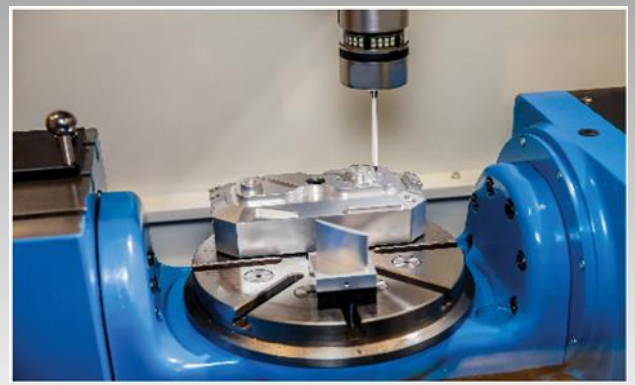
METROLOGY SOLUTIONS FOR SMART MANUFACTURING

AAT 3D

SMART MACHINING PROCESS



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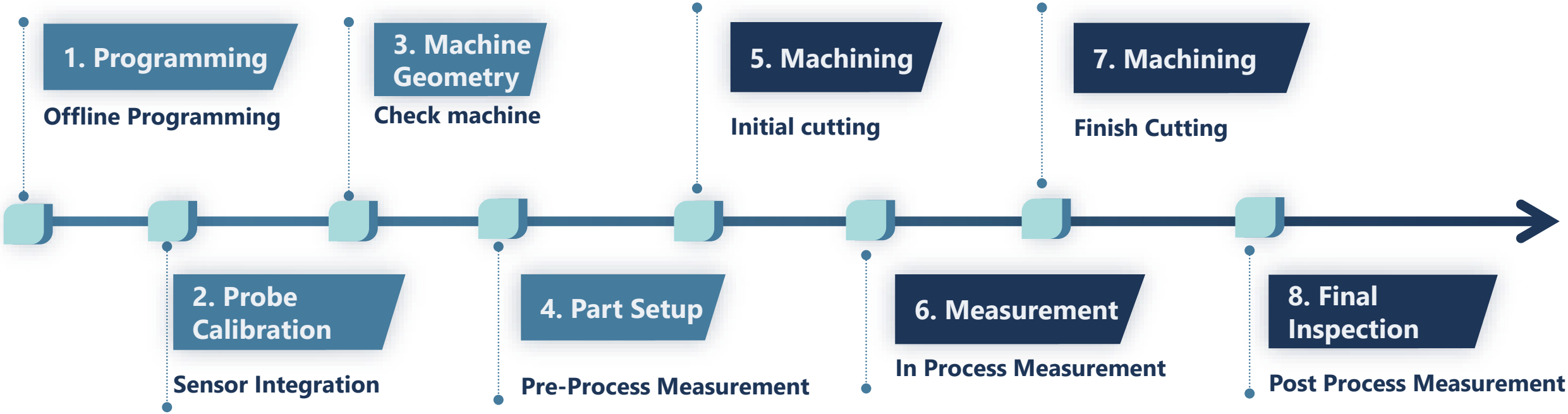
APPLIED AUTOMATION TECHNOLOGIES, INC

CappsNC Smart Machining Process



CappsNC Smart Machining Process

1. Programming

CappsNC-PS : Offline Programming System

Create measurement programs offline including feedback commands using CappsNC-PS in virtual environment

2. Probe Calibration

Calibrate Sensors

Automatic Calibrations to remove all probing errors and adapting to other tools

3. Machine Geometry

Verify machine geometrical accuracy, head and table alignment

4. Part Setup

Pre-Process Measurement

Locate part in 6DOF. Update work offsets. NCFIT cut programs for non-rigid parts or when controller can't handle 6DOF work offsets

5. Machining

Initial cutting

Rough cutting and initial cutting to bring part to desired shape

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8. Final Inspection

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Final inspection reports and SPC data generated for the completed part

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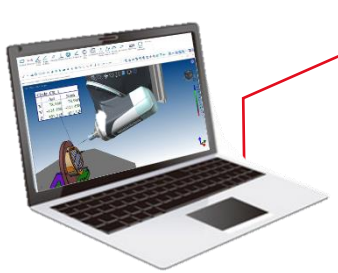
METROLOGY SOLUTIONS FOR SMART MANUFACTURING

CAPPSNC

Engineering Office:
Programming Systems



CAPPSNC
OFFLINE
Programming
System

CappsNC Implementation

Post processed NC program

Measurement projects
DMIS programs

Machine Shop
Advanced or Execution
Module

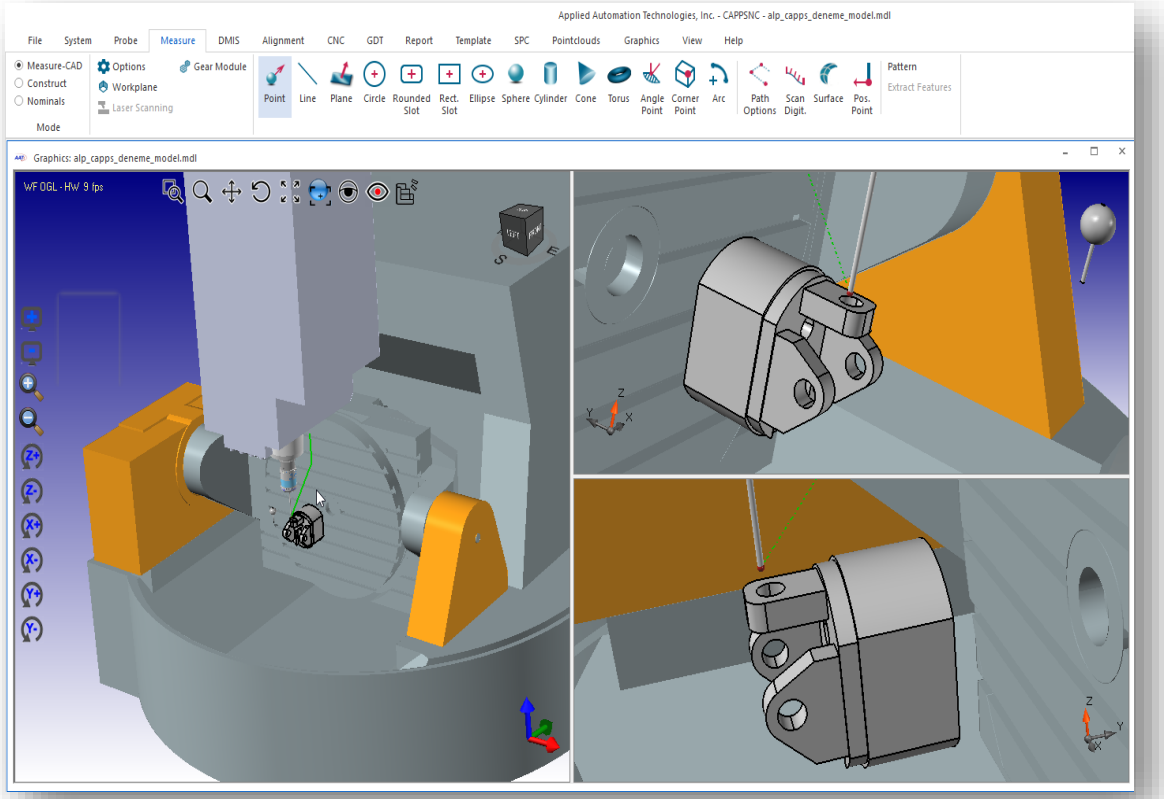
Work Offsets - Tool Offsets
Feedback data

All CappsNc program sent directly to the shop floor machine computer or control panel via DNC or any other transfer protocol

Measurement Reports: all geometry, GD&T and graphical reports, NC feedback data created automatically at the end of the process.
Measurement Results: real time feedback from the machine.
Complete inspection reports

CappsNC Offline Programming

CappsNC Programming System is used to create measurement programs with GDT and feedback commands for the machine tools.



