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Case study: Precision manufacturing

Maximising machine uptime: Renishaw Central boosts weekly machine availability by 79 hours

Background:

Renishaw Central was born out of our own need to digitalise, visualise and control the manufacturing and measurement processes within our production facilities.

Challenge:

Ensuring that Renishaw's manufacturing processes remain at the leading edge, making best use of data, and demonstrating a factory of the future.

Solution:

Collect accurate, actionable data and enable intelligent process control across the factory using Renishaw Central.

> **"Renishaw Central provided traceability for process consistency across multiple machines, processes, and jobs. This included tool setting, in-cycle measurement, tool offset adjustments and machine health metrics."**

David Miles
Manufacturing Engineering Manager, Renishaw plc

We are a vertically integrated company with significant in-house process development and manufacturing capabilities. This helps us to retain intellectual property and has proven invaluable during supply chain disruptions.

Renishaw has long recognised the importance of data to the machining process. In the 1980s our data was collected using DPRINT dot-matrix printers, followed later by DPRINT file to network. This was followed by the Shop Floor Data Collection System, using Direct Numeric Control (DNC) for program transfer and manual input of machine status.

As an early adopter of automation, we created the Renishaw Automated Mill Turn Inspection Centre (RAMTIC), a fully automated, in-house manufacturing system with closed-loop process control. When we created the RAMTIC system in the early-1990s, automation systems suited to our high-precision, low volume, high product mix were not available on the market.

With the emergence of the Industrial Internet of Things (IIOT), we implemented a factory-wide machine status monitoring system. However, this still required some manual input from the machine operator, which prevented true 'lights out' operation. Additionally, the system did not collect detailed metrology or process data.

"Today, our Manufacturing Services Division (MSD) produces an average of 1.2 million parts per month, with a works order average of 3,850 machine set-ups," explains David Miles, Manufacturing Engineering Manager. "**Our highly automated machining processes enable around 1,400 product changeovers per month, which equates to 2,800 machining operations that incur zero manual setting time. This allows us to run much smaller batches closer to the assembly consumption rate.**"

The act of collecting data is not enough to impact productivity. When analysing data, it is only when you start to put thresholds and context around the data that it becomes informative and actionable. As experienced manufacturers ourselves, we've been gathering insights from the data captured in our own machine shops and using them to automate our production processes for over 30 years.

We took these insights and developed Renishaw Central, a manufacturing connectivity and data platform that collects and provides visibility of manufacturing process data.

Renishaw Central enables users to monitor and update machining and quality control systems. Introducing the platform in our UK factories has ensured that our in-house manufacturing remains at the leading edge, makes the best use of data, and demonstrates the factory of the future.

> **"The scale of Renishaw Central's integration is impressive. We've connected the platform to 69 machines across our two main manufacturing sites in the UK. At our Miskin facility in South Wales 43 machines are loaded and run by just 4 staff per shift.**
>
> **At this level of automation, CNC alarms and other unplanned stoppages have a significant effect. Renishaw Central has addressed this issue leading to unexpected efficiency gains."**
>
> David Miles
> Manufacturing Engineering Manager, Renishaw plc

Using real-world shop floor experiences, our in-house manufacturing services team were able to prove out Renishaw Central's capabilities. They were also able to create a centralised repository for metrology, quality, and utilisation data. This in turn enabled the use of the latest business intelligence and AI analysis tools, both now and in the future.

"As well as proving out the platform's capabilities, Renishaw Central provided traceability for process consistency across multiple machines, processes, and jobs. This included tool setting, in-cycle measurement, tool offset adjustments, and machine health metrics," David added.

Although some of this data collection had been conducted already, it was localised, and stored primarily for retrospective failure investigation. Recurrences of the same issues and actions taken could not be effectively recorded on a factory-wide level and, despite multiple attempts, it proved impossible to extract, collate and interrogate data in a single silo before the data became out-of-date. Importing live data into Renishaw Central allowed fast, proactive corrections and improvements.

