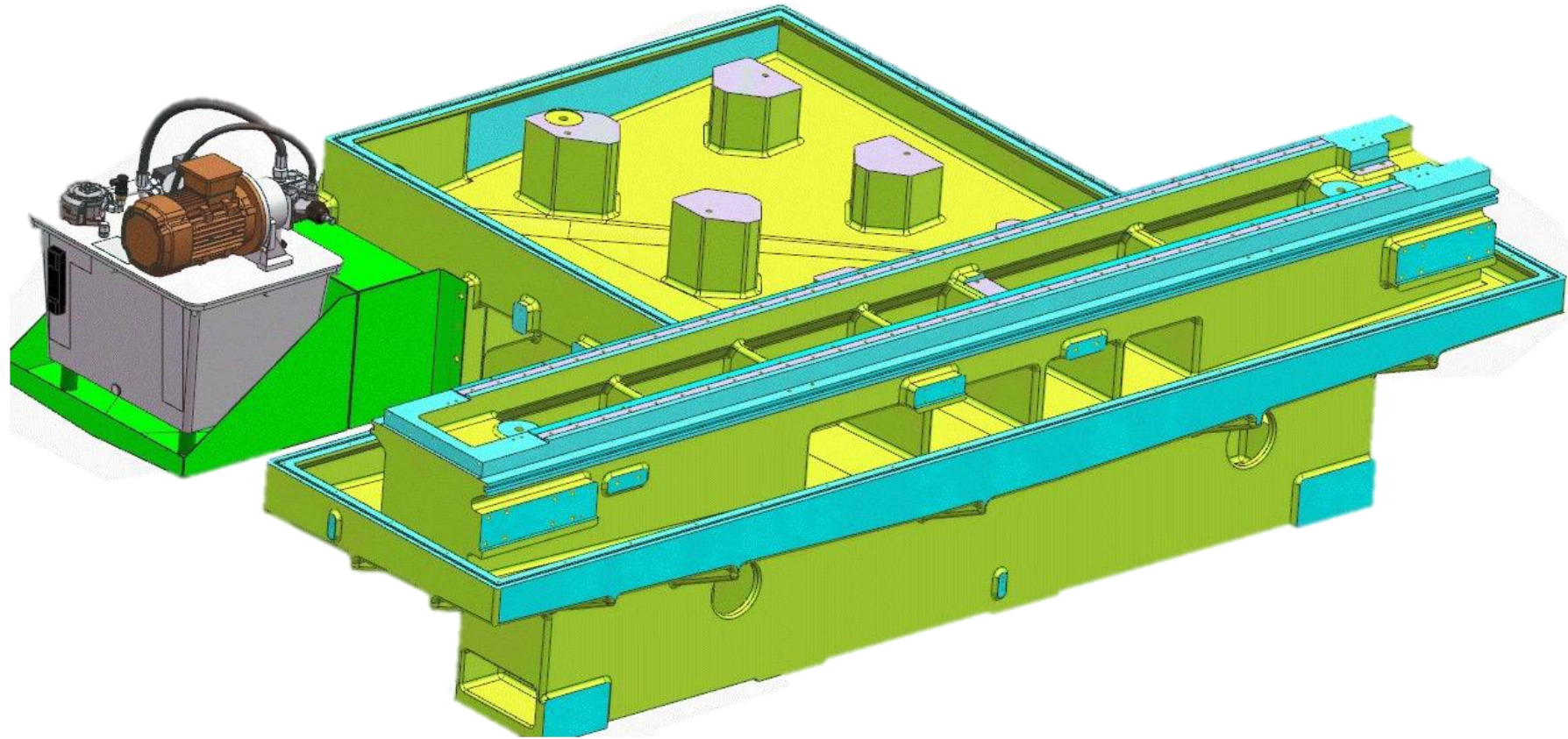
Landis 3LVe

Date: 2/2023

Prepared by: Caitlin Barnhart

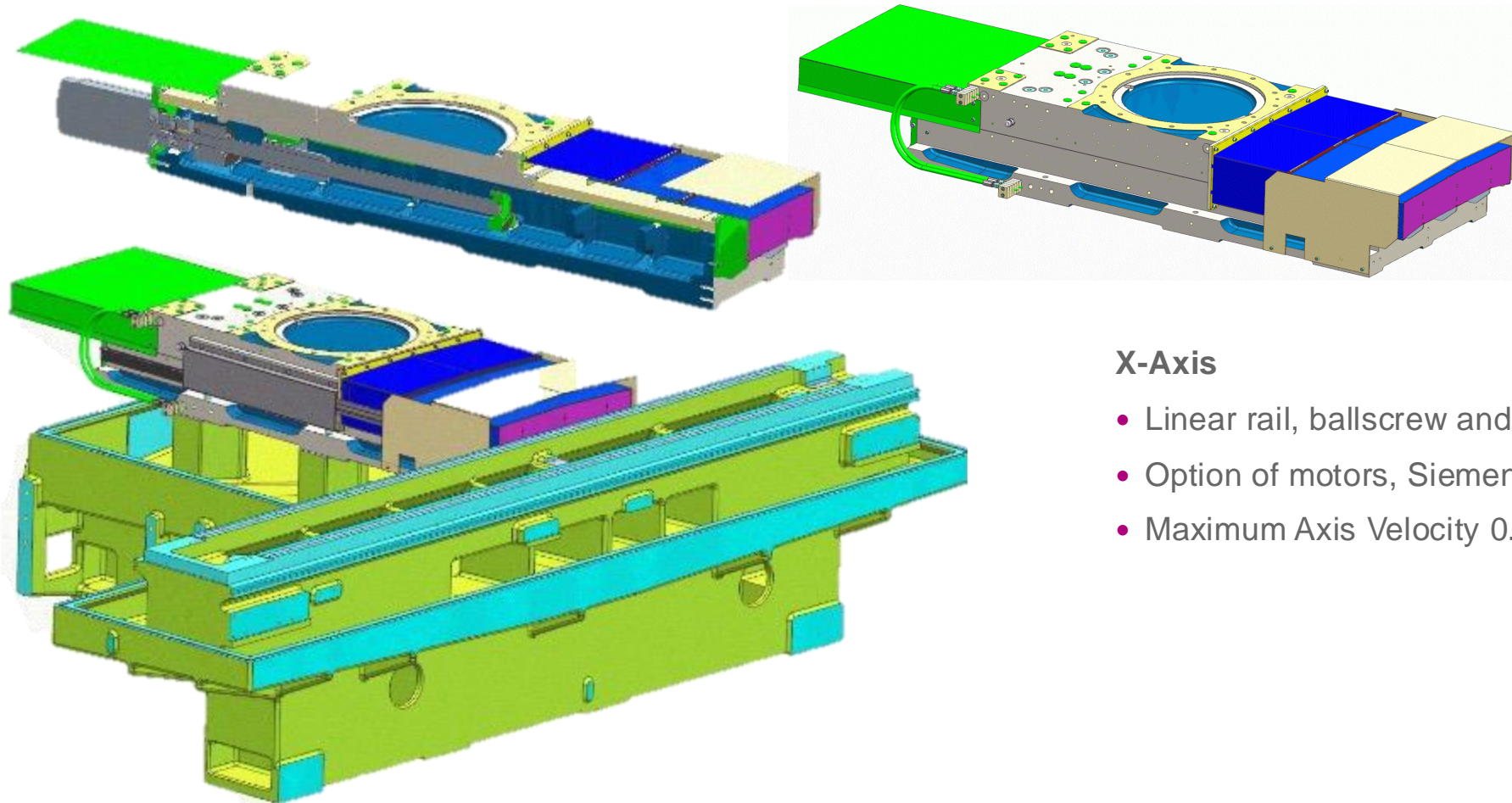
MACHINE STIFFNESS

Fundamental machine designed for stiffness, rigidity and thermal stability



X-AXIS

Increased footprint for superior stiffness and power delivery