- Generate measurement programs from the CAD model using virtual machine models.
- Graphically build probes and laser sensors.
- Complete metrology, GD&T and report programming.
- Automatic collision avoidance and 5 axis programming.
- Create coordinate system and work-offset feedback.
- Program measure-cut-measure strategy.
- Verify program for collision and generate simulated reports
- Post to NC G-Code program

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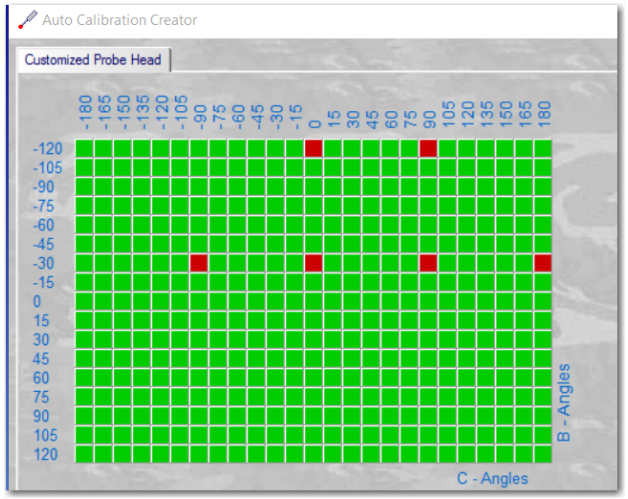
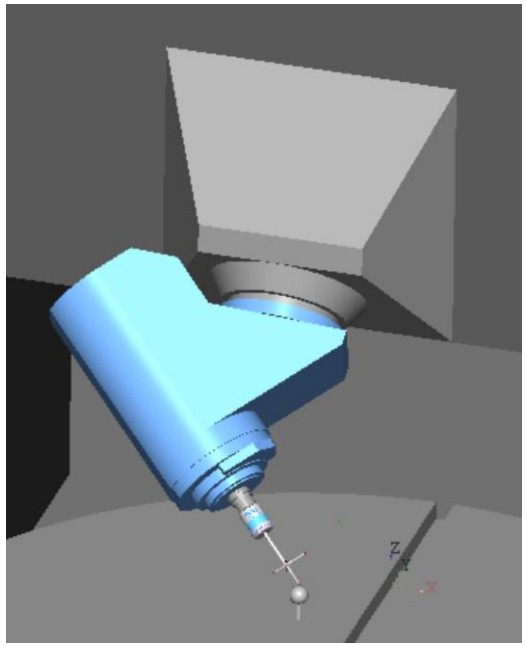
Probe Calibration

Calibrate probe to eliminate all probe errors and correlate data to other cutting tools on the machine

- Calculate probe electronic length
- Calculate probe effective radius
- Detect lobing errors for kinematic probes
- Auto detect probe run-out offsets
- Calculate errors due to head misalignment
- Create verification reports for quality of calibrations