Support for automation processes is included in Renishaw Central, by design. Renishaw Central is designed to support automation processes. It does this by incorporating data from different types of measurement routines: in-process (using probes in CNC machines), in-line or near-line (using Equator™ gauging systems), and end-of-line (using shop-floor co-ordinate measuring machines).

Results are collected by Renishaw Central, where the intelligent process control (IPC) module calculates closed-loop process control feedback using customer-defined limits. This flexible system allows measurement data from any device to be used to automatically control processes on any other CNC machine if needed, such as tool-offset updates. Manual changes in tool offset can cause errors and quality problems in the entire process. IPC can avoid this variability by using measurement data to update offsets automatically on machine tool controls. IPC also enables real-time quality monitoring.

Within an automation context, Renishaw Central gives users the confidence that part quality is being monitored, tracked, and acted upon before a manufacturing process goes out of control. This helps to overcome a well-known concern among automation users that, without constant monitoring, automation systems can produce scrap at an impressive rate.

> **“The Renishaw Central concept was born out of our own need to digitalise, visualise and control the manufacturing and measurement processes within our own production facilities.**
>
> **We wanted to reduce assumptions when problem solving and facilitate the adoption of automated process control. Because we live and breathe many of the same challenges faced by our customers, we’re confident that we’ve created a digital solution capable of driving actionable data across machining shop floors everywhere.”**
>
> Guy Brown
> Renishaw Central Development Manager, Renishaw plc

By collecting data across operations, Renishaw Central can rank processes, machines, lines and even manufacturing sites in terms of product quality, equipment utilisation, stoppages, and other useful indicators.

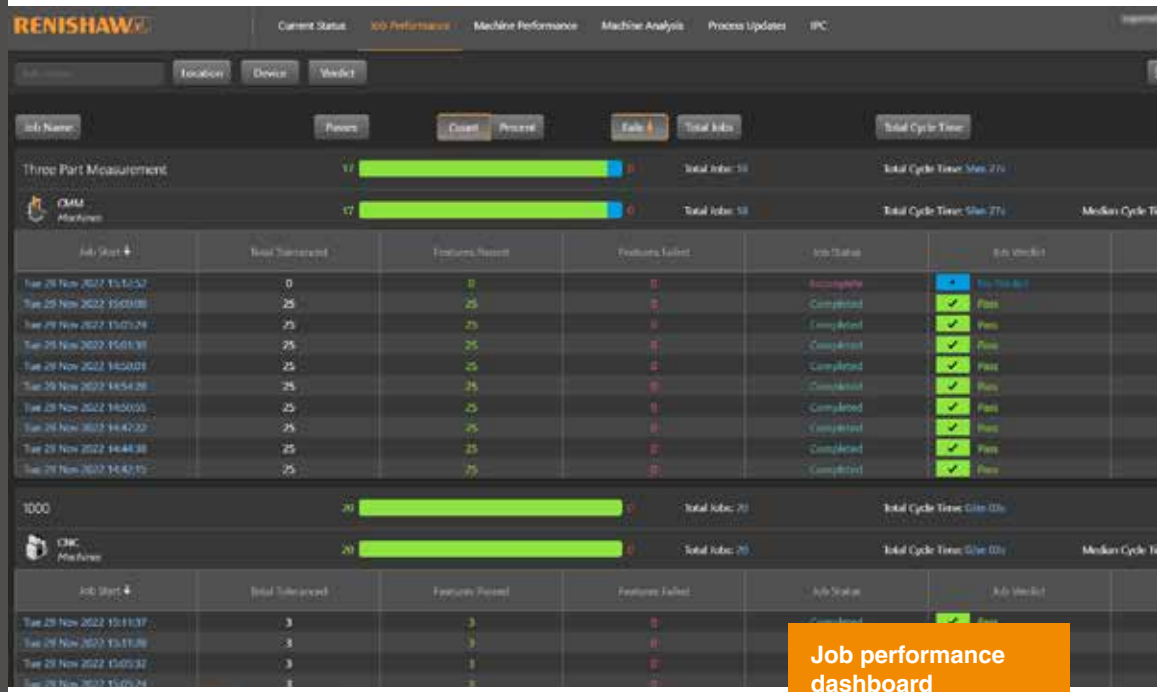
The most eye-catching results in the Renishaw Central analysis dashboards were that certain automation cells and machining processes were associated with a much higher number of machine alarms and stoppages.