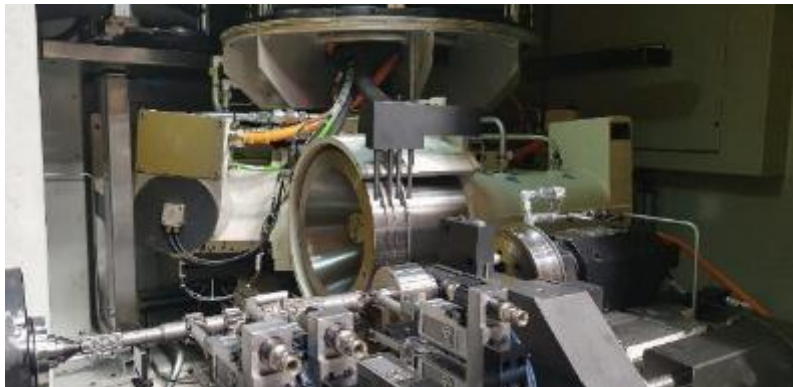
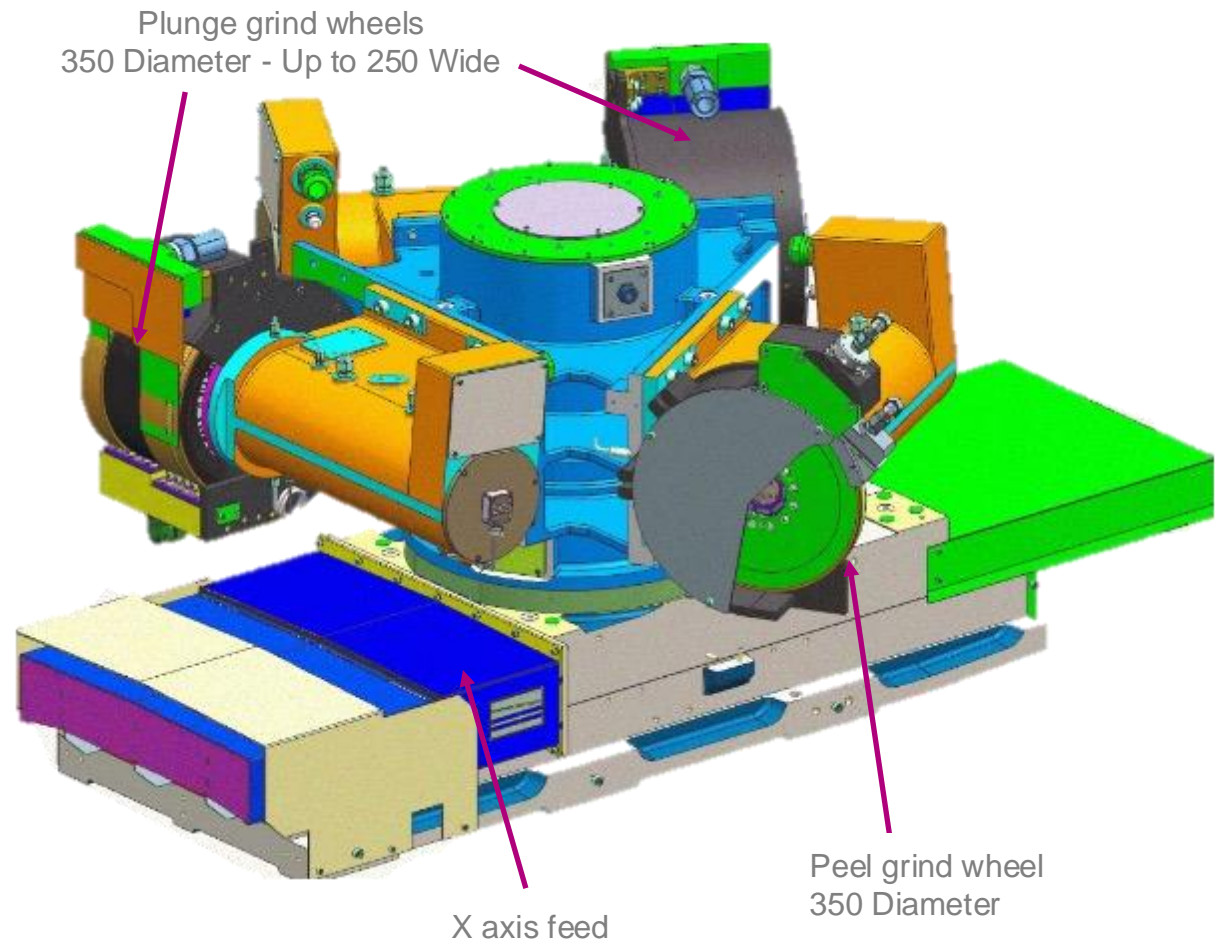
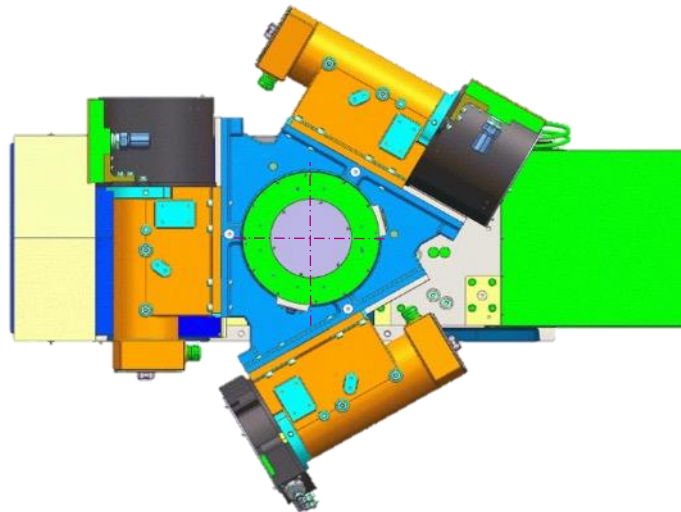


X-Axis

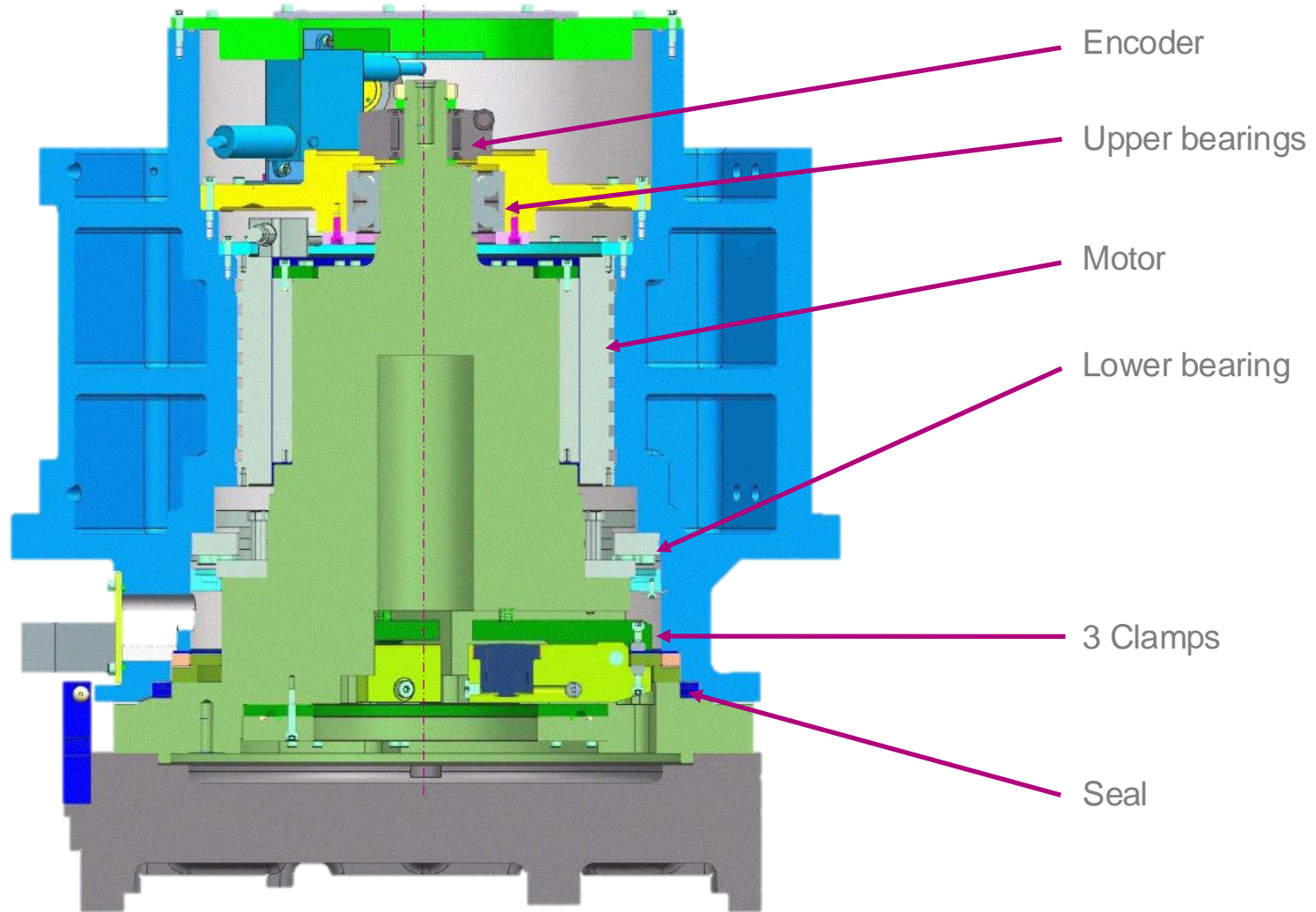
- Linear rail, ballscrew and nut
- Option of motors, Siemens, Bosch, Fanuc
- Maximum Axis Velocity 0.50 M/sec

