Apply innovation in Advanced and Additive manufacturing Technologies

The future

Intelligent factories with zero waste and optimised efficiency, using automated processes.

Smart use and re-use of materials, energy efficient and environmentally friendly

Enabling technology?

✓ Connectivity and IT
✓ Integrated sensors
✓ Predictive analytics
✓ Real-time monitoring

The benefits

✓ Intelligent process control
✓ Process stability and high machine availability
✓ Understanding performance *during* the process
✓ High productivity and capability
Renishaw technology enables…

Highly productive precision machining
Reduced skill requirements
Reduced quality costs
Factory automation
Advanced Manufacturing involves Industrial Metrology

CNC machine calibration and performance assessment
Consistent process output - accommodate variation
Compensate for changes or drift during machining
Verification of parts to meet design intent
Traditional factory...

- High labour content / cost
- Skilled operators
- Remote QC area
- Low productivity
- Queuing
- High quality costs
Future factory

- Direct process control
- Intelligent manufacturing
- Highly automated
- High productivity
- Lower quality costs
- Low labour costs
Integrated process control solutions
Applications relevant to many industries

<table>
<thead>
<tr>
<th>Process Input / source of variability</th>
<th>Aerospace</th>
<th>Automotive</th>
<th>Precision manufacturing</th>
<th>Heavy industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine dynamic performance – accuracy of interpolated features</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmetic surface finish on circular interpolation</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine set up – critical alignments and positions</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool length and diameter offset measurement</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirmation of expected tool assembly</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work piece set up – position and alignment</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation for input material variation</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine and part thermal growth compensation</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Tool breakage detection</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process control of tool offsets</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Point of manufacture QA</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Final certification and pass off prior to assembly</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
Additive Manufacturing is part of Advanced Manufacturing

Experience developing advanced manufacturing processes

AM technology and know-how
RenAM 500Q – Delivering productivity through product innovation

AM produced galvo mounting gives 4 lasers full field of view
Standard vs high productivity

2 lasers

4 lasers

Build progress after 19 hours
RenAM 500Q – Delivering productivity through product innovation

Compatibility with InfiniAM process monitoring
RenAM 500Q – Compatibility with InfiniAM process monitoring

RenAM 500Q system sensors automatically control and monitor the build process

- Make informed decisions about process quality during build with InfiniAM Central.
- System sensors: Atmospheric, Pressure, Thermal sensors and cooling control, Gas control, Powder.

Fully prepared for InfiniAM Spectral melt pool sensing technology

- Collect and view part quality information live, as the build progresses.
RenAM 500Q – Delivering productivity through product innovation

High volume intercooled gas flow with cyclone separator
Maintain process consistency and laser energy transmission

- Superior gas flow removes process emissions from 4 lasers.
- Intercooled gas reduces condensate contamination inside the build chamber.
- Cyclone separator captures larger particulates, extending filter life and maintaining effective gas flow throughout the build.
RenAM 500Q – Delivering productivity through product innovation
RenAM 500Q – On-board sieving

Practical automated management of additional powder throughput on high-productivity systems.

Focus on productivity:

- Minimise waste and reduce operating costs.
- Reduce operator intervention and risks associated with human factors.
- Drastically shorten turnaround times.

Powder is recycled and re-used in a single process under an inert atmosphere.