> **Even the best machine shops have room for continuous improvement, and this was demonstrated once our data was collected and ranked. The original expectation of shop-floor technicians was that Renishaw Central would highlight tool life as the biggest barrier to achieving maximum efficiency.**
>
> **However, it quickly became clear that unplanned stoppages were a much more significant factor than previously assumed. Our original aim for Renishaw Central was to introduce further automation for lathes using our IPC module, and this is progressing well. But an unexpected and positive outcome has been Renishaw Central's ability to highlight and rank unplanned stoppages of our automation systems.**

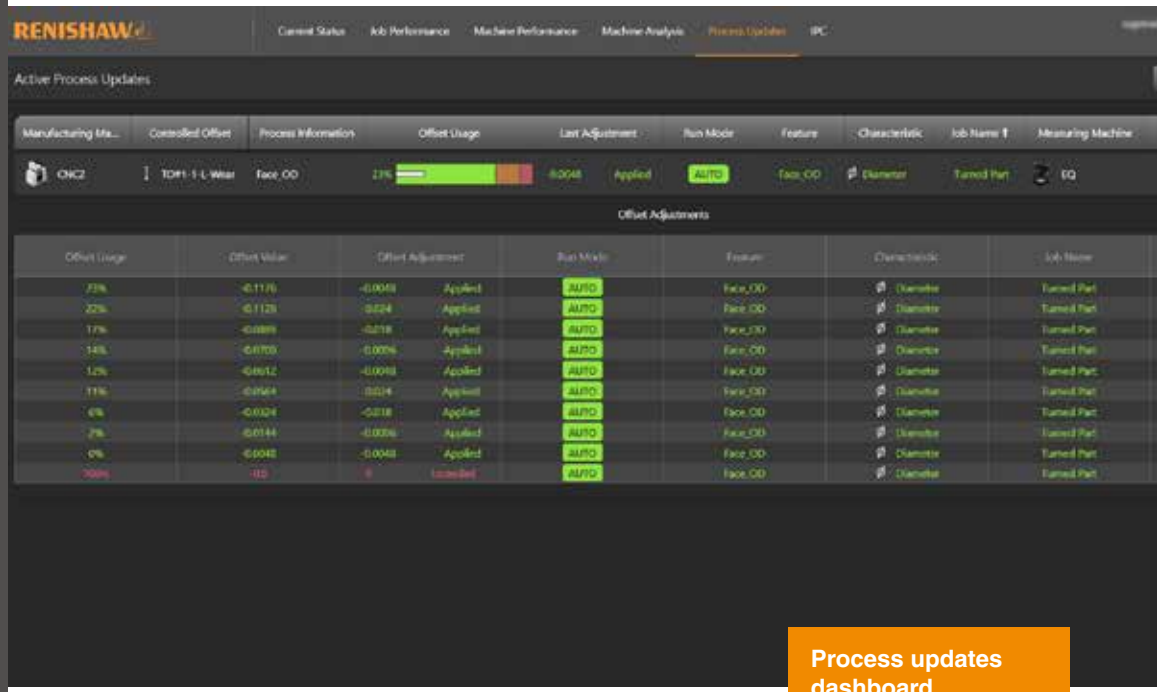
Guy Brown
Renishaw Central Development Manager, Renishaw plc

Renishaw Central has fostered increased collaboration among Operations, Maintenance, and Engineering teams to drive actionable outcomes.

Unexpected results



Job performance dashboard



Process updates dashboard

Proven in the data collected, some machines appeared to need more active controls to produce the same high-quality parts, compared to other identical machines running the same program. While machine shop personnel learn and adapt to the quirks of each machine and manually rectify, this valuable knowledge remains localised at shop level and unknown to others. Renishaw Central made it possible to view and rank the data across the whole manufacturing organisation, highlighting trends not visible at single manufacturing line level.