B-AXIS – INFINITELY VARIABLE POSITION

Ultra stiff design with YRT bearing and direct drive motor



INFINITELY VARIABLE B-AXIS POSITION



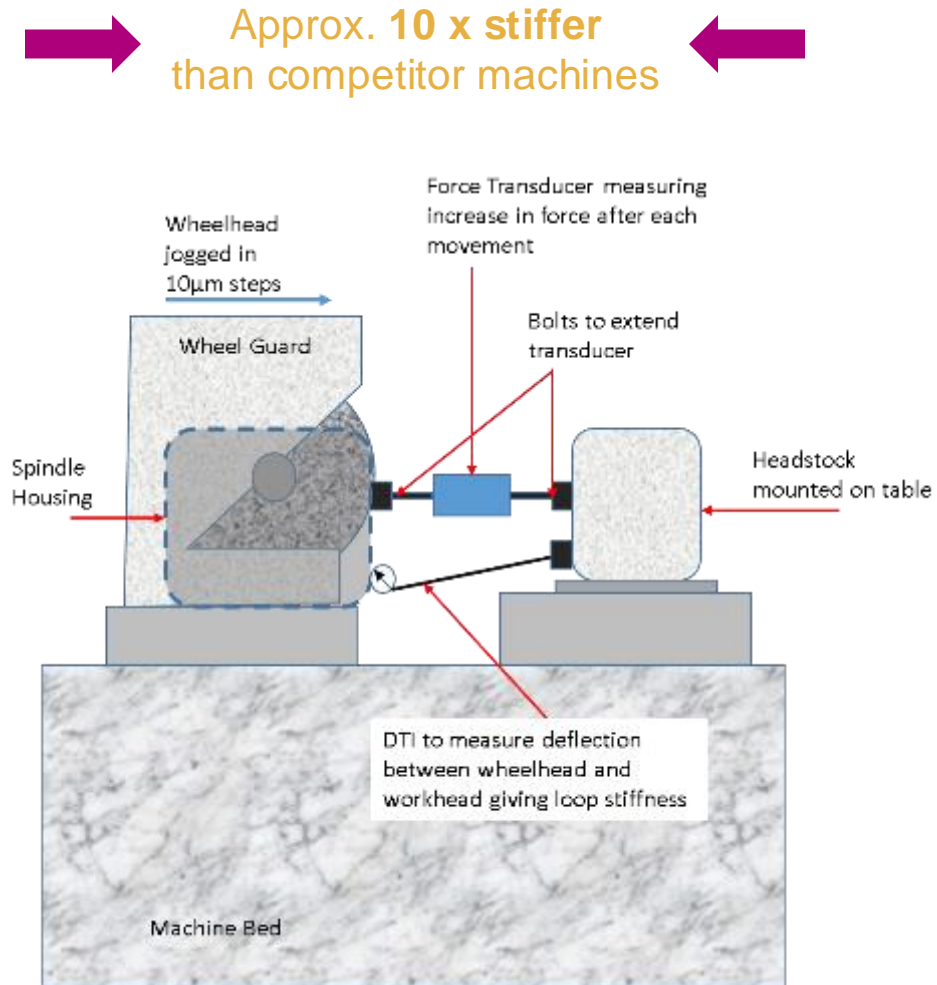
MACHINE STIFFNESS

Landis 3LVe vs. Competitor

Machine Type	Loop Stiffness (N/ μ m)
Landis 3LVe (3-spindle)	58.24
Competitor M/C #1	7.71
Competitor M/C #2	3.99



Setup on competitor machine #2





fives

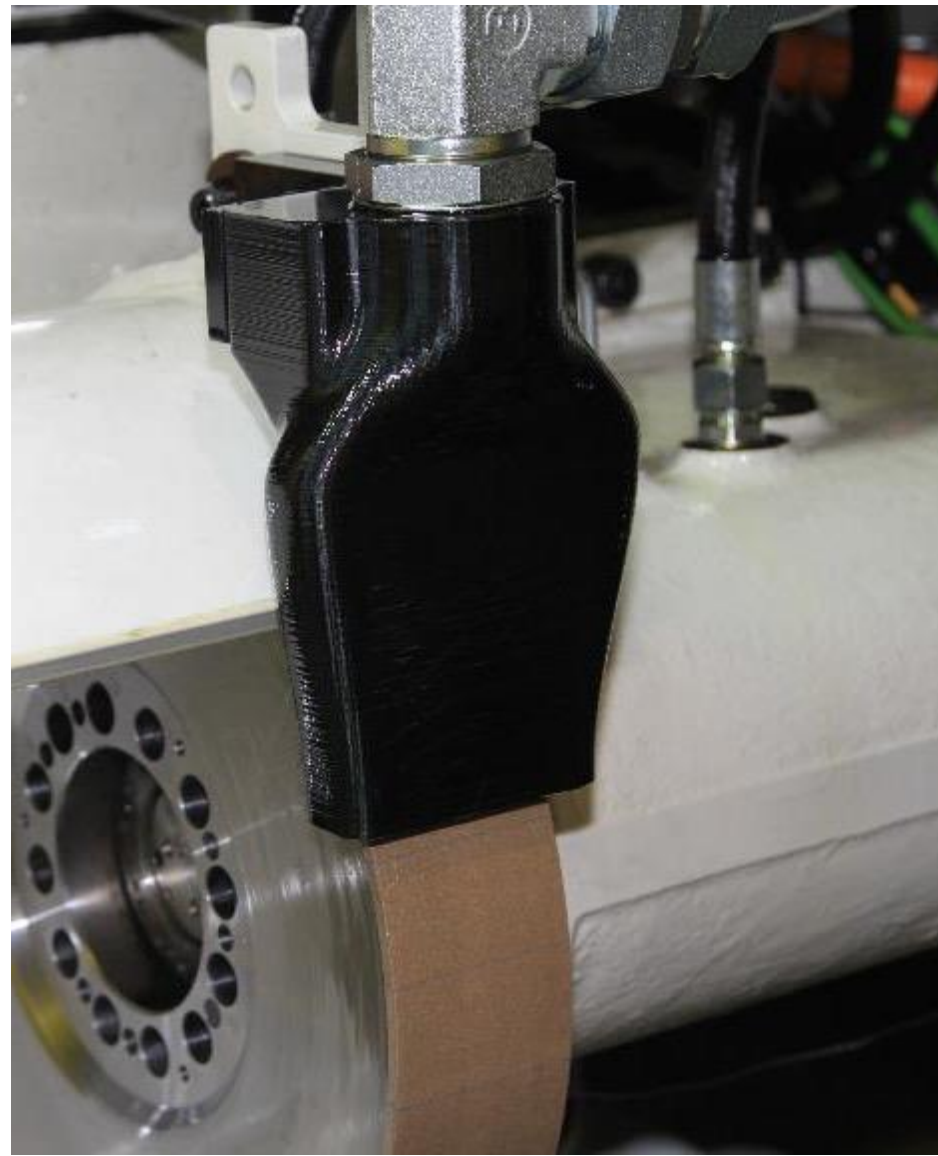
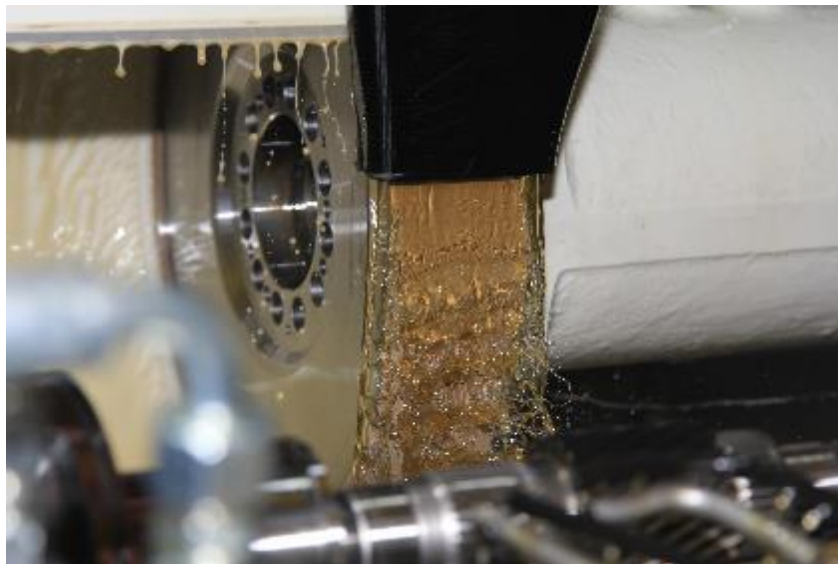
MACHINE CONFIGURATION

