

# Technologies for smart manufacturing

Manufacturing process control & part verification



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# Manufacturing technologies

Industrial Metrology



Position measurement



Additive manufacturing



# Industrial Metrology

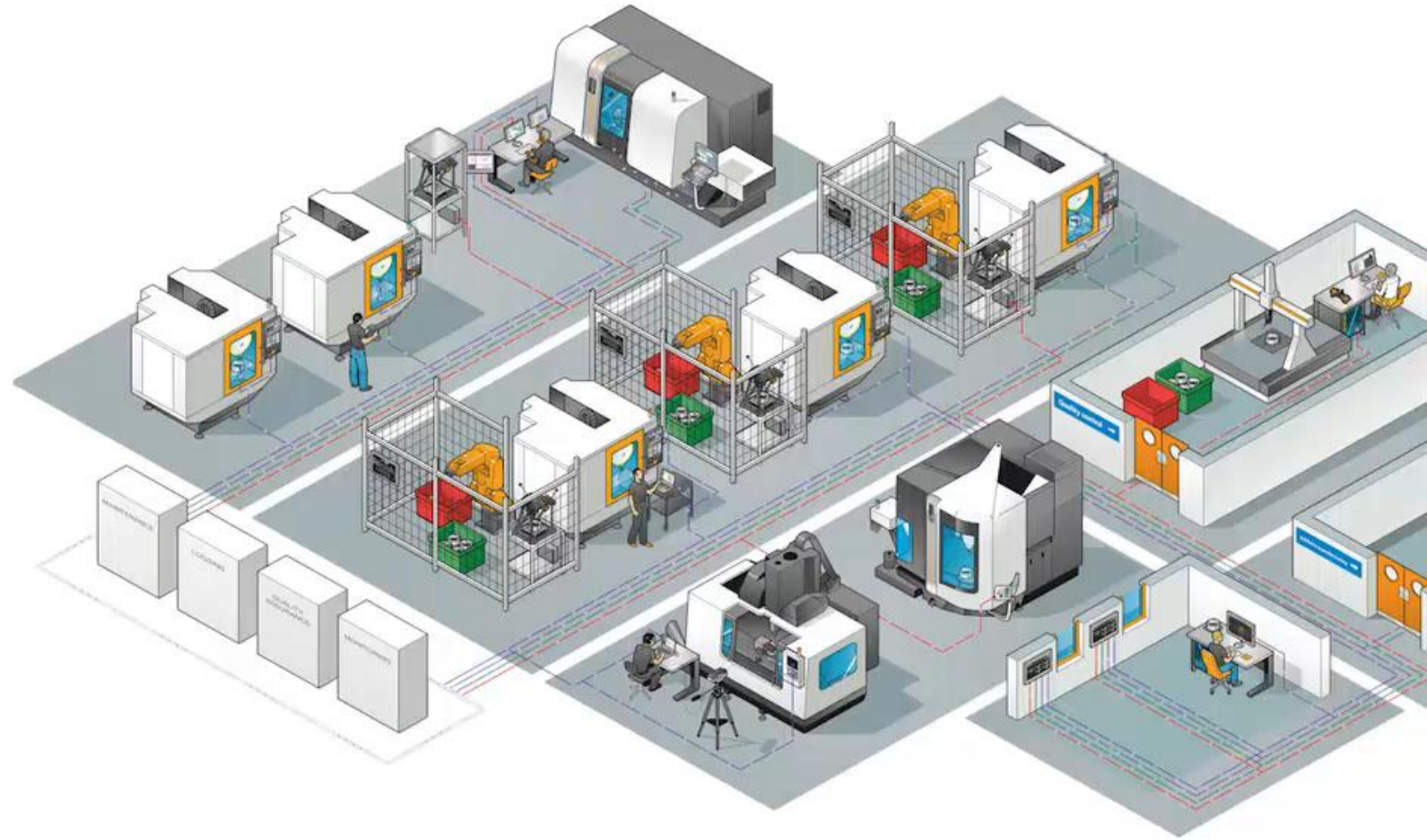
## Process control and part verification