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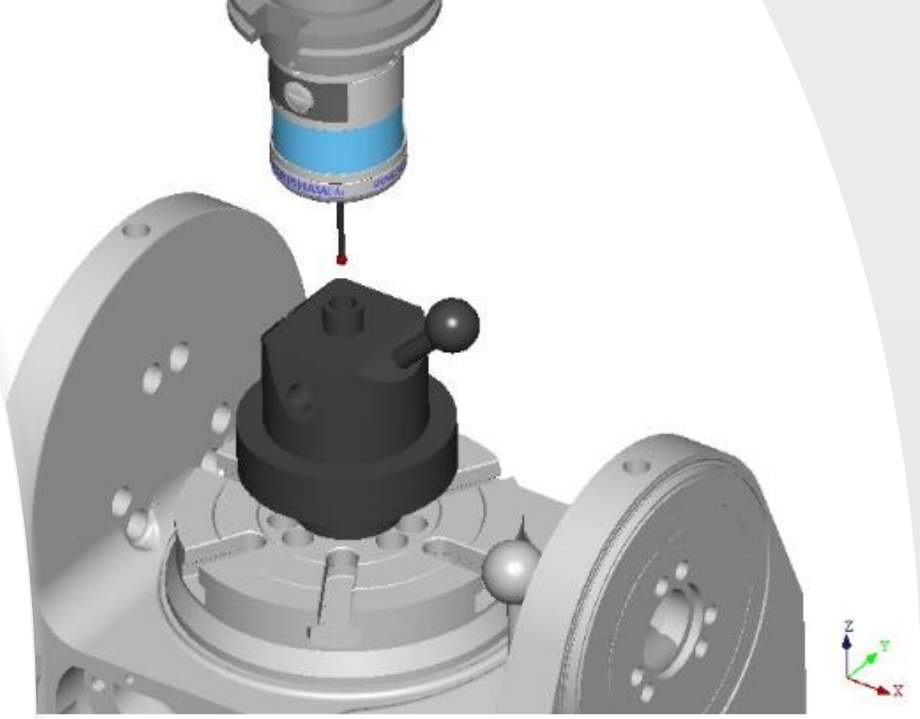
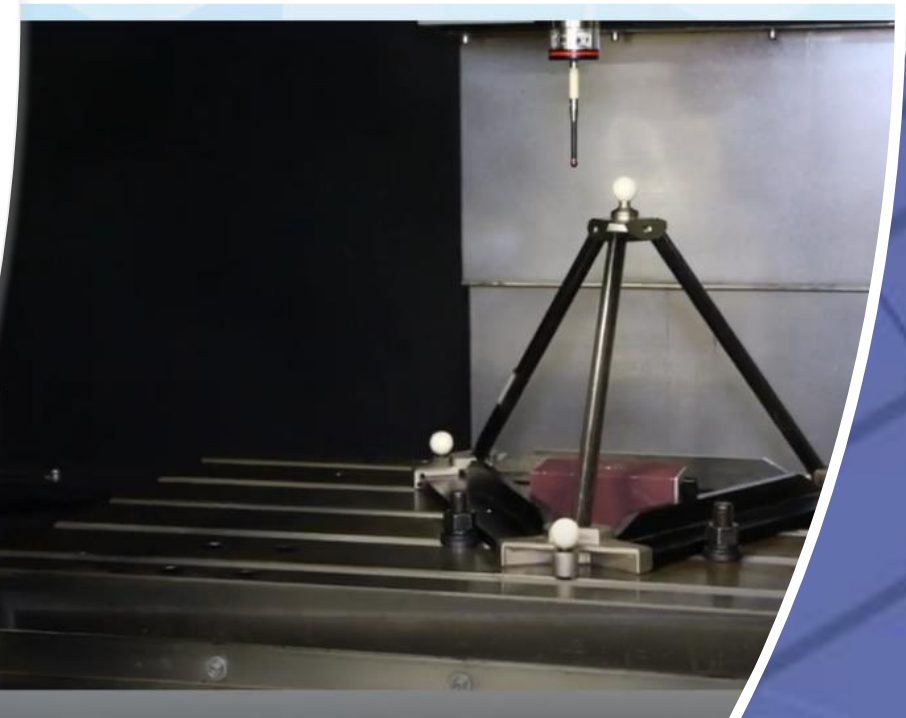
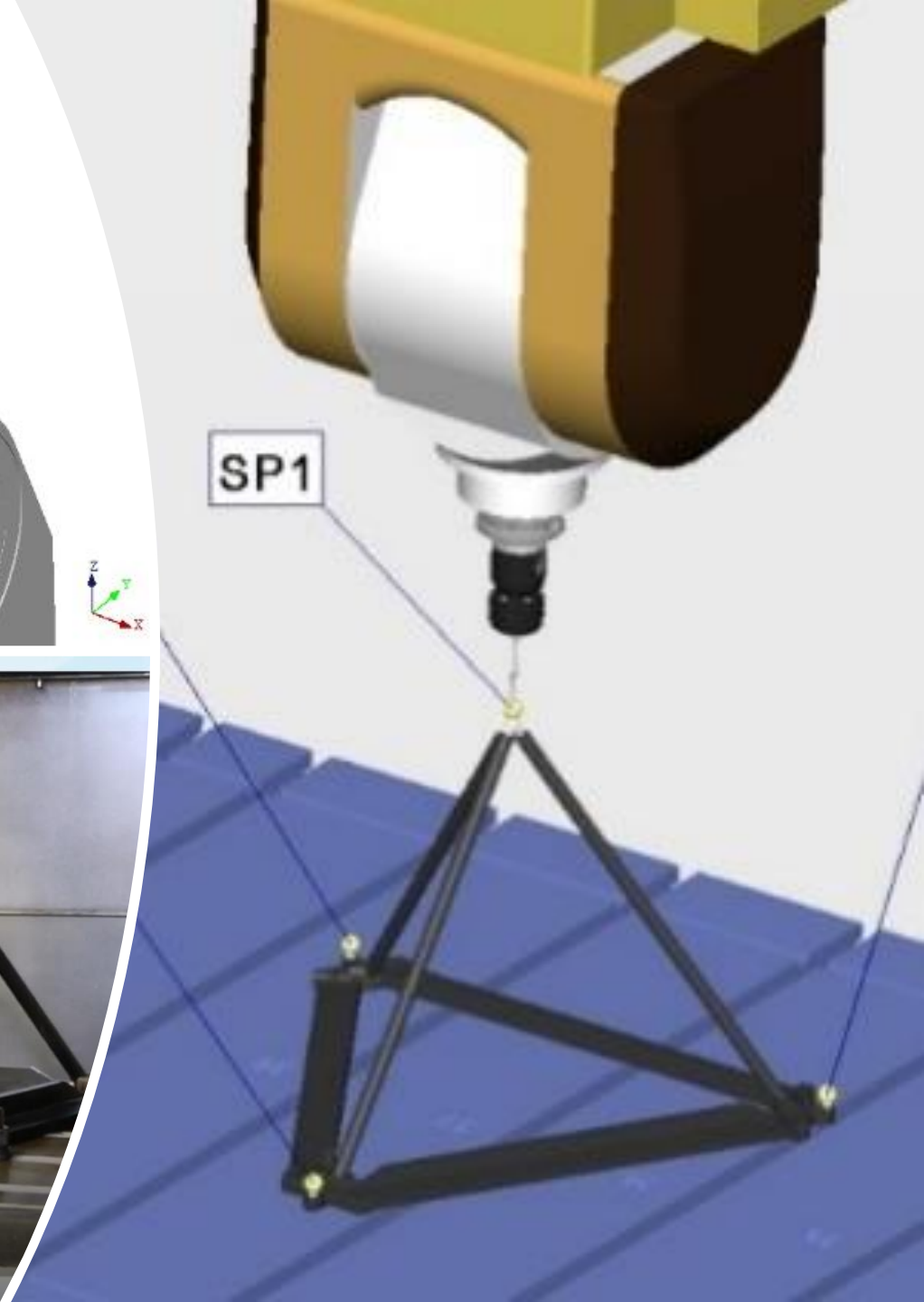
Machine Geometry

- Verify machine tool geometry to assure all measurements are correct
- A master artifact such as tetra-gage ball bar can be used to quickly check machine geometry
- Machine linear and squareness errors are measured and reported
- Machine head and table errors are calculated and monitored over time







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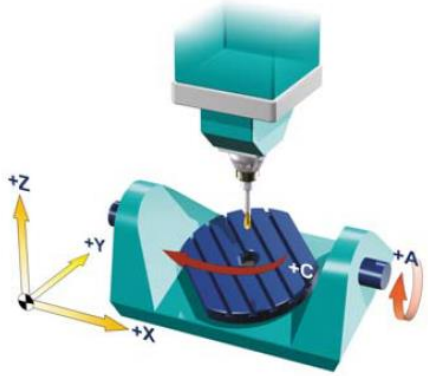
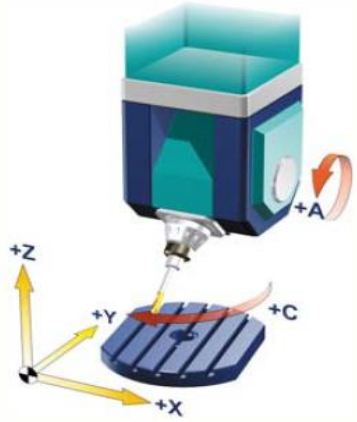
Machine Tool Geometry & Traceability

- Metrology data generated by a machine tool is very important to Digital Manufacturing and I4
- This information must be reliable and traceable
- Machine Tool Geometrical integrity must be monitored
- Simple and effective methods can be developed by using standard gages
- Machine geometry changes can be monitored and stored
- Machine linear errors, squareness errors, table and spindle errors can be calculated between the parts and monitored.
- PAS verifications between the machine tools and CMM's provides the confidence of the tools, software, and final products