Landis 3LVe

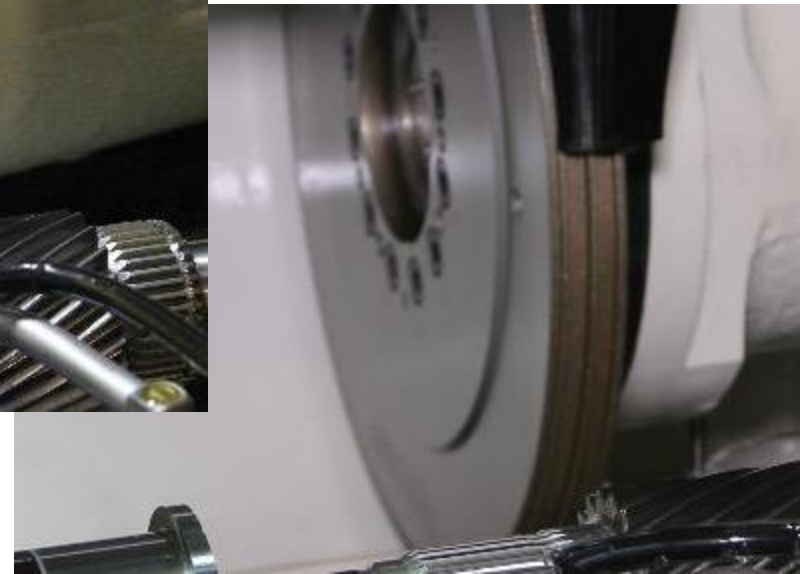
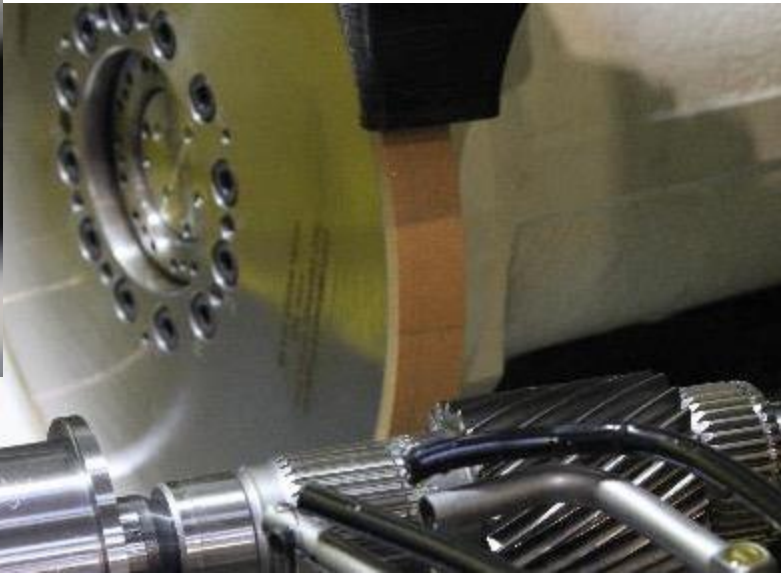
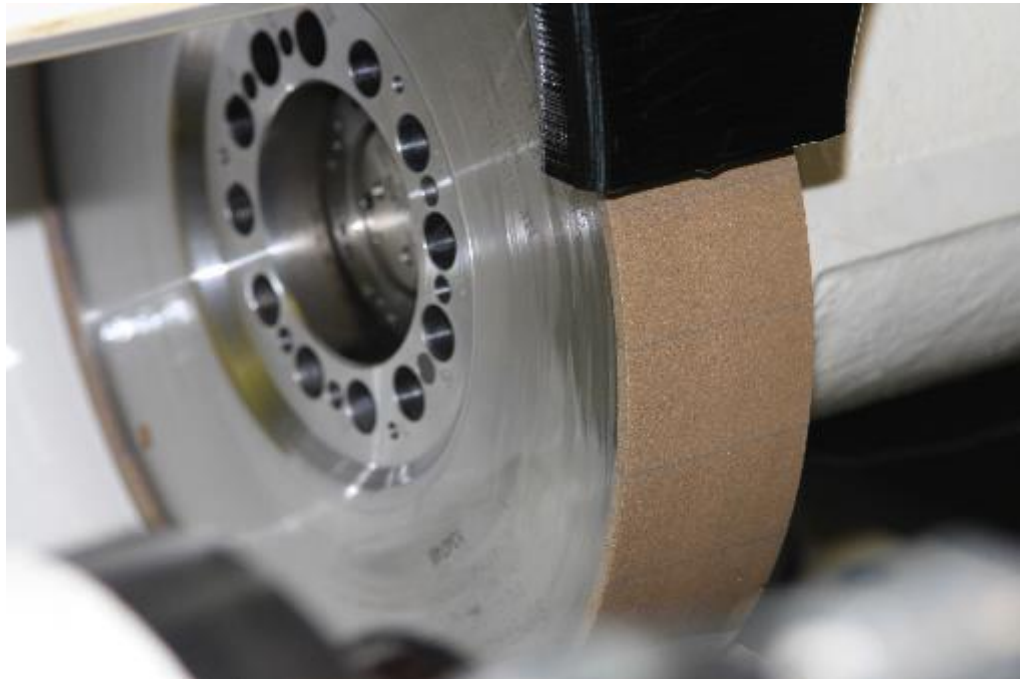
Date: 2/2023

Prepared by: Caitlin Barnhart

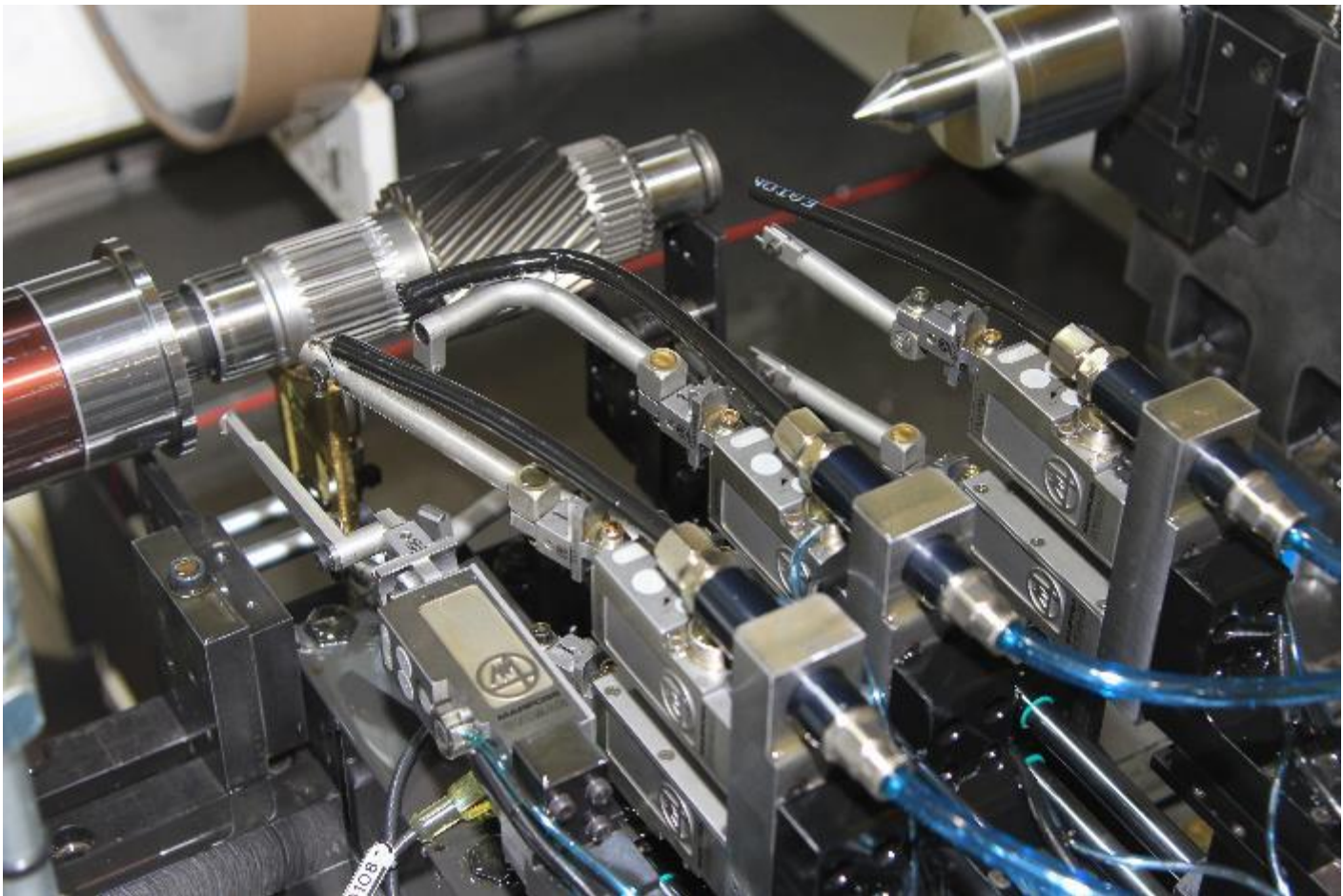
RAPID-PROTOTYPE 3D PRINTED COOLANT NOZZLES




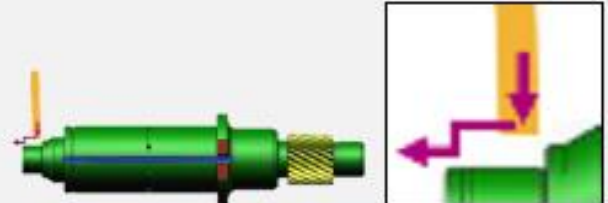
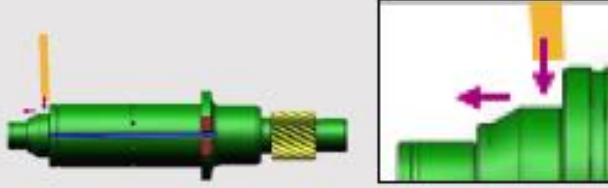


3 GRINDING WHEELS

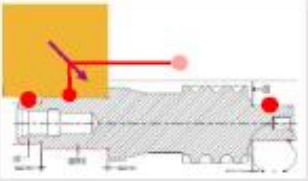

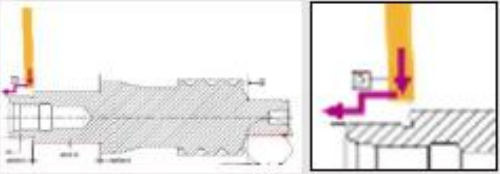
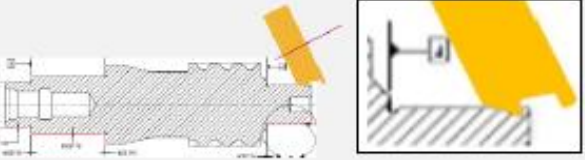