CNC machine calibration and performance assessment

Consistent process output to accommodate variation

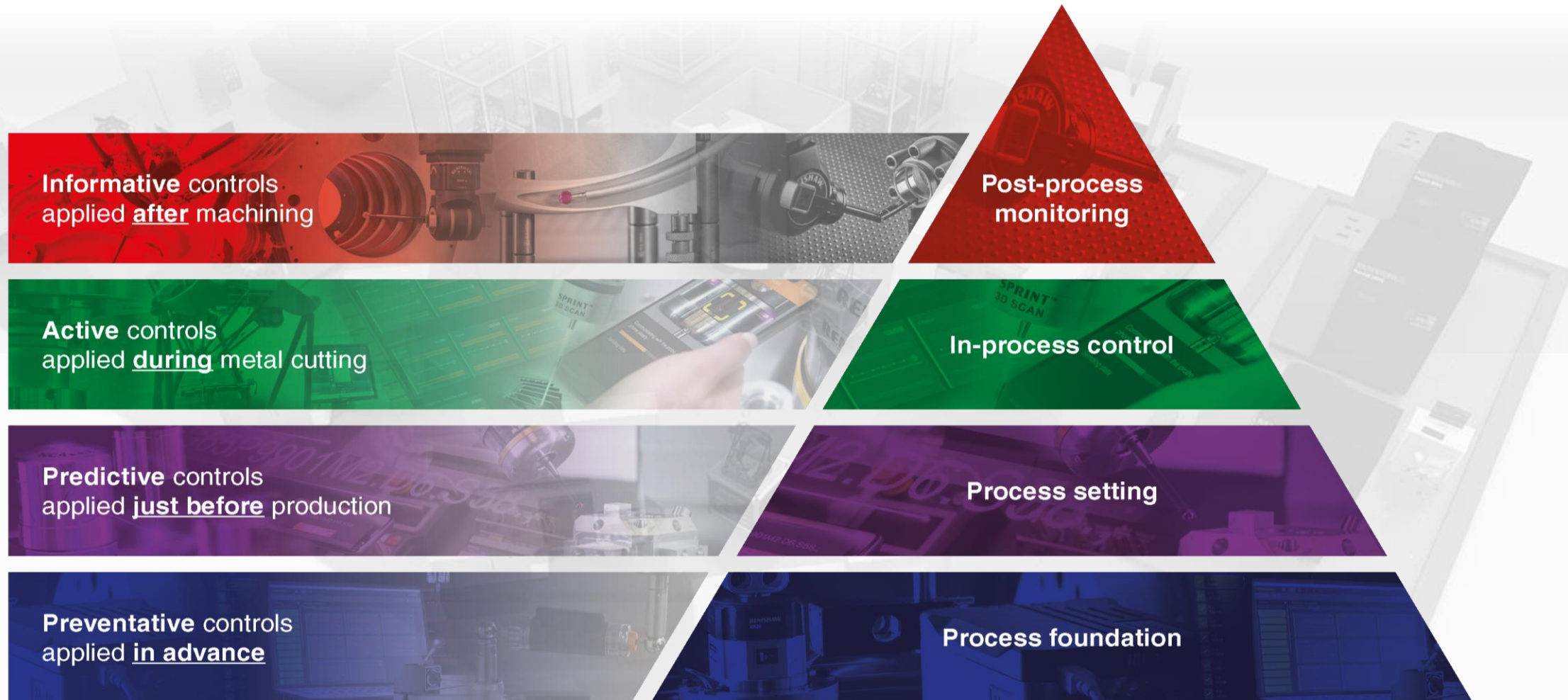
Compensate for changes or drift during machining