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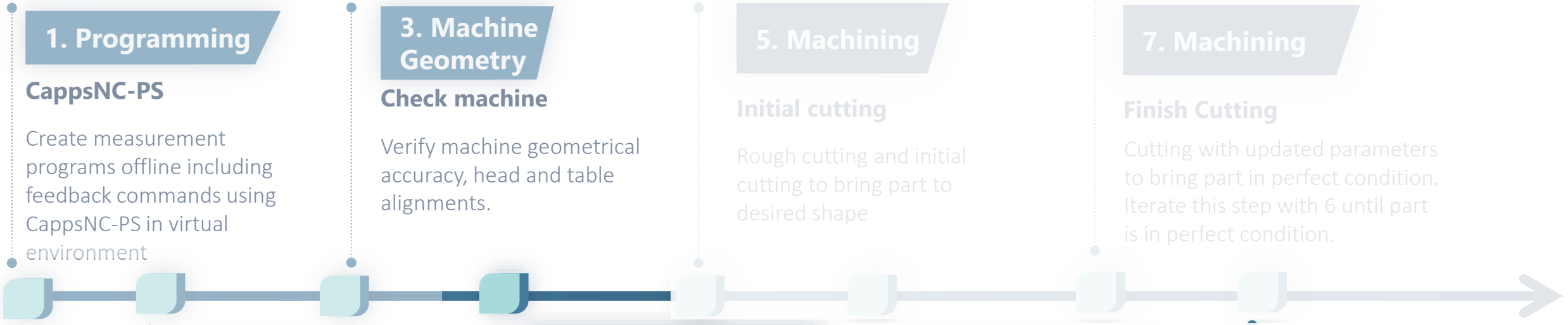

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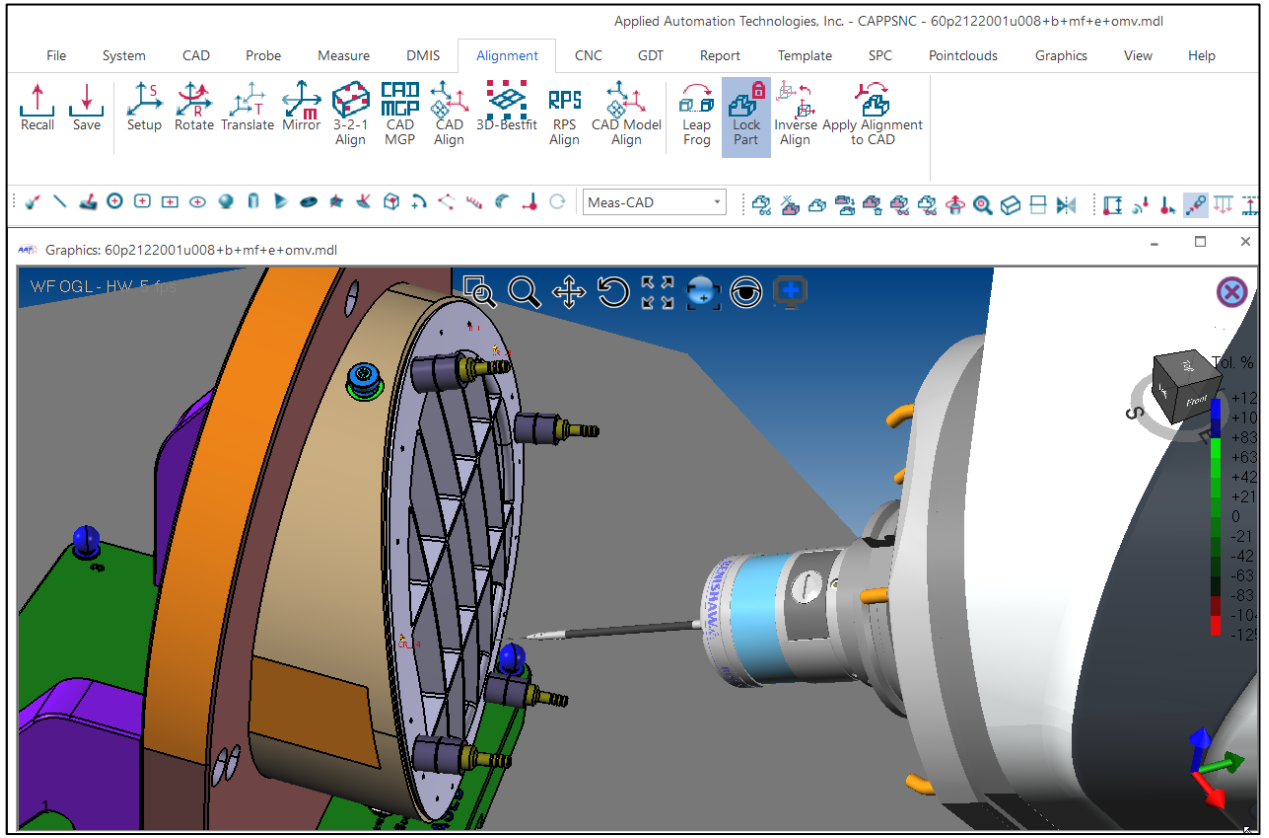
Part Setup

Precise part setup for 6DOF coordinate system

- Automatic upload of coordinate systems to work offsets for any work offsets as absolute, incremental and fine updates.
- G54.4 , G68.2, Cycle800, TCP, Traori and any Euler coordinate system configurations.
- Apply offsets to table offsets to physically bring part in position with tool
- Re-Post NC programs into exact profile and locations of non-rigid parts

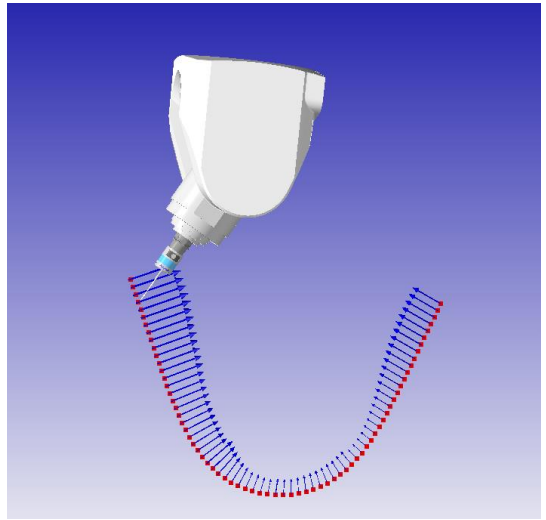


METROLOGY SOLUTIONS FOR SMART MANUFACTURING

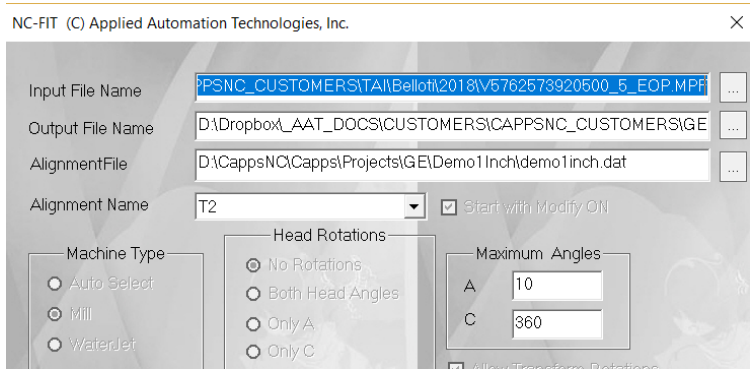
NCFIT NC Program Reposting

Process:

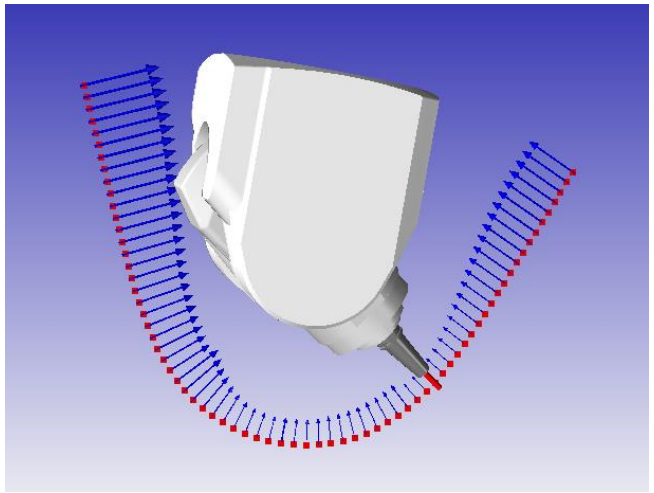
1) Measure part to detect exact position and shape
2) Re-post original NC program to adapt to current part
3) Use new cutting program



Measure



NCFIT



CUT

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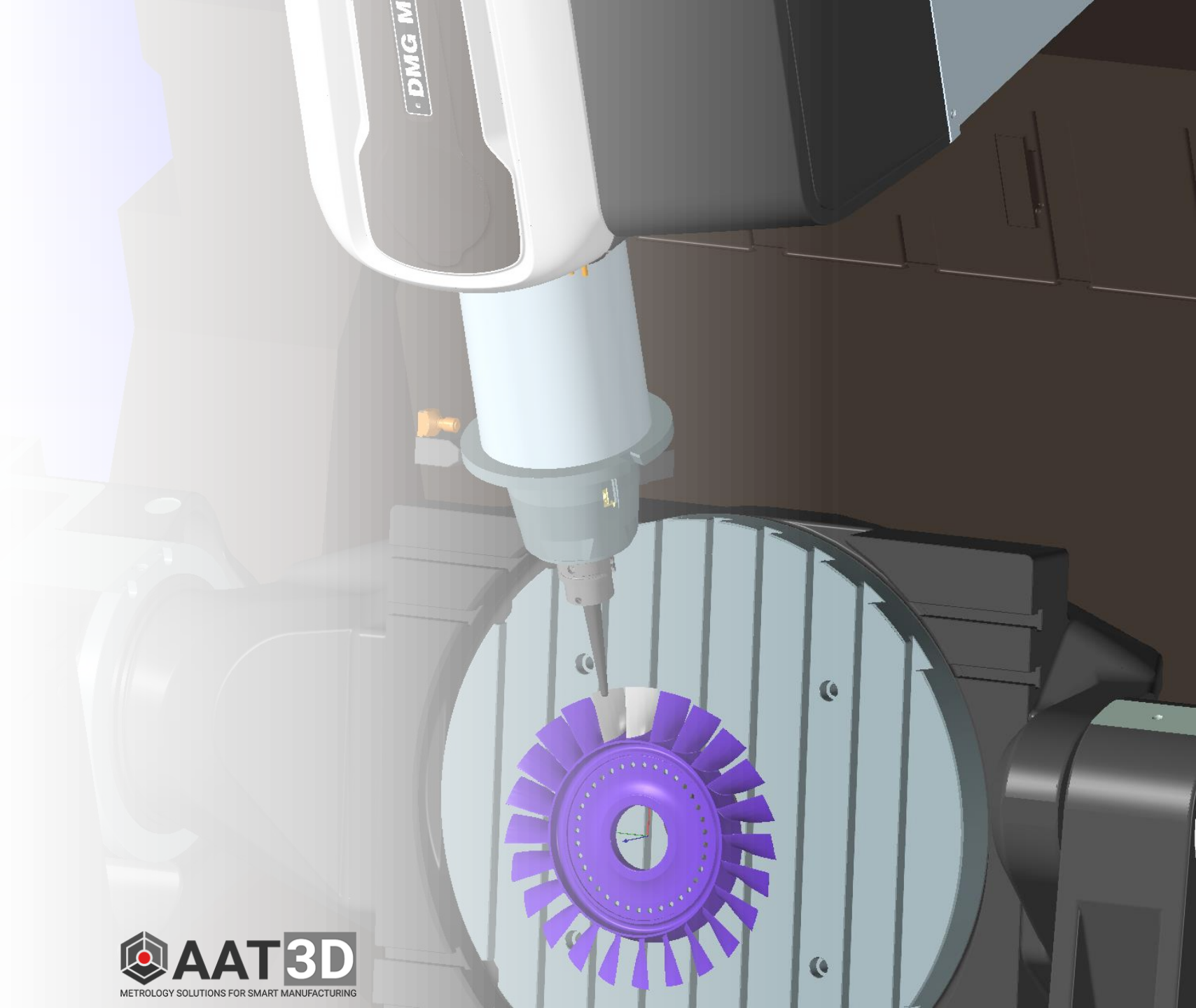
METROLOGY SOLUTIONS FOR SMART MANUFACTURING

Machining

Part cutting may include rough cutting and finish cutting to finish a part at desired shape

- After part location is calculated and work offset is updated, machining process can start.
- Measure-Cut-Measure process can be created directly from CappsNC or organized by the CAM process
- Feature by feature machining can be used to control each feature to be finished within its tolerance
- Iterative machining leaves logical decision making on CappsNC to decide if the feature is completed
- Datum locations can be controlled and updated between features to achieve a part that confirms with multi-datum requirements