IN-PROCESS GAUGING



<p>Plunge 1 Wheel #1 Red marks indicate the gauge locations for this shaft type. Main dia. Gauges are linked for taper check & compensation</p>		<p>10 sec</p>
<p>Plunge 2 Wheel #1 Vector grind</p>		<p>17 sec</p>
<p><u>Note:</u> The two plunges will blend seamlessly. A final wipe across the diameter (traverse grind) following the double-plunge won't be necessary based on the given tolerance requirements.</p>		
<p>Plunge 3 Wheel #1</p>		<p>8 sec</p>
<p>Plunge 4 Wheel #2 Peel grinding of the journal profile</p>		<p>18 sec</p>
<p>Plunge 5 Wheel #2 Peel grind</p>		<p>12 sec</p>



Plunge 1 Wheel #1 Vector grind		17 sec
Plunge 2 Wheel #1 Vector grind		15 sec
Plunge 3 Wheel #2 Peel grinding of the journal profile		18 sec
Plunge 4 Wheel #3 Electroplated wheel for groove		8 sec

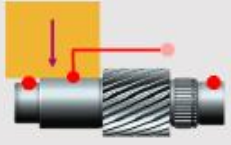




Total Grinding Time: 58 sec

Load / Unload: 6 sec

Machine movements: 19 sec

Dress delay / shaft: 3 sec

Total Floor to Floor Cycle Time: 86 sec

Plunge 1 Wheel #1 The taper gauge will have one head retracted as dia. is not sufficiently wide to justify taper check & compensation.		10 sec
Plunge 2 Wheel #1		8 sec
Plunge 3 Wheel #2 Peel grinding of the journal profile		18 sec
Plunge 4 Wheel #3 Electroplated wheel for groove		8 sec
Plunge 5 Wheel #3 Electroplated wheel		10 sec