Verification of parts to meet design intent



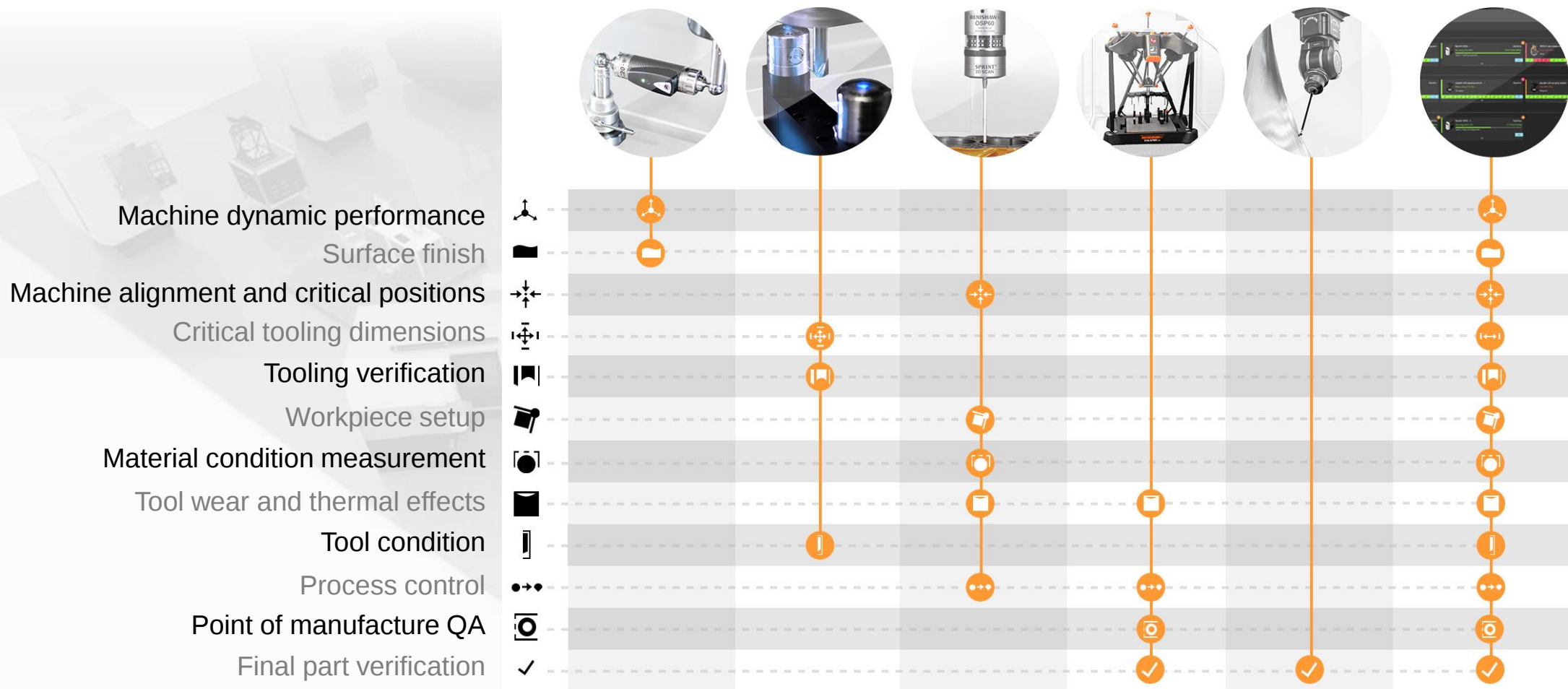
# The Productive Process Pyramid™

Identify and control variation – before, during and after machining



# The Productive Process Pyramid™

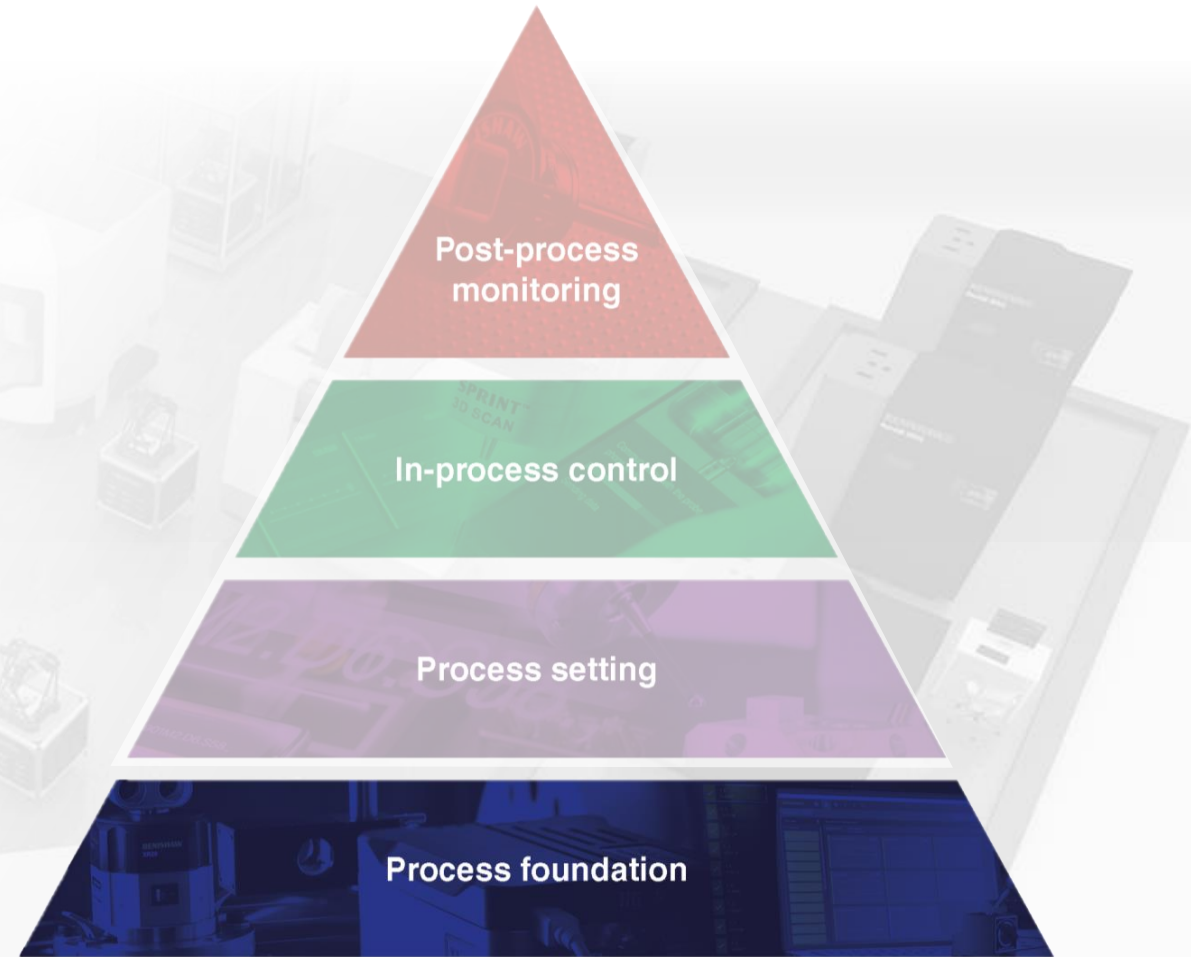
Identify and control variation



