Case brief

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Mould and die manufacturing: ensure optimum accuracy and consistency

- Eliminate errors due to thermal effects
- Guarantee accuracy
- Reduce scrap

Overview

Company information	BK Tooling is a precision toolmaker specialising in the manufacture of high-quality plastic injection mould tools.	
	The company, based in Bishops Stortford (UK) was established over 30 years ago. Its main markets are the medical, leisure, industrial automotive and electrical sectors.	
Products and services	Mould design, moulding analysis, rapid tooling and production mould manufacture using a range of machining technologies, low-volume injection moulding.	
Industry standards	Kaizen	Six Sigma and standardisation
Company objectives	To work with customers to deliver mould tools and services that exceed expectations, achieving this through a combination of experience and the use of the latest manufacturing technology.	
	To serve industries that require low to medium volumes of injection mouldings or are nervous about their IP security.	

Process

BK Tooling is focused on high-quality one-off manufacturing. Typically moulds produced are for research, development and prototype work.

Mould tool components are machined using XYZ 1060 high-speed vertical machining centres equipped with Siemens 840D Shopmill controllers

Larger components may involve many hours of machining; high constant surface speeds are used to maintain a high-quality surface finish.

Challenge

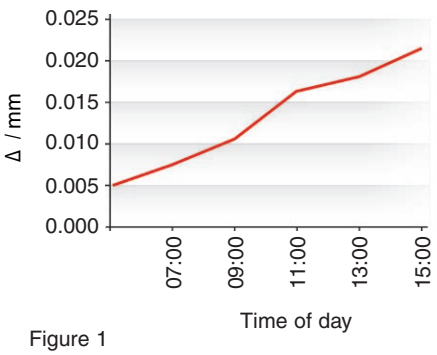
1 Ensure and maintain accuracy

All machine tools are subject to thermal effects, generated by their operation and changes within their environment. Known as thermal drift, this can vary significantly depending on circumstances. For three axis VMCs the greatest effects generally occur in the Y and Z axes. For example, high-speed machining coupled with long cycle times can result in thermal drift of up to 100 µm in the Z axis. Uncorrected, this kind of variation causes positional errors leading to incorrectly machined parts.

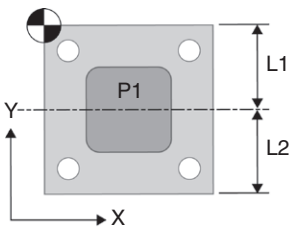
BK Tooling typically experiences movement of 15 µm. When working to tolerance below ±10 µm, and taking other variation such as tool wear into account, it is vital for BK Tooling to control the metal cutting process.

Figure 1 illustrates thermal drift and its effect on machined features.

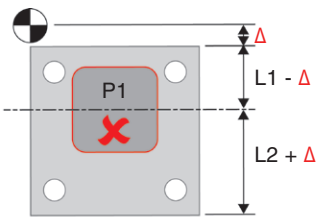
1. **Example of thermal drift over time (Y axis)**



2. **Pocket feature (P1) as required**



3. **Thermal drift is uncorrected – P1 is machined incorrectly**



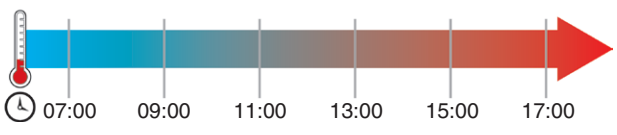
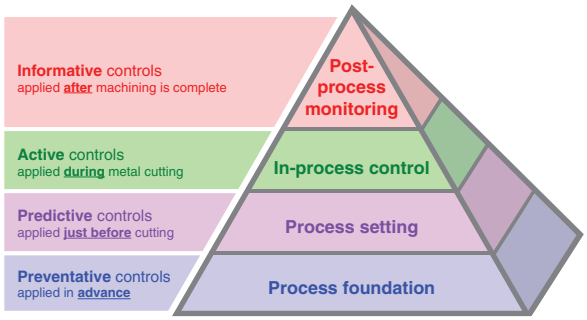


Figure 1

Process considerations

Renishaw engineers considered key elements within BK Tooling's process and production stages of manufacturing using Renishaw's ***Productive Process Pyramid™***. This framework is used to identify and control the variations that can occur at key stages of the machining process.