Total Grinding Time: 54 sec

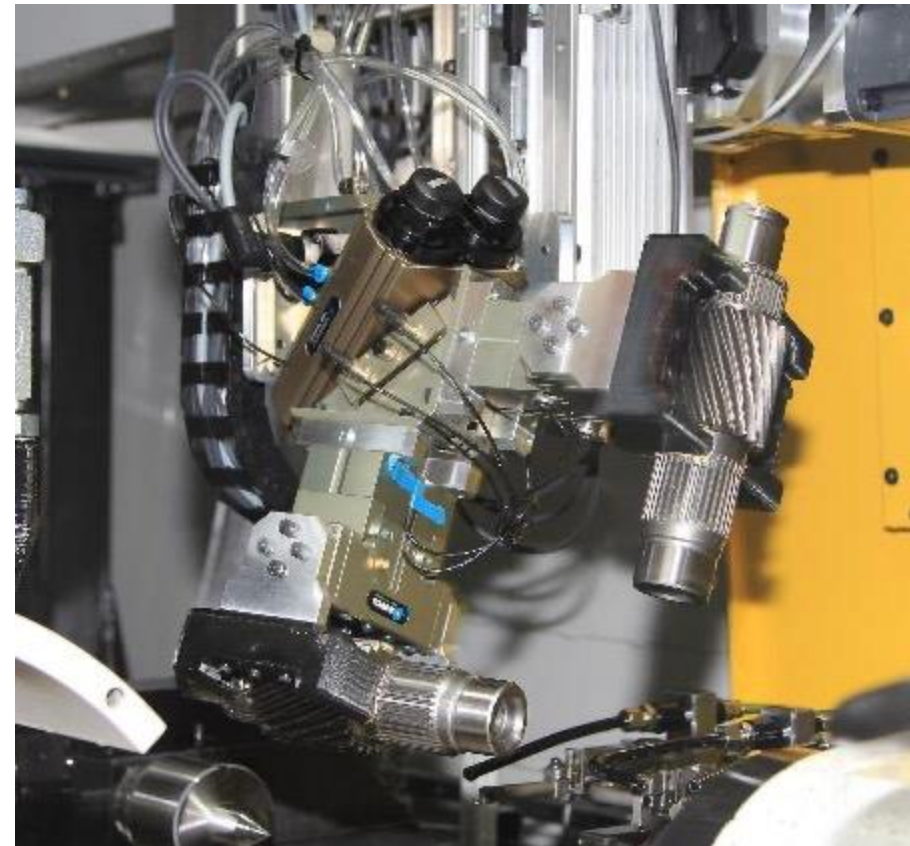
Load / Unload: 6 sec

Machine movements: 20 sec

Dress delay / shaft: 3 sec

Total Floor to Floor Cycle Time: 83 sec

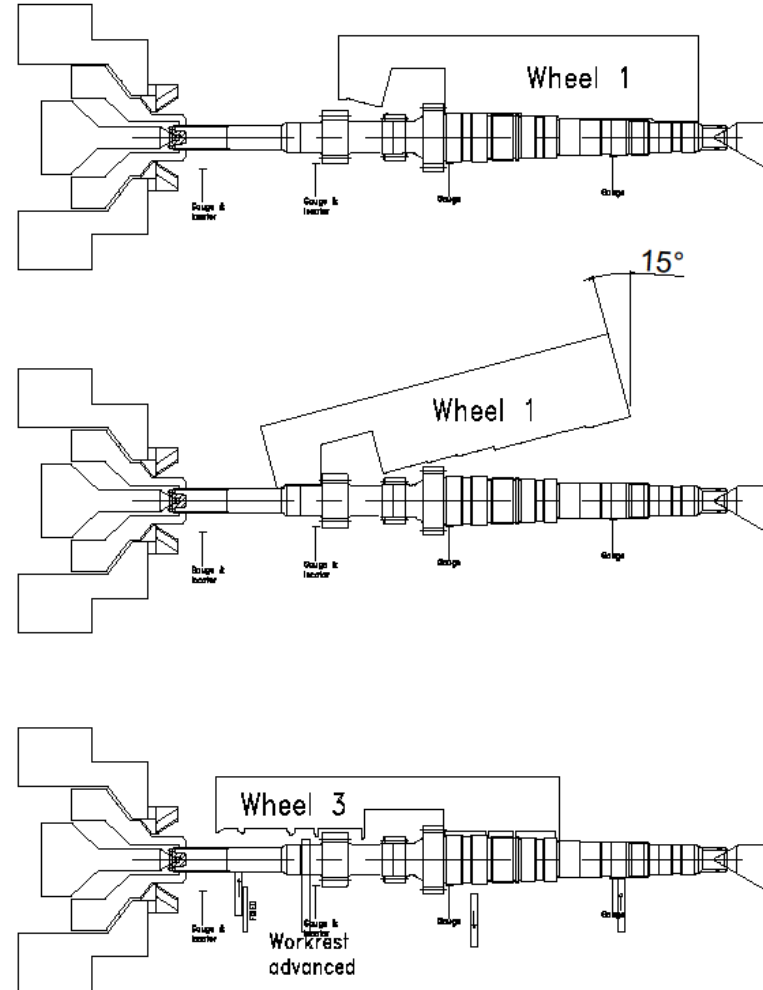
INTEGRATED AUTOMATION



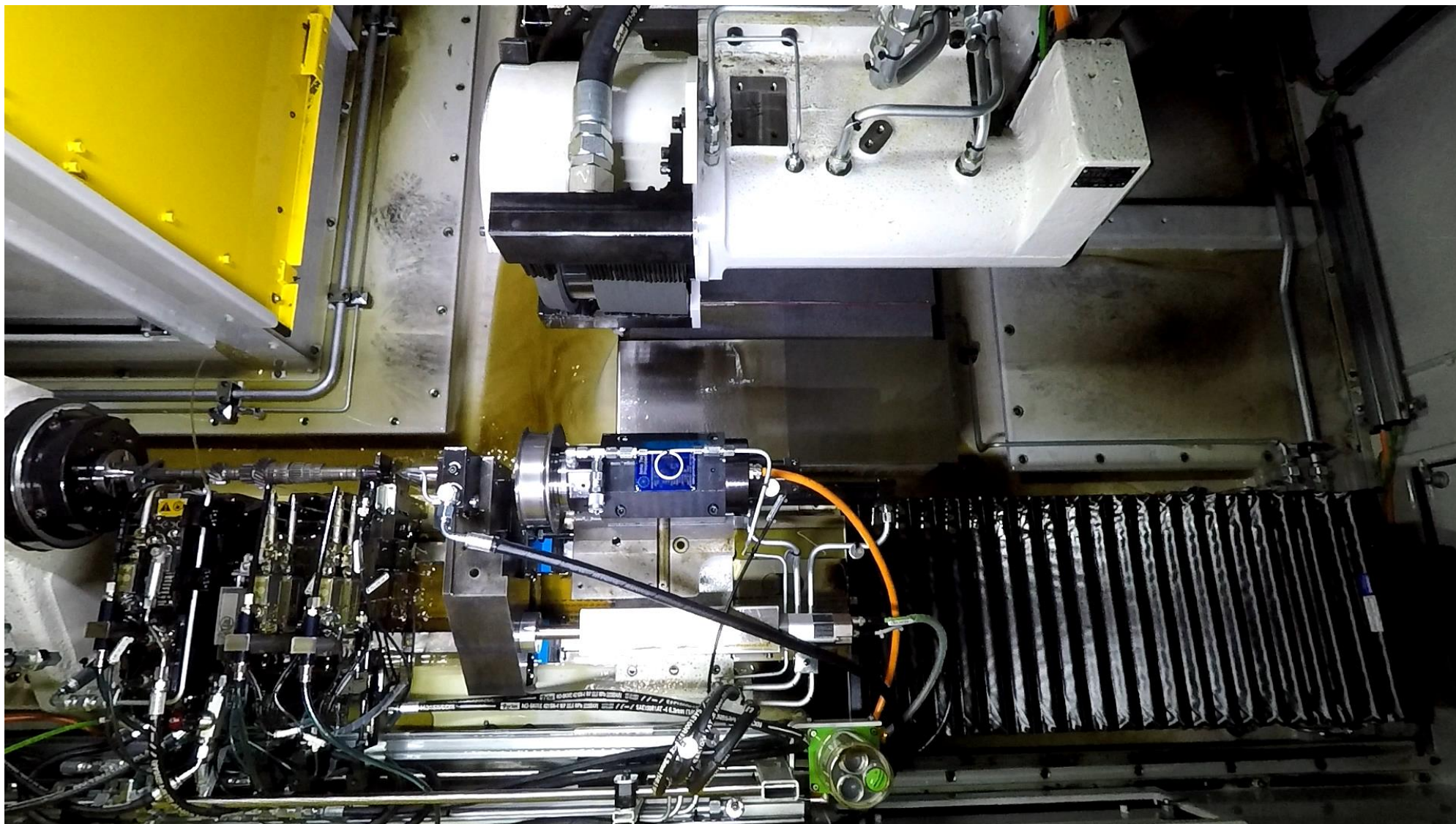
LANDIS 3LVE – EV FD PINION SHAFT



MANUAL TRANSMISSION INPUT SHAFT



LANDIS 3LVE – INPUT SHAFT



HIGH SPEED GRINDING



Floor to floor time achieved: 45 seconds

Faster grind times

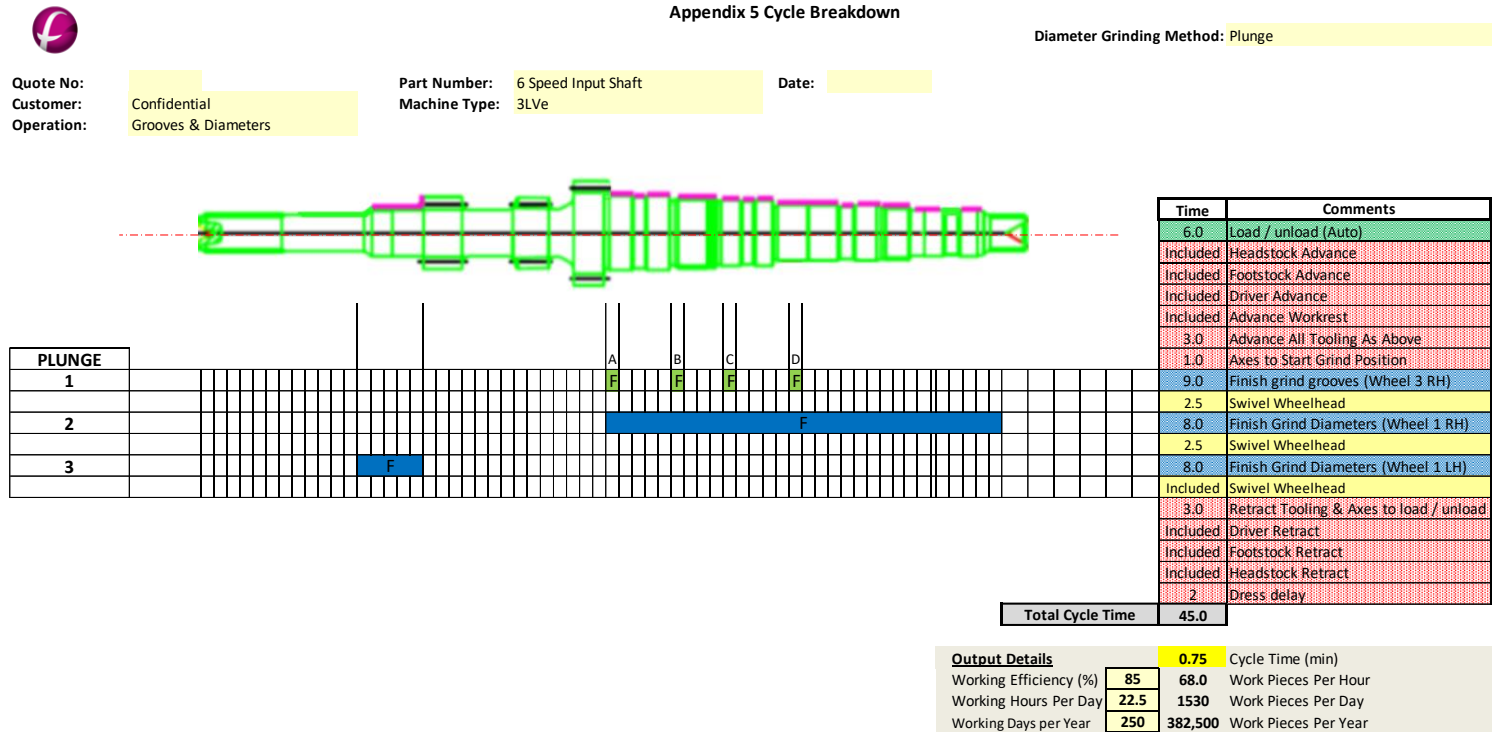
- Higher metal removal rates
- Higher spindle power
- Stiffer machine

Faster non-value-add machine time

- Simultaneous machine NVA motions
- Direct drive B-axis for industry-leading index time