# Process foundation

Baseline for highly productive manufacturing

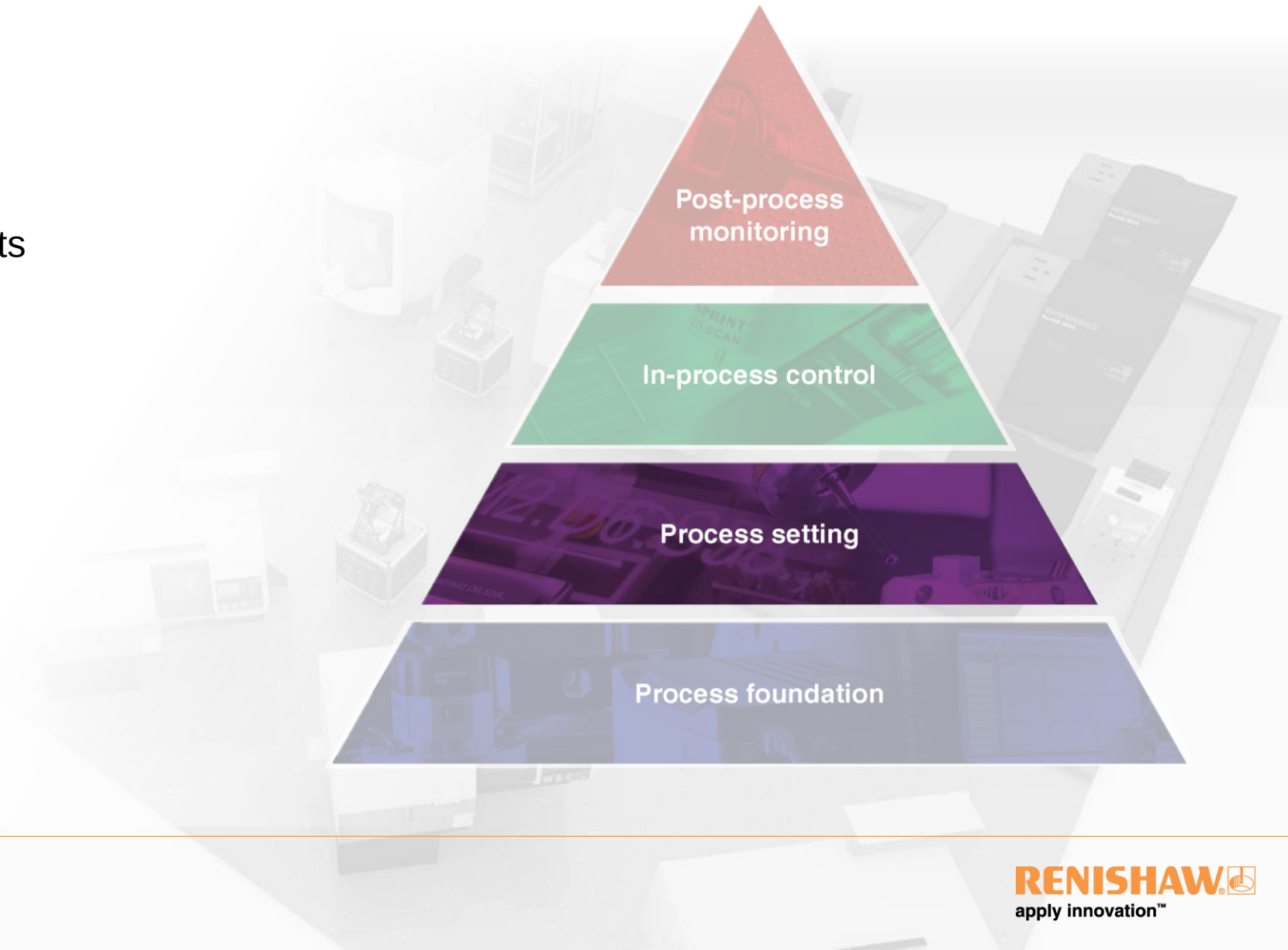
- Consistency
  - Machine tool performance
  - Process design
  - Standard tooling / processes
  - Known capability / reuse best practice
  - Controls and limits replace expertise
  - Ongoing monitoring and audit