For more information, please visit the **When do I probe?** section of the Renishaw website:
www.renishaw.com/whendoiprobe



Productive Process Pyramid

Solutions

Manufacturing process focus: in-process control

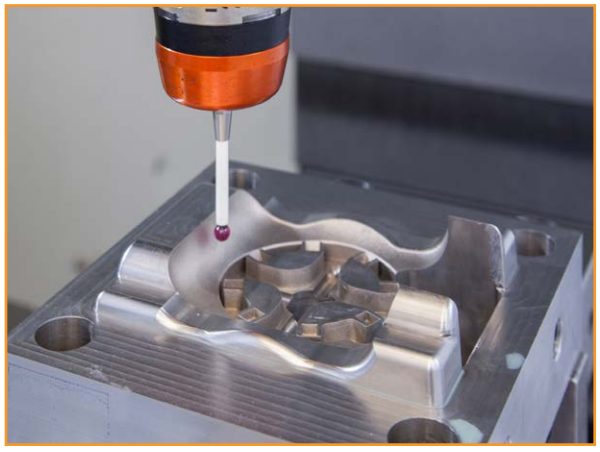
Focusing on in-process control, Renishaw engineers introduced measures to increase automation and eliminate manual intervention.

The introduction of automated in-cycle probing using Renishaw probes enables BK Tooling to:

- **Track thermal growth of machine tool axes and automatically update offsets as required. Regardless of the amount of drift, it can be corrected and machining errors avoided.**
- **Maintain an accuracy of ± 0.01 mm.**
- **Avoid scrap and rework.**

Figure 2 illustrates the ease with which operators can check for and correct thermal drift as part of the machining cycle.

using a Renishaw probe.



In-cycle probing with a Renishaw Primo Radio Part Setter on an XYZ high-speed vertical machining centre.

1. Component is probed in-cycle – thermal drift is measured

2. Work offset is automatically updated – error is compensated

3. P1 feature is machined correctly

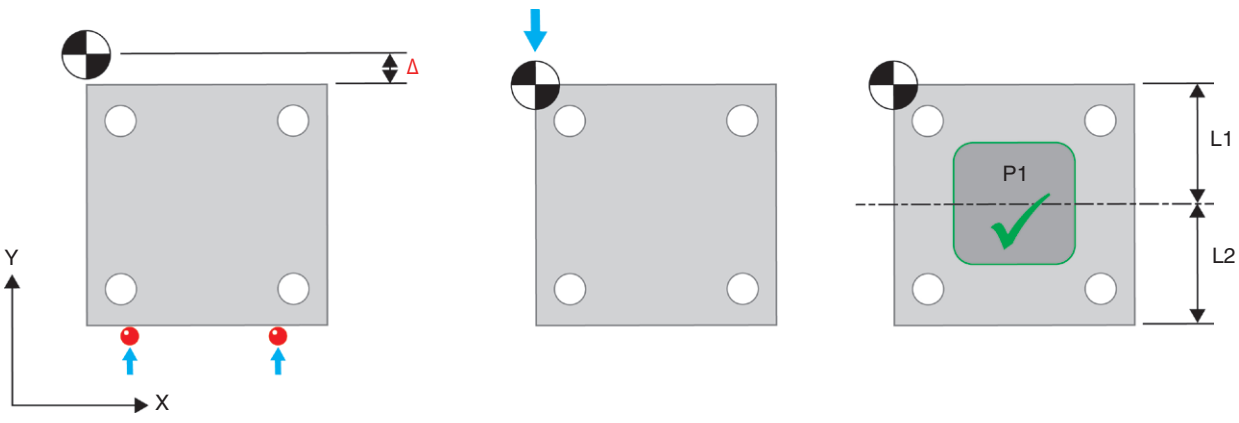
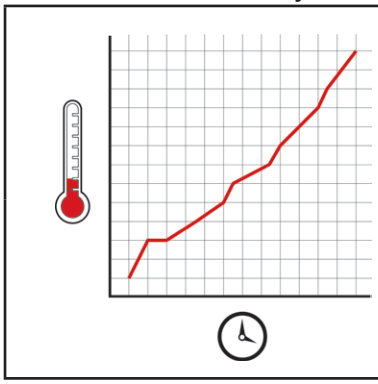