Faster part exchange time

- Integrated automation





fives

CONTROL SYSTEM

Best of both worlds

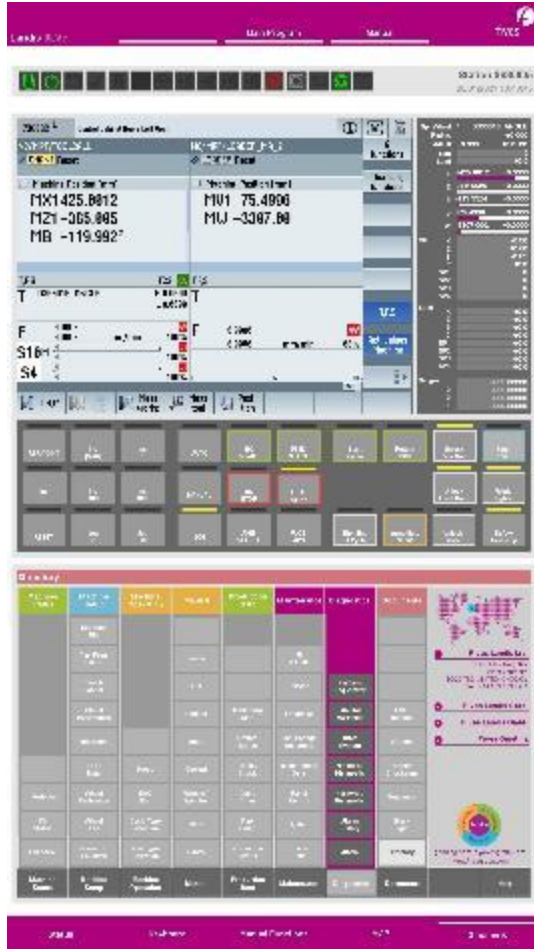
Date: 2/2023

Prepared by: Caitlin Barnhart

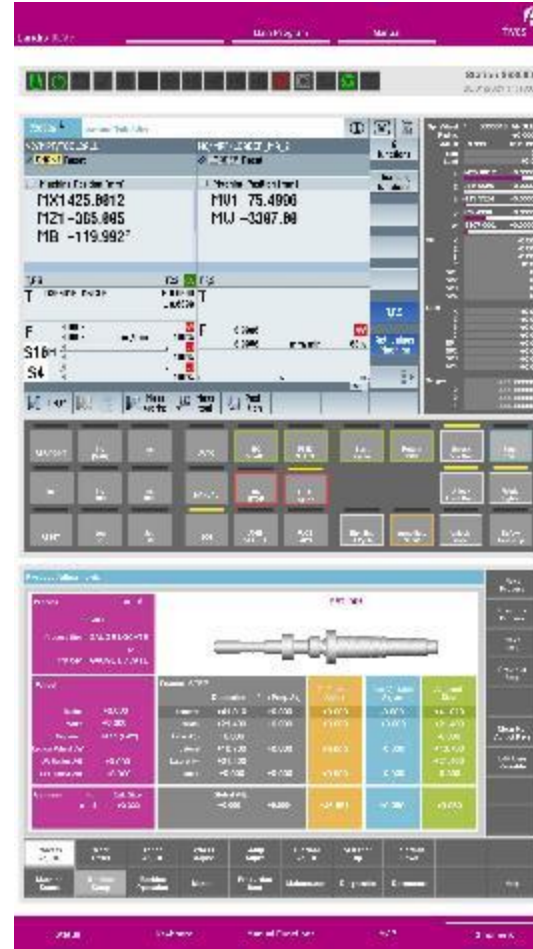
CONTROL SYSTEM DEVELOPMENT



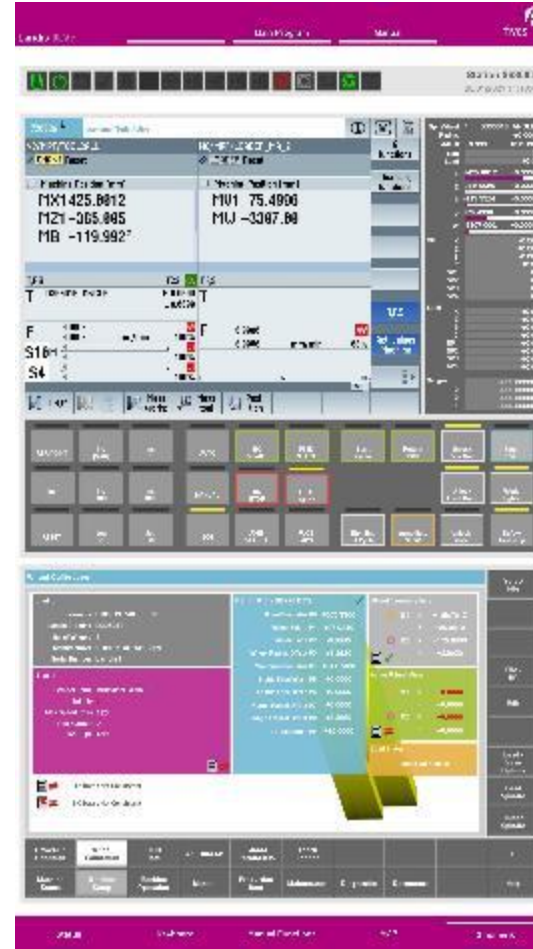
CONTROL SYSTEM DEVELOPMENT



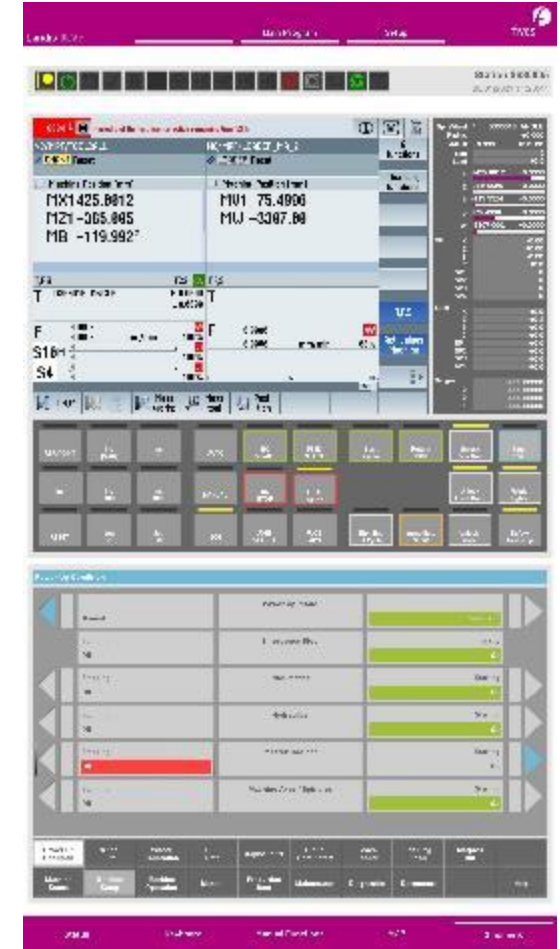
Screenshot 1: Main control panel showing a data table with columns for 'Name', 'Value', and 'Unit'. The table contains data for 'MX1 425.8612', 'MU1 75.4900', 'MZ1 -365.895', and 'MUJ -3387.88'. Below the table is a control panel with buttons for 'Start', 'Stop', 'Reset', and 'Emergency Stop'. A status bar at the bottom shows 'J26.8', '12/18/2018', '10:00:00', and '3.00.00.00'.



Screenshot 2: Detailed view of a component, likely a valve, showing a 3D model and a data table. The table has columns for 'Name', 'Value', and 'Unit'. The data includes 'MX1 425.8612', 'MU1 75.4900', 'MZ1 -365.895', and 'MUJ -3387.88'. A status bar at the bottom shows 'J26.8', '12/18/2018', '10:00:00', and '3.00.00.00'.



Screenshot 3: Detailed view of a component, likely a valve, showing a 3D model and a data table. The table has columns for 'Name', 'Value', and 'Unit'. The data includes 'MX1 425.8612', 'MU1 75.4900', 'MZ1 -365.895', and 'MUJ -3387.88'. A status bar at the bottom shows 'J26.8', '12/18/2018', '10:00:00', and '3.00.00.00'.



Screenshot 4: Detailed view of a component, likely a valve, showing a 3D model and a data table. The table has columns for 'Name', 'Value', and 'Unit'. The data includes 'MX1 425.8612', 'MU1 75.4900', 'MZ1 -365.895', and 'MUJ -3387.88'. A status bar at the bottom shows 'J26.8', '12/18/2018', '10:00:00', and '3.00.00.00'.

CONTROL SYSTEM DEVELOPMENT

736032 ↓ Control Cabinet Doors Left Open

NC/MPF/TOOLCALL NC/MPF/LOADER_MA_2

CHAN1 Reset LOADER Reset

Machine Position [mm] Machine Position [mm]

MX1 425.0012 MV1 75.4996
 MZ1 -385.005 MW -3307.00
 MB -119.992°

T,F,S TC2 T,F,S

T D305019_ANGLE R 0.0000 T
 L 0.0000

F 0.0000 mm/min 100% F 0.0000 mm/min 100%
 0.0000

S10M 0 100%
 0 100%
 S4 0 100%

T,S,M Meas. Meas. Position
 workp. tool

G functions
 Auxiliary functions
 T,F,S
 Act. values Machine

Sp / Wheel 1 D305019_ANGLE
 Radius +0.000 +0.000
 Adjust +0.000 +0.0500
 rpm 0
 Load +0.0

X +425.0012 +0.0000
 Z -385.0050 +0.0000
 B -119.9924 +0.0000
 V +75.4996 +0.0000
 W -3307.0000 +0.0000

Vel X -0.30
 Z +0.60
 B -0.32
 C +0.0
 SP1 0
 SP2 0
 SP3 0
 SP4 0

Load X +0.0
 Z +0.0
 B +0.0
 C +0.0
 SP1 +0.0
 SP2 +0.0
 SP3 +0.0
 SP4 +0.0

Gauges 1 -999.00000
 2 -999.00000
 3 -999.00000
 4 -999.00000

CONTROL SYSTEM DEVELOPMENT



CONTROL SYSTEM DEVELOPMENT

Directory

Machine Status	Machine Setup	Machine Operation	Manual	Production Data	Maintenance	Diagnostics	Documents	
	Marposs Dbi							 <p>Fives Landis Ltd. Cross Hills - Kershley West Yorkshire BD20 7BD UNITED KINGDOM Tel: +44 150 563 3211</p> <p>Fives Landis Corp.</p> <p>Fives Landis GmbH</p> <p>Fives Giustina</p>  <p>grinding-service@fivesgroup.com www.fivesgroup.com</p>
	Part Prog. Editor		Loader		IFM VSE004			
	Teach Loader		TR1		Service	Perform. Log Viewer		
	Global Parameters		Gauges	IT Memory Map	Language	Monitor Variables	EOC Reason	
	Adjustments		Axes	Hexnet Status	Tool Change Sequence	Drive System	Version	
	RFID Data	Dress	Coolant	Quality Check	Maintenance Data	Networks Diagnostic	Safety Checksum	
Interlocks	Wheel Calibration	EOC Stop	Wheels / Spindles	Cycle Times	Panel Control	Hardware Diagnostic	Sequence	
IO Status	Wheel Life	Cycle Type Selection	Work	Part Count	System	Alarm History	Stack Light	
Overview	Power Up Condition	Part Type Selection	Days	Production Status	Trade Calls	Alarm	Directory	
Machine Status	Machine Setup	Machine Operation	Manual	Production Data	Maintenance	Diagnostics	Documents	


Status Keyboard Manual Functions MCP Sinumerik

CONTROL SYSTEM DEVELOPMENT

Process Adjustments

Process: 1 of 6
F1S0P0
Process Step: GAUGE LOCATE
Step Type: GAUGE LOCATE

Part Type:



Wheel	Feature	STEP	Dimension	Part Prog. Adj	Reference Adjust	User Variable Adjust	Adjusted Size
Radius			+0.000				
Width			+0.000				
Alignment			Head (Left)				
Logical Wheel LW							
LW Radius Adj.			+0.000				
LW Lateral Adj.			+0.000				
Diameter			+41.010	+0.000	+0.000	-0.000	+41.010
Width			+21.400	+0.000	+0.000	+0.000	+21.400
Lateral (-)			+0.000				-0.000
Lateral			+10.700	+0.000	+0.000	-0.000	+10.700
Lateral (+)			+21.400	+0.000	+0.000	-0.000	+21.400
Taper			+0.000	+0.000	+0.000	-0.000	-0.000
Gauge(s)	Num	Cal. Size	Global Adj.				
	A 4	+0.000	+0.000	+0.000	+45.561	+0.050	+0.050

Process Adjust.	Work Offset	Taper Adjust	Wheel Adjust	Gauge Adjust	Thermal Adjust	Selection Up	Selection Down	
Machine Status	Machine Setup	Machine Operation	Manual	Production Data	Maintenance	Diagnostics	Documents	Help