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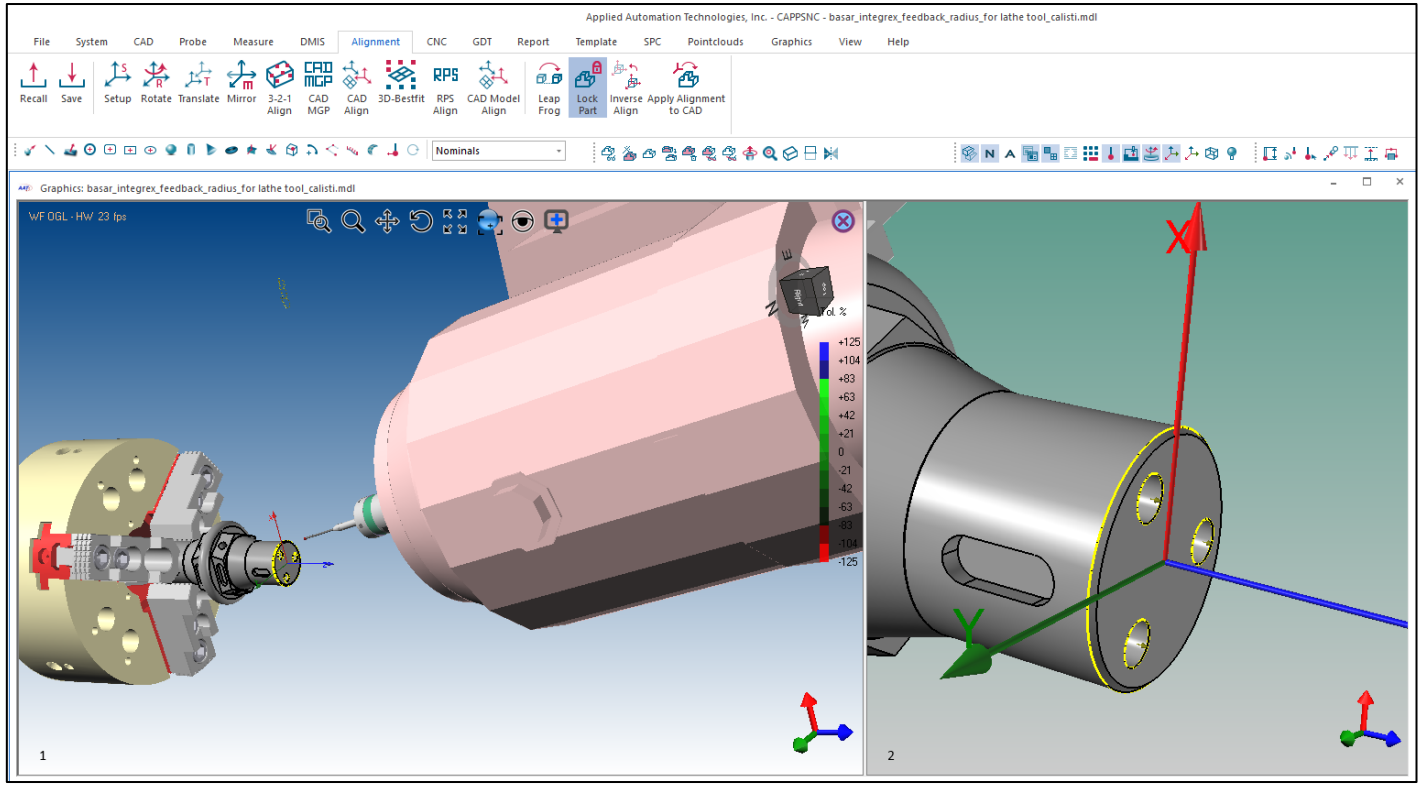
In Process Measurement

Measure part to calculate part errors and convert correction parameters such as dynamic tool offset

- Measure part to detect if finishing is completed
- Calculate dynamic tool offset corrections and update controller for final finish
- Decide if features are completed within the tolerance specs and iterate if needed
- Complete part to always within the configured tolerances in automated cycle



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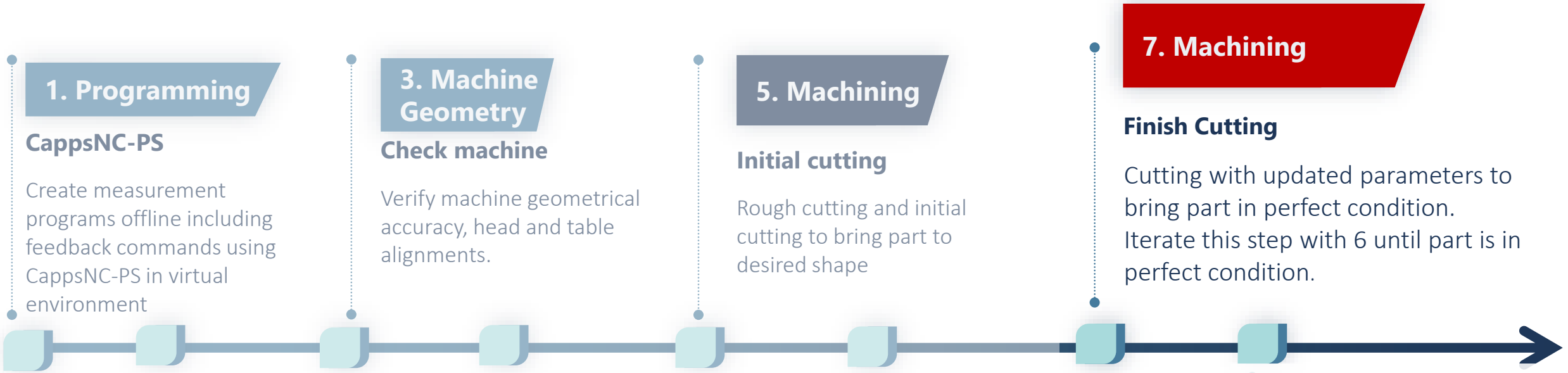

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CAM Automation with Metrology

CUT-MEASURE-CUT-MEASURE

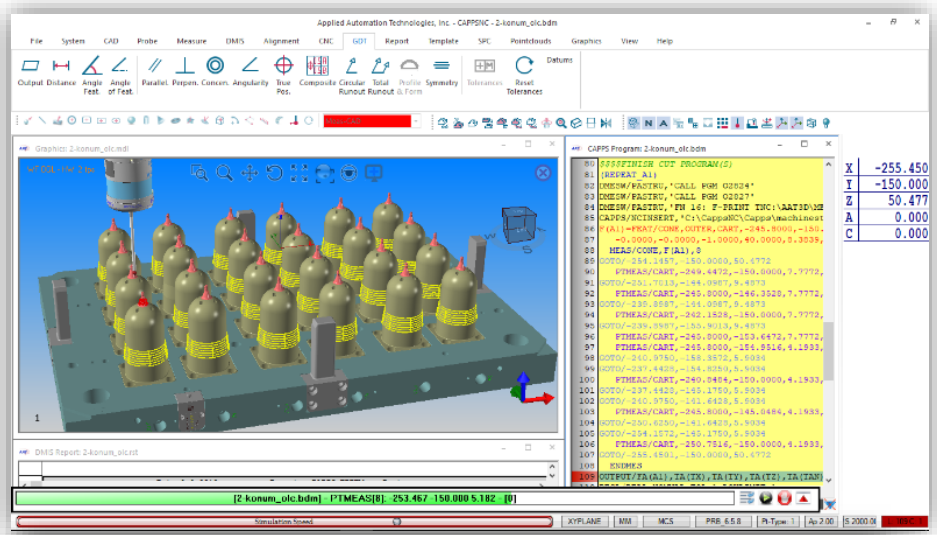
Rough Cut
Measure Size → **Dynamic Tool Comp**
Finish Cut
Measure to Check → **Dynamic Tool Comp**
Final Report