# Process setting

Preparing to make good parts

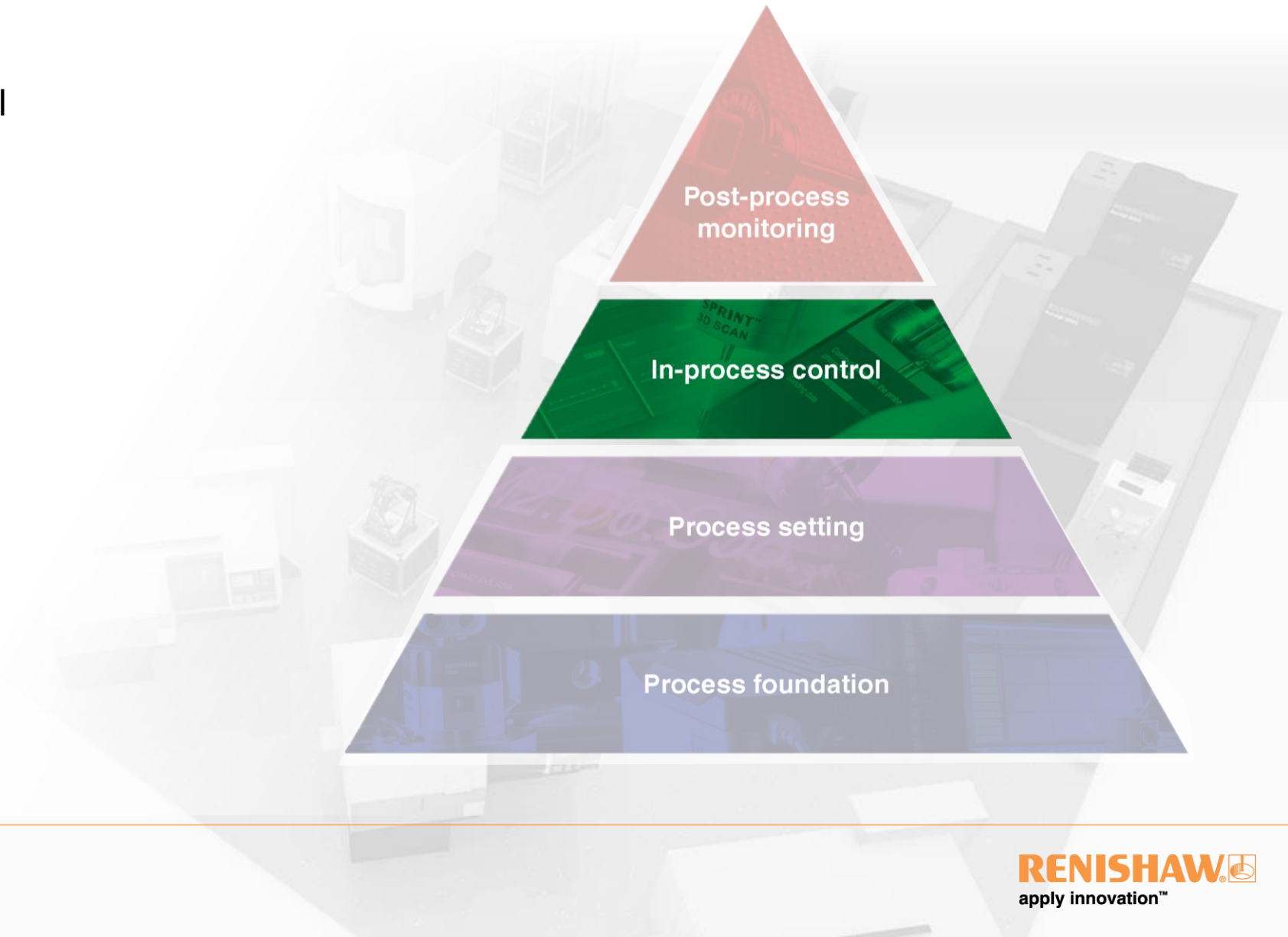
- Establishing initial conditions
  - Machine kinematics
  - Tool length and diameter offsets
  - Tool build assessment
  - Input material condition
  - Part location
  - Part alignment



# In-process control

Reacting to variation and process drift

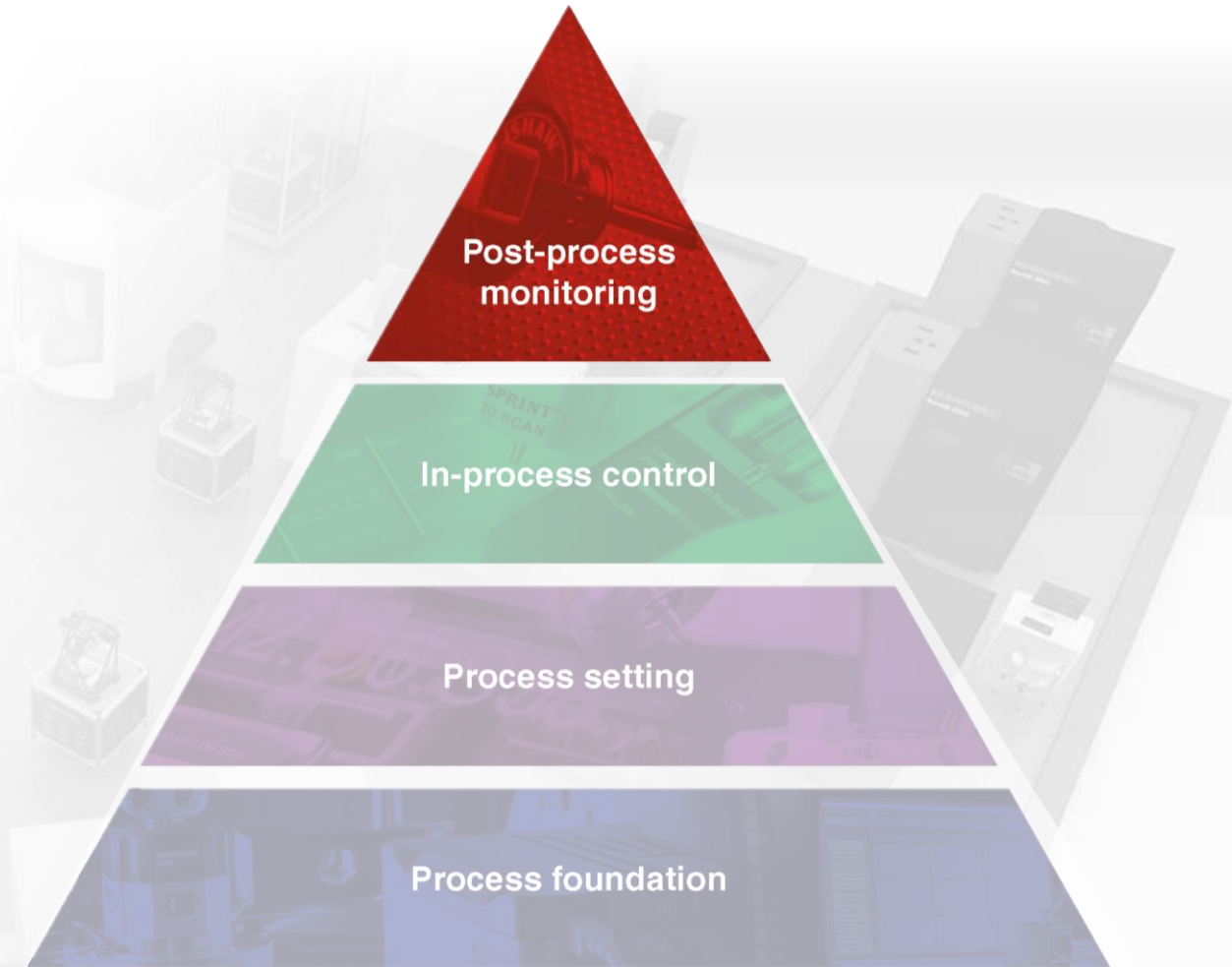
- Keeping the process on nominal
  - Tool compensation
  - Part deflection
  - Tool deflection
  - Tool wear
  - Thermal drift
  - Tool condition monitoring