Next Process
Previous Process
Next Step
Previous Step
Clear Ref Adjust Data
Edit User Variable

Status Keyboard Manual Functions MCP Sinumerik

CONTROL SYSTEM DEVELOPMENT



Wheel Calibration

3 of 3

Filename: D305019_ANGLE.INI
 Landis Drawing: D305019
 No. of Wheels: 1
 Manufacturer: SUPER_ABRASIVES
 Serial Number: Landis1

Calibration Sheet Data

Wheel Diameter P0: +353.8900
 Wheel Width P1: +27.0340
 Inside Face P2: -0.9930
 Wheel Radius Offset P3: +1.2520
 Minimum Diameter P4: +S41.7400
 Inside Face Worn P5: +0.0000
 Outside Face Worn P6: +0.0000
 Plunge Radial Offset P7: +0.0000
 Plunge Lateral Offset P8: +3.8960
 Profile Angle P9: +15.0000

Wheel Geometry Data

D1 X: +189.7013
 Z: +26.0410
 D2 X: +175.6500
 Z: +2.9000

1 of 1

Wheel Name: D305019_ANGLE
 Spindle: ●
 Max Speed (m/s): 125
 Tool Number: 2
 Tool Type: 400

Active Wheel Wear

D1 X: +0.0000
 Z: +0.0000
 D2 X: +0.0000
 Z: +0.0000

Load Status

Loaded On Spindle

File Data: Not Consistent

NC Data: Not Consistent

Power-Up Condition

Wheel Calibration

RFID Data

Adjustments

Global Parameters

Teach Loader

>

Machine Status

Machine Setup

Machine Operation

Manual

Production Data

Maintenance

Diagnostics

Documents

Help

Select File

File / NC

Edit

Load / Save Options

Load Spindle

Unload Spindle

Status
Keyboard
Manual Functions
MCP
Sinumerik

CONTROL SYSTEM DEVELOPMENT

Power-Up Condition

Manual	Power Up Mode	Automatic
Stopping Off	Emergency Stop	Ready On
Stopping Off	Pneumatics	Starting On
Stopping Off	Hydraulics	Starting On
Stopping Off	Master Coolant	Starting On
Stopping Off	Machine Axes / Spindles	Starting On

Power Up Condition	Wheel Life	Wheel Calibration	RFID Data	Adjustments	Global Parameters	Teach Loader	Part Prog Editor	Marposs Dlu
Machine Status	Machine Setup	Machine Operation	Manual	Production Data	Maintenance	Diagnostics	Documents	Help

Status Keyboard Manual Functions MCP Sinumerik

CONTROL SYSTEM DEVELOPMENT



Machine status and parameters screen. The top bar shows 'MachOp 1' and 'Mach' status. The main area displays 'MachOp 1' and 'Mach' status. The bottom bar shows 'MachOp 1' and 'Mach' status.

Machine status and parameters screen. The top bar shows 'MachOp 1' and 'Mach' status. The main area displays 'MachOp 1' and 'Mach' status. The bottom bar shows 'MachOp 1' and 'Mach' status.

Machine status and parameters screen. The top bar shows 'MachOp 1' and 'Mach' status. The main area displays 'MachOp 1' and 'Mach' status. The bottom bar shows 'MachOp 1' and 'Mach' status.

Machine status and parameters screen. The top bar shows 'MachOp 1' and 'Mach' status. The main area displays 'MachOp 1' and 'Mach' status. The bottom bar shows 'MachOp 1' and 'Mach' status.

Schedule for X80_Pinion_1. The screen shows a Gantt chart with steps: COARSE, PLANE SET, PLANE SET, PLANE SET, PLANE SET, PLANE SET, PLANE SET, PLANE SET, PLANE SET, PLANE SET. The bottom bar shows 'MachOp 1' and 'Mach' status.

Features for X80_Pinion_1. The screen shows a technical drawing of a pinion and a table of features. The bottom bar shows 'MachOp 1' and 'Mach' status.

Name	STEP	SPINES	FACE	VECTOR	GROOVE
Label	13	99	93	18	175
Material					
Diameter	40.01	45.01	47.01	34	40.7
Depth	212	26	9	26	253
Flank	0	0	0	0	0
Thro	0	0	0	0	0
Span Ang	0	0	0	0	0
Lead Chamf	0	0	0	0	0
Flank Thro	0.3	0.3	0.15	0.15	0.35

IP ZEROING settings screen. The screen shows 'MEASURE A' with 'ZEROING OFFSET MEAS. A' set to 3942 μm. The bottom bar shows 'MachOp 1' and 'Mach' status.



CONTROL SYSTEM DEVELOPMENT



The screenshot displays a CNC control system interface for a machine named 'X80_Pinion_1'. The main window shows a 'Schedule' view with 7 operations listed in a table:

WH1	STEP	SPLINES	FACE	VECTOR	GROOVE
1	LOCATEGGE	0.000			
2	PLUNGE_SET1	14.150			
3	PLUNGE_SET3	17.700			
4	PLUNGE_SET2	14.150			
5	PLUNGE_SET4	14.150			
6	PLUNGE_SET5	23.800			
7	Go to - Load Position	0.000			

Summary statistics: Number of operations: 7 Total time: 88.00s

Navigation tabs at the bottom: Machine Status, Machine Setup, Machine Operation, Manual, Production Data, Maintenance, Diagnostics, Documents.

Control panel at the bottom: Keyboard, Manual Functions, MCP, Sinumerik.

CONTROL SYSTEM DEVELOPMENT



The screenshot displays a software interface for control system development, specifically for a pinion component. The interface is titled "X80_Pinion_1" and "Features". It shows a 3D model of the pinion and a table of feature parameters.

Name	STEP	SPLINES	FACE	VECTOR	GROOVE
Laternal	0 1.0	98 1.0	83.6 1.0	173.6 1.0	172.01 1.0
Rotational	0°	0°	0°	0°	0°
Diameter	40.01	45.501	47.701	34	46.7
Width	21.4	35	0	35	2.23
Depth	0	0	0	0	0
Throw	0	0	0	0	0
Taper Angle	0	0	0	0	0
Groove Clearance	0	0	0	0	0
Radial Stock	0.3	0.3	0.15	0.15	0.25

At the bottom of the interface, there are several tabs: Machine Status, Machine Setup, Machine Operation, Manual, Production Data, Maintenance, Diagnostics, and Documents. Below these tabs, there are four buttons: Keyboard, Manual Functions, MCP, and Sinumerik.

CONTROL SYSTEM DEVELOPMENT



The screenshot displays the 'IP ZEROING' control interface. At the top, there is a navigation bar with icons for back, home, and settings, and a status bar showing 'OE#4H' and 'CPU#227'. Below this is a 'DASHBOARD' section with a breadcrumb trail: 'HOME > DASHBOARDS > IP ZEROING'. The main interface is divided into several sections:

- MEASURE A:** Contains 'ZEROING OFFSET MEAS. A' with a value of 3942 µm and 'ZERO ADJUST' with a value of 0 µm. A 'SELECT' button is present.
- SET SELECTOR:** Shows a value of 3942 µm with 'ZERO' and 'RST' buttons.
- IP MEASURE CORRECTIONS SUMMARY:** A horizontal bar chart with a scale from -1,000 to 1,000 µm. A yellow bar is highlighted, and a red arrow points from this section to the 'IP MECHANICAL ZEROING' section.
- IP ELECTRICAL ZEROING:** A horizontal bar chart with a scale from -25 to 50 µm. It includes 'START' and 'STOP' buttons.
- IP MECHANICAL ZEROING:** A horizontal bar chart with a scale from -1,000 to 1,000 µm. A value of 43911 µm is displayed.

At the bottom, there is a 'MARPOSS' logo and a navigation menu with buttons for 'Machine Status', 'Machine Setup', 'Machine Operation', 'Manual', 'Production Data', 'Maintenance', 'Diagnostics', and 'Documents'. A footer bar at the very bottom contains 'Keyboard', 'Manual Functions', 'MCP', and 'Sinumerik'.

CONTROL SYSTEM DEVELOPMENT



LANDIS 3LVE



Specifications

	Landis 3LVe
Working capacity	
Center height	220 mm (8.7")
Center distance (min/max)	300 / 500 / 700 mm (11.8" / 19.7" / 27.6")
CBN grinding wheel	
Wheel diameter	350 / 500 / 600 mm (13.8" / 19.7" / 23.6")
Max. wheel width	5 / 50 / 150 / 250 mm (0.2" / 2" / 5.9" / 9.8")
Max. surface speed	125 or 200 m/sec (410 or 656 ft/min)
Wheel spindle & workhead	
G.W. spindle motor	19 / 22 / 25 / 50 kW
Max. G.W. speed	2,500 / 7,500 / 12,000 rpm
Workhead spindle motor power	5.5 / 9.5 kW
Workhead spindle motor torque	12 / 125 / 260 Nm
Max. workhead speed	600 / 7,500 / 2,250 rpm

	Landis 3LVe
Axes	
Linear guide ways	Precision linear guideways
Grinding spindle	Super precision ceramic bearing
Drive	High precision ball screw / Linear motor option
Dimensions	
Dimensions (W x D x H)	4,030 x 3,050 x 2,338 mm (13.2' x 10' x 7.7')
Machine weight	10,000 kg (22,046 lb)