Figure 2

Results

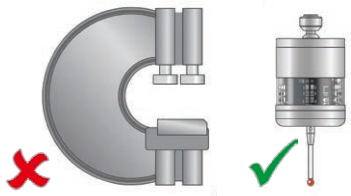
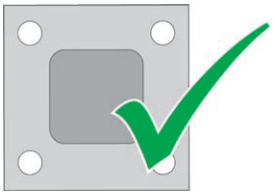
These charts provide a typical illustration for this industry application where probing has been introduced.

Maintained accuracy



	Without probing		With probing	
Positional errors caused by Y-axis thermal drift	> 0.02 mm	Out of tolerance	< 0.01 mm	In tolerance
Positional errors caused by Z-axis thermal drift	> 0.1 mm	Out of tolerance	< 0.01 mm	In tolerance

Improved in-process capabilities

		Without probing	With probing
	In-process gauging	Not practical	Enables adaptive machining, in-cycle
	Update tool offsets	Not practical	Enables in-cycle compensation for thermal drift
	Finished part conformance	Requires breakdown of set-up and measurement on a CMM (co-ordinate measuring machine)	Enables potential on-machine verification

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Summary

In-process control applied to mould and die manufacturing through the use of Renishaw probing systems has significantly enhanced machining performance at BK Tooling. In addition to the improvements to its efficiency, the company and its customers benefit from increased confidence in precision and quality.

Through a combination of experience and use of the latest technology BK Tooling has gained wide recognition as a highly competent partner in a challenging and demanding industry sector.

Renishaw probes applied to mould and die machining have helped BK Tooling to:

- **Eliminate uncertainty and variation associated with thermal drift**
- **Improve accuracy, repeatability and quality**
- **Guarantee parts that are right first time**
- **Introduce process setting controls in addition to in-process controls**

Contact

To find out how you could benefit from our process control solutions, contact us today – find your local office at **www.renishaw.com/contacts**

Customer comment

"If you took our probes away, how could we possibly do these jobs accurately? We really do produce the tooling 'right first time', while achieving better than 10 µm repeatability on any feature, when compared to the CAD model."

BK TOOLING **BK Tooling (United Kingdom)**

Best practice

Productive Process Patterns™ from Renishaw provide guidance on best practice and the implementation of a wide range of probing solutions.

For more information regarding job set-up and other applications, visit **www.renishaw.com/processcontrol**

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About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading-edge products that increase process productivity, improve product quality and deliver cost-effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Products include:

- Additive manufacturing and vacuum casting technologies for design, prototyping, and production applications
- Dental CAD/CAM scanning systems and supply of dental structures
- Encoder systems for high-accuracy linear, angle and rotary position feedback
- Fixturing for CMMs (co-ordinate measuring machines) and gauging systems
- Gauging systems for comparative measurement of machined parts
- High-speed laser measurement and surveying systems for use in extreme environments
- Laser and ballbar systems for performance measurement and calibration of machines
- Medical devices for neurosurgical applications
- Probe systems and software for job set-up, tool setting and inspection on CNC machine tools
- Raman spectroscopy systems for non-destructive material analysis
- Sensor systems and software for measurement on CMMs
- Styli for CMM and machine tool probe applications

For worldwide contact details, visit www.renishaw.com/contact

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