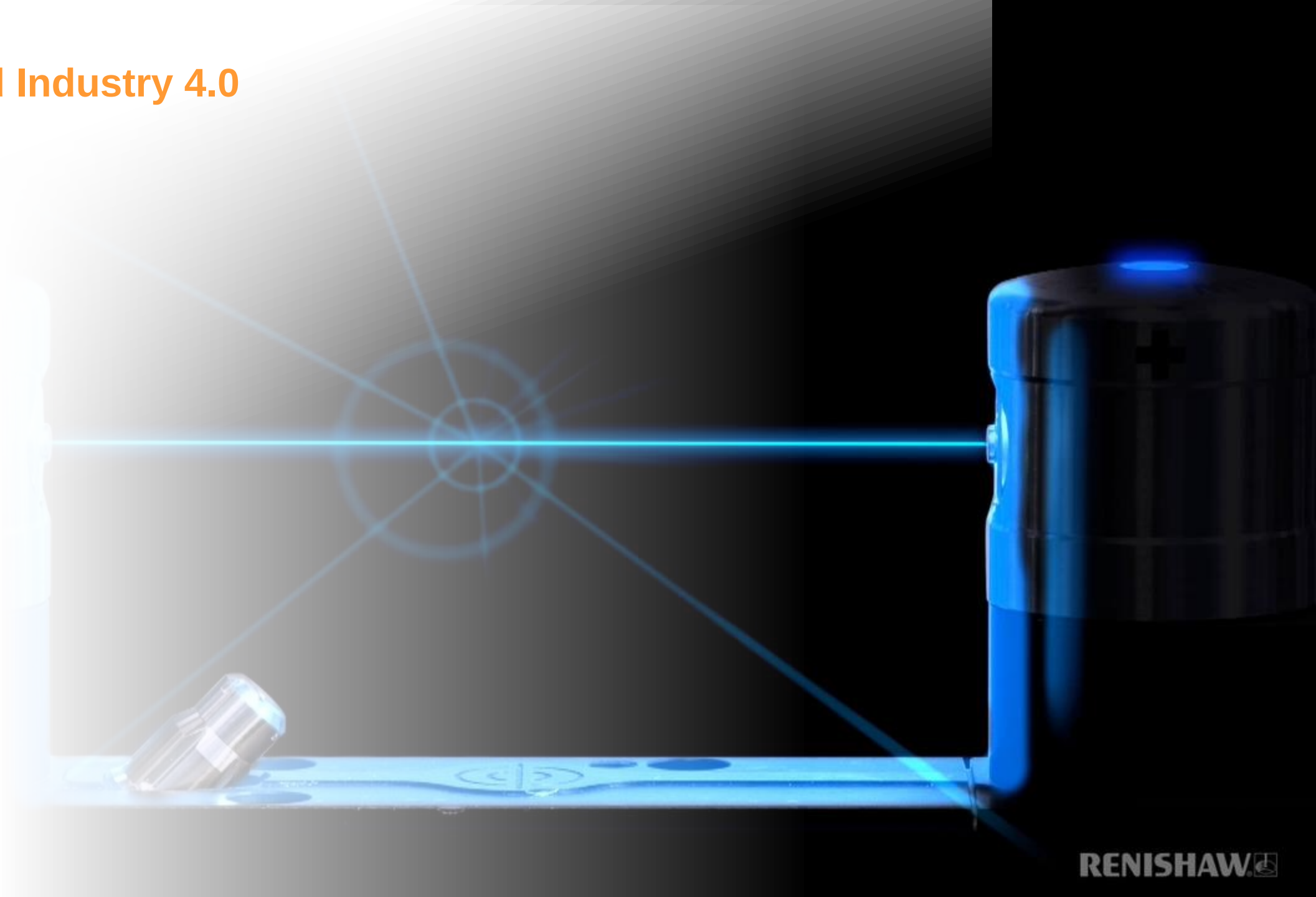
# Post process monitoring

Process and part validation

- Validating process performance
  - Discrete processes or operations
  - Built-in confidence
  - Valuable data for analysis
  - Full part verification