When this output is combined with other available sources of data, individual causes can be identified. For example, particular alarm types, on certain machines, running particular jobs, with specific tools. This methodology allowed us to identify that 82% of all our stoppages could be traced to just two types.

Concerns about automation stoppages are nothing new. In the past, issues might have been addressed with unnecessary increases in planned and unplanned service and maintenance, or less predictable ‘one off’ solutions. Now, thanks to Renishaw Central, particularly problematic jobs or processes are identified, ranked, and acted on.

Having identified stoppages as an area of significant potential for improvement, the Operations, Production Engineering and Maintenance teams were brought together to investigate further and introduce cross-functional solutions.

"A working group was formed with representatives from Operations, Maintenance and Engineering," says David. "**The objective was to create specific reports, using the Renishaw Central data source to identify opportunities for productivity improvement. When working together to create these reports, there was a collective ownership and confidence in what the data showed, which ultimately created a strong team which could work together to improve the process."**

Renishaw Central's API allows data to be exported into Microsoft® PowerBI where rich, interactive visualisations can be created. This enabled the various teams to combine and cross-reference Renishaw Central's data with data from other sources, such as our tooling database and in-house automation system.

A single problematic automatic pallet transfer stage was identified as the cause of most stoppages. Once identified, the in-house maintenance team was able to implement a range of effective remedial actions, including targeted realignment of the automation stage, and specific inspection of the problematic feature on the pallet (the dovetail), which was discovered to be critical for reliability.

The team also established that, due to historic tool setting methods, tool setting tolerances were unnecessarily tight for some circumstances. These caused false alarms and unnecessary tool replacement costs which were reduced by updating guidance for tolerances and updated tool setting methods.

What was the ultimate result of converting actionable data into remedial actions?

"We found that 82% of stoppages could be traced back to two issues and an increase in weekly machine availability of 27.5 hours (23 machines)," says David. "**Across all of our shop-floor automation cells, this has increased weekly available machine time by 79 hours."**

Renishaw Central has also supported our efforts to improve the productivity and sustainability of our manufacturing operations. As well as allowing us to reduce unproductive machining time and minimise scrap, Renishaw Central's intelligence can also stop us from wasting energy. An unplanned stoppage during a 'lights out' machining process on a Friday, for example, could leave a machine powered on but unproductive until the following Monday. Renishaw Central constantly monitors processes, making our manufacturing truly 'lights out'.

Emerging technologies will play a crucial role in the future of Renishaw Central, with ten additive manufacturing machines in our in-house manufacturing facilities already integrated with Renishaw Central's smart manufacturing data platform.

The next phase of our Renishaw Central implementation includes the roll-out of lathe set-up and process control applications across sites. Uniquely, this will provide the flexibility of measuring workpieces on any in-line gauge with process control feedback sent to the appropriate CNC controller in the form of a tool offset update.

"The early indications are positive. With the introduction of bespoke setting pieces and automated offset updates, we have achieved significant set time reductions. Critically, set-up has been de-skilled and can be reviewed and redone quickly, if necessary, which is increasingly important in a tightening labour market. At the same time, records of the updates made are available for traceability and ongoing data interrogation." said David.

A global selection of pilot customers who trialled Renishaw Central also confirmed that access to standardised end-to-end data provided an insight into their processes that has allowed them to improve manufacturing performance. Every shop floor is different, with even the most well-established automated processes having untraceable issues. Renishaw Central provides complete visibility of local issues, no matter how wide-ranging, enabling the efficient resolution of previously undetected or unsuspected process constraints.

What's next for Renishaw Central?

"**We plan to build on the success of Renishaw Central, with the incorporation of live dashboard views to help monitor the health of our processes. This will involve the incorporation of more data sources to increase our coverage of data throughout our Productive Process Pyramid."**

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Our key ‘real world’ takeaways

- Compatibility with third-party inputs is important as no single supplier ‘owns the shop floor’.
- To avoid data silos and allow self-service data analysis, an open API allowing connection to tools such as Microsoft® PowerBI is essential.
- Engagement with IT departments early in the process is critical and documentation appropriate to them must be provided.

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