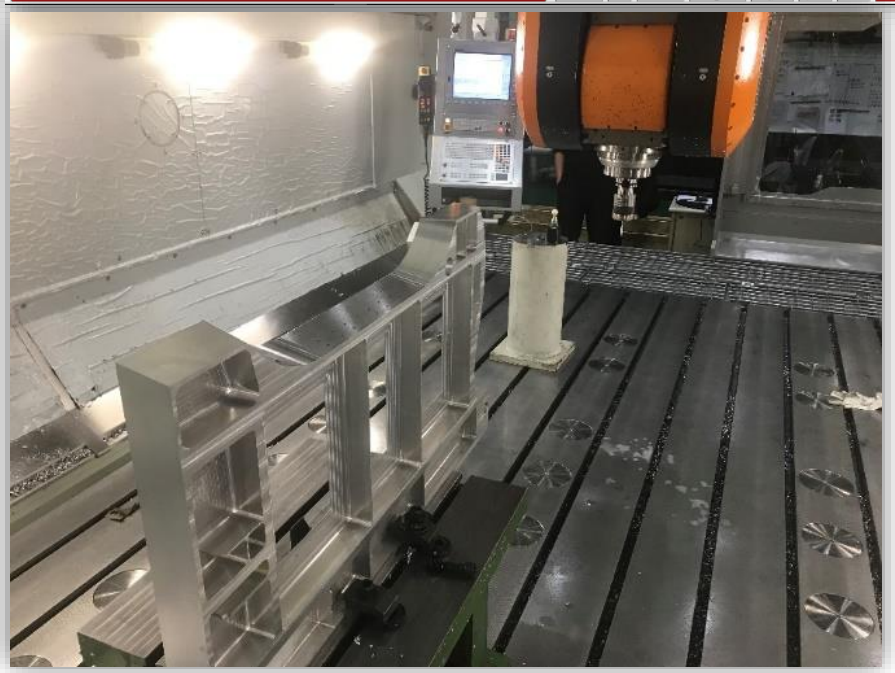
MESURE-CUT-MEASURE

Measure → **Set Datum – Work offset**
Finish Cut
Measure to Check → **Dynamic Tool Comp**
Final Report

CUT-MEASURE-CUT

Rough Cut
Measure → **Update NC parameters Repost G-Code**
Finish Cut





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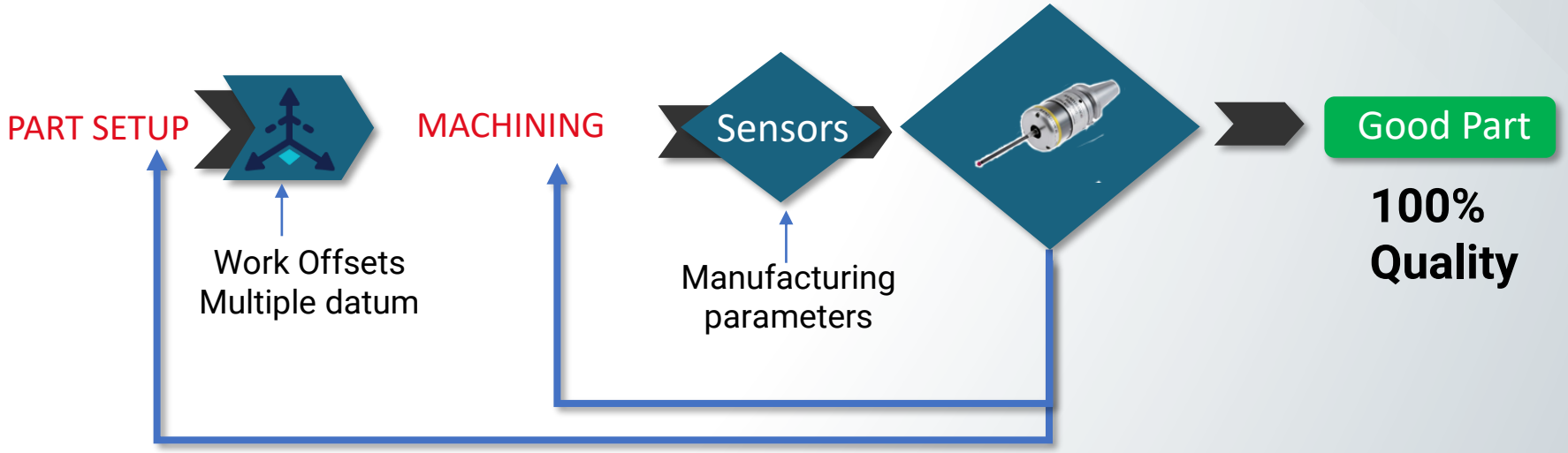
CAPPSNC

CLOSED LOOP METROLOGY



Closed loop smart machining with metrology feedback

- Create metrology information on the machine with automated programming cycle
- CAD based CMM software able to calculate advanced measurement results and able to make decisions
- Calculated measurement data are converted into machining parameters and correction values
- Machining process adjustments are made, and machining performed in efficient automatic loops
- Parts are finished meeting dimensional specifications at lowest cost and minimum time with complete measurement reports generated

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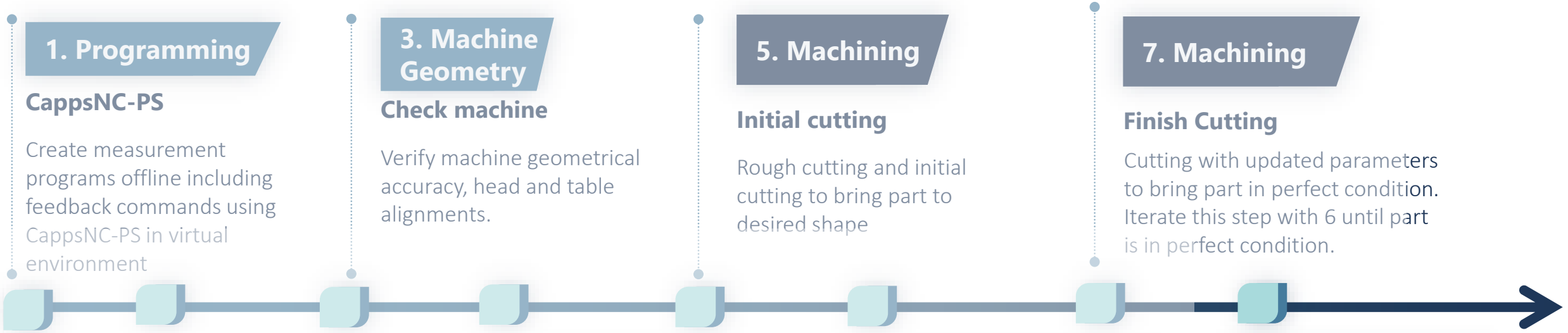