  - Fast assessment and collection of all quality data.



## Data and Industry 4.0



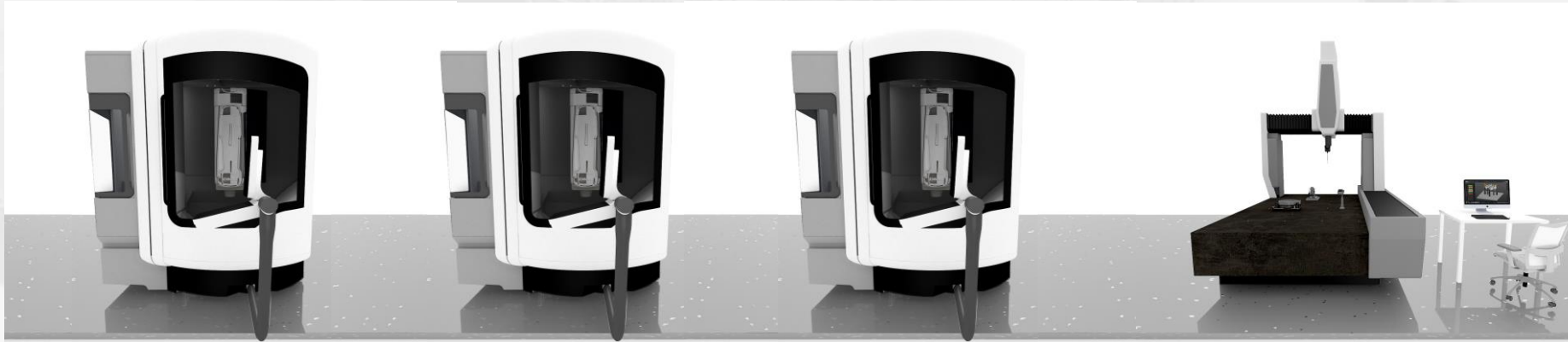
## The problem with final measurement...

Final inspection is an overhead (cost)

Op 10

Op 20

Op 30



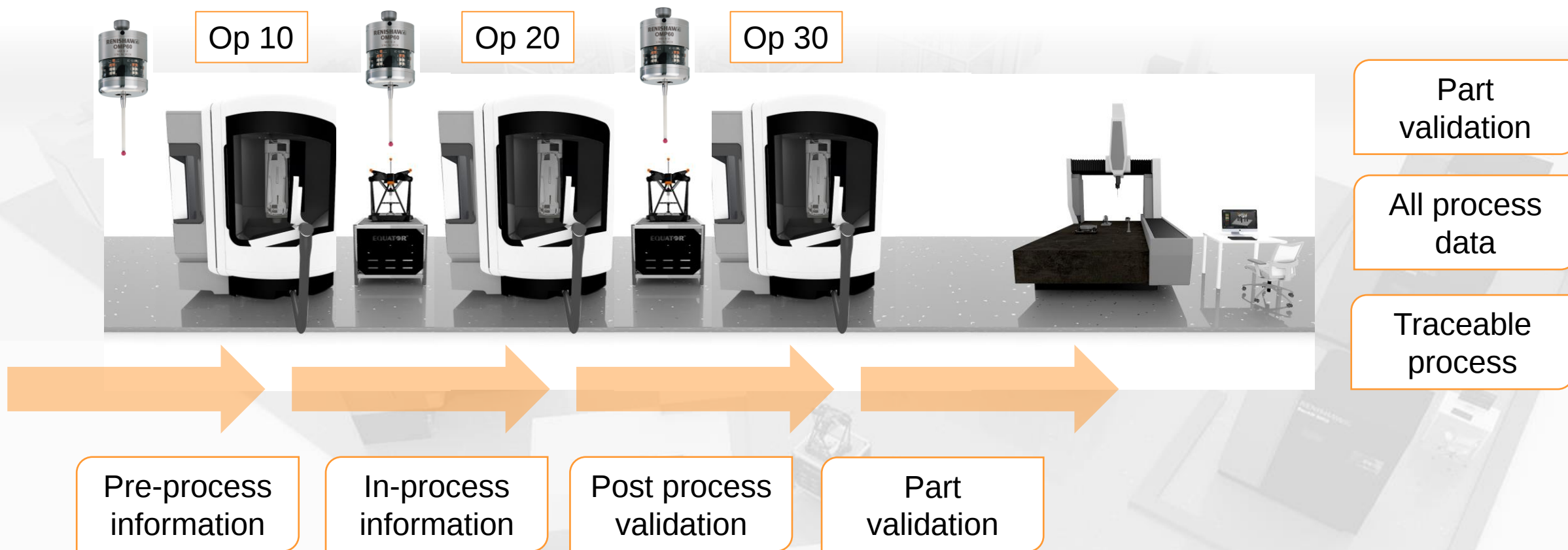
Part status –  
good or bad?