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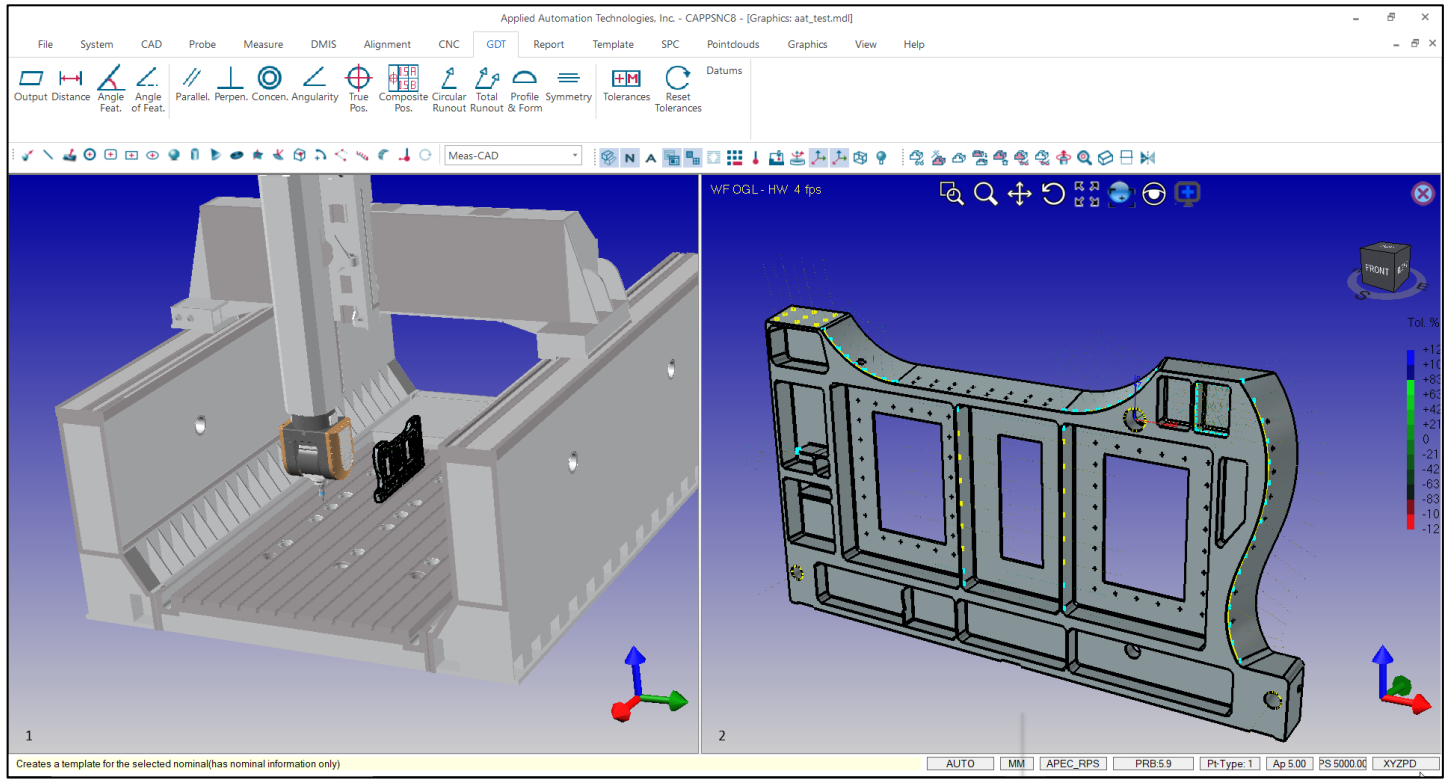
Final Inspection

Execute complete inspection programs and create full metrology and GDT reports directly on the machine.



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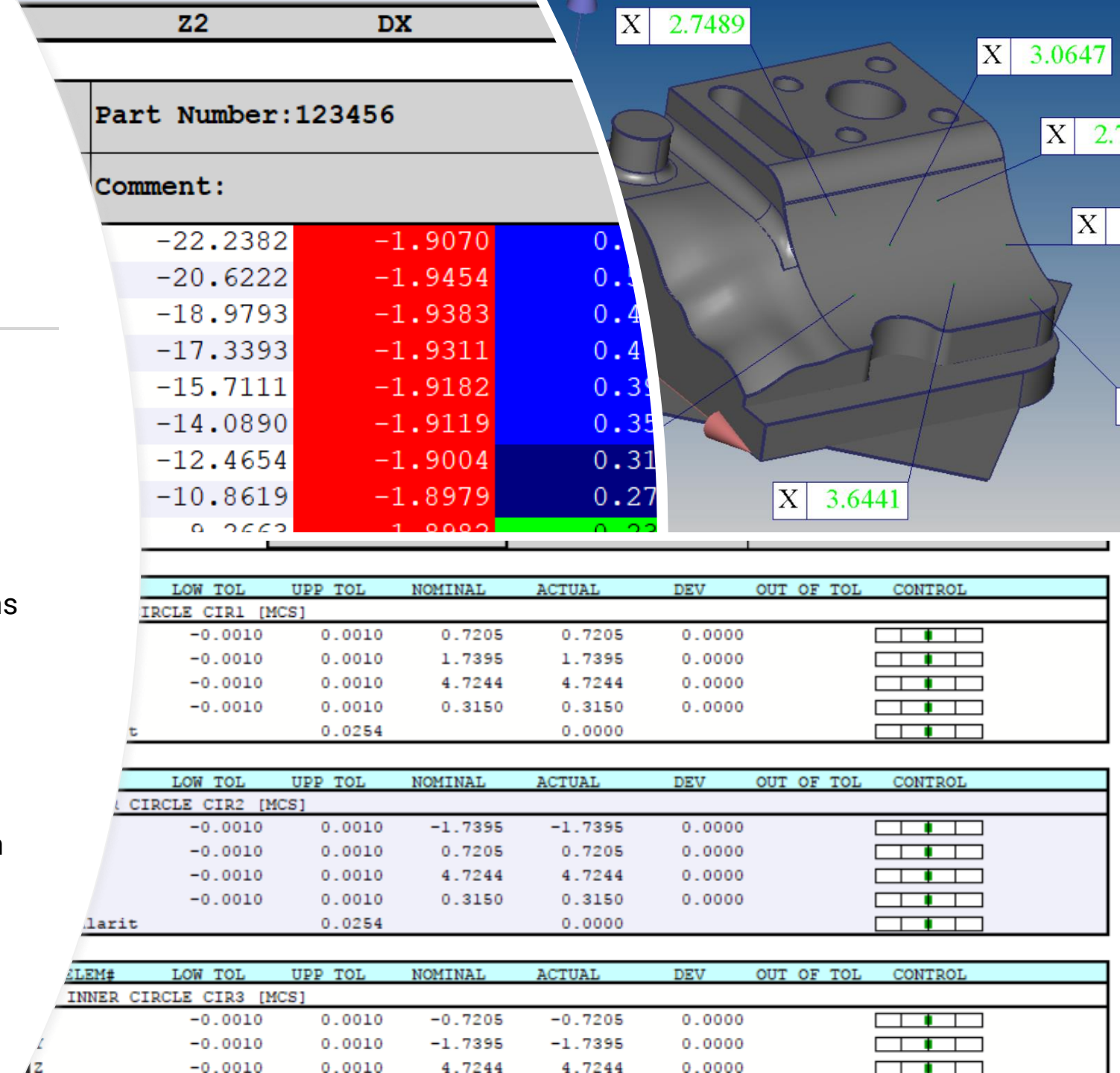
Measurement Reports

- CMM Style Inspection Results
- Complete measurement report capability on NC Machine
- ISO & ANSI compliant GDT Analysis
- Support of Multiple datums with material conditions
- Form & Profile analysis
- Standard report or graphical reporting for easy Go/No Go reporting
- Real-time SPC data creation and reporting
- Automatic email & text message to engineers from automatic executions



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Thank You

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