How did the  
part evolve?

Audit and  
traceability?

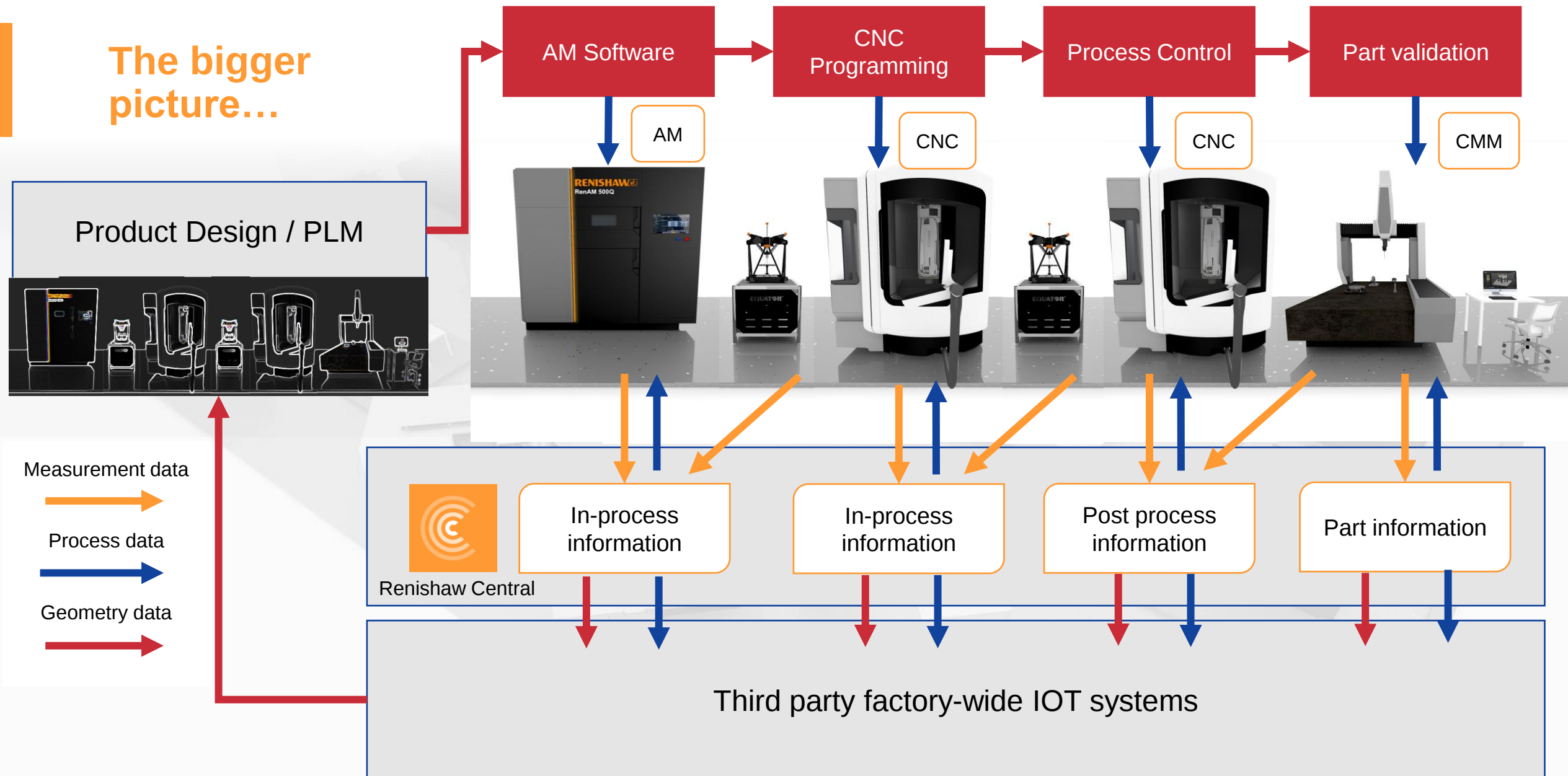
Generally there is a lack of evidence or enough process data to demonstrate how a part reaches it's final condition – this makes process optimisation and continuous improvement a real challenge.

## Where can we gain insights?



Process control adds value and builds confidence at every step. The data provided allows easier optimisation, fault finding and continuous improvement activity.

## The bigger picture...





***Thank you***

For more information please visit:  
**[www.renishaw.com](http://www.renishaw.com)**

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