RENISHAW
apply innovation™

TE500

Tool setting and broken tool detection

Tool setting and broken tool detection

The objective of the TE500 series of modules is to:

- summarise the benefits of tool setting and broken tool detection operations
- introduce the available tool setting technologies, and their operational advantages and limitations
- outline the considerations when selecting the most suitable tool setting product for an individual application

What is tool setting?

On-machine tool setting and broken tool detection are hugely important because of the effect they can have on cycle times and scrap rates. They form a part of process setting and in-process activities required for the accurate machining of a component.

To ensure a machined component is within specification, it is essential that:

- the machine tool knows the geometric parameters for the cutting tools being used
- the cutting tool is in good condition
- changes in cutting tool condition or dimension can be detected and compensation applied in-process
- the methods used to obtain this information are repeatable and accurate

Tool setting is the process of determining geometric information - length, radius and/ or diameter - of a cutting tool using a tool setting device and dedicated software, then communicating this information to the machine tool control.

Tool condition monitoring is an in-process control that does not determine geometric information of the tool, looking simply for tool breakage and giving an output of ‘not broken’ or ‘broken’.

These processes are performed using specialised devices and dedicated software cycles incorporated into the machine tool and machining processes. The most basic tool setters are only capable of measuring tool length. More sophisticated systems can also determine tool radius (and diameter). Broken tool detection is available as a function of most tool setters as well as via dedicated devices.

Modules IM200 and IM201 introduce Renishaw’s Productive Process Pyramid™ (shown in Figure 1) with four layers - preventative, predictive, active and informative - and identify the process improvement activities that are recommended in each layer.

These processes include:

- **Tool setting** as a predictive, process setting activity
- **Tool condition monitoring** as an active, in-process control activity

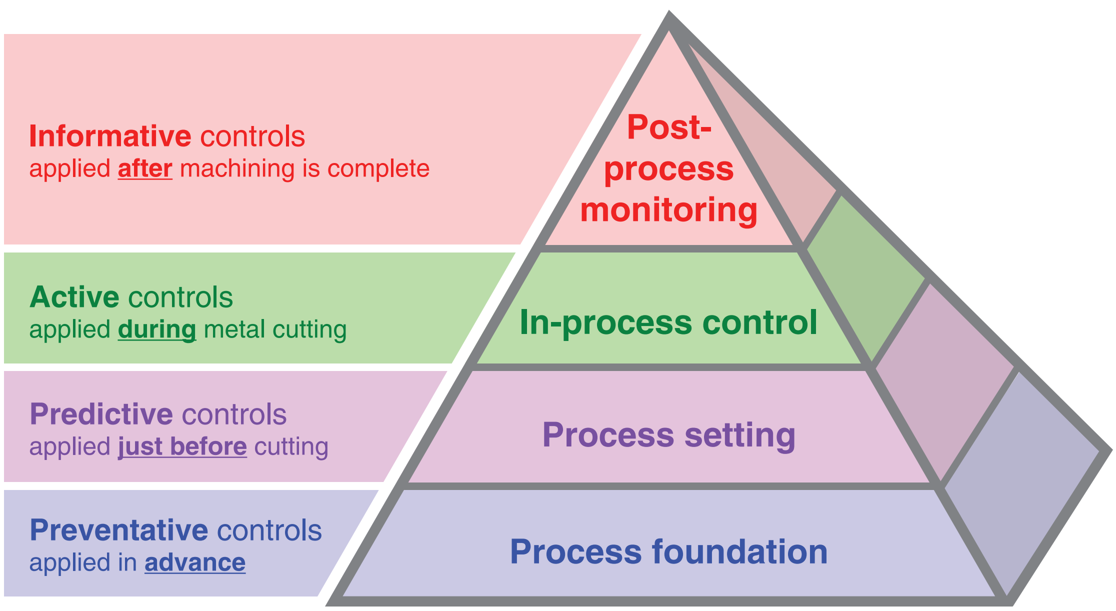

Figure 1: Renishaw’s Productive Process Pyramid™

Why toolset?

To accurately machine a component, the machine tool needs to know the position of the tool tip or cutting edge relative to the spindle nose and the position of the material to be machined within the machine co-ordinate system. Therefore it is vital that the geometric data and dimensions for the tools are accurately known and input into the machine tool. This can be done offline or within the machining cycle.

Tool setting off-line using a pre-setter can introduce a number of errors, both through the manual input of length and radial offsets, operator error, and through the inability of the method to allow for physical attributes of the machine: tool clamping, 'run out', thermal stability and the spindle 'pull up' effect cannot be taken into account. Therefore it is considered preferable to use on-machine methods, using the technology described in the TE500 series of modules and Productive Process Pattern™ AP204, *Tool setting**.

Determining geometric information and the actual condition of a cutting tool on the machine can help to improve the manufacturing process in a number of ways. Primarily, the advantages are to help remove operator induced errors, checking the correct tool for the scheduled machining program has been loaded, assisting in the automation of tool offset information input, correcting for tool wear and checking for tool breakage, as well as reducing the time taken to accomplish these tasks.

The make, model and technology used by the tool setter installed on a machine affects the level of information that can be determined for a specific tool, the cycle time and the measurement repeatability. Current technology allows tools to be measured with a repeatability of less than 1 µm. (Tool setting methods and their various advantages and limitations are covered in module *TE510, Tool setting technology*.)

The benefits of performing tool setting at the process setting stage are:

- Ensures a tool is capable of performing the required task
- Improves process accuracy
- Reduces the level of operator intervention required

Whilst it would usually be too time consuming and unnecessary to carry out tool setting after every machining operation, it is worth performing frequent broken tool detection cycles as tools, especially small diameter ones, can become chipped or broken during a machining cycle. The recommended checking frequency is dependent upon the scenario, and could be determined by experience of which tools break most often.

Detection of a broken tool is a good indicator that previously machined features may have been produced incorrectly. Detection cycles can be programmed to sound an alarm, call an operator or change to a sister tool when a broken tool is detected, saving time, re-work and scrap, and further manufacturing costs.

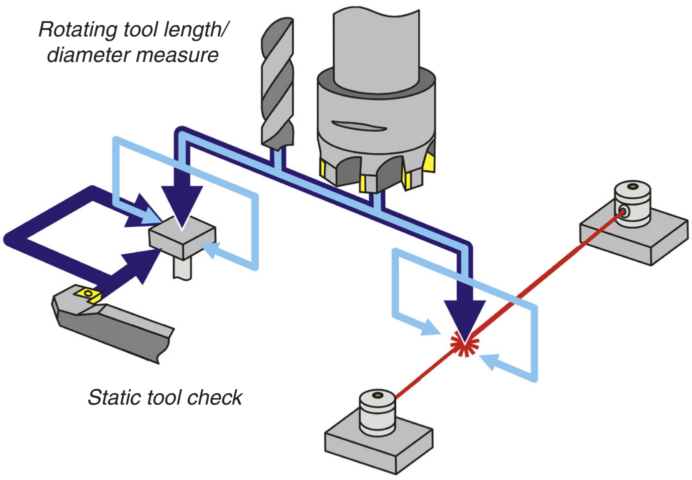

Figure 2: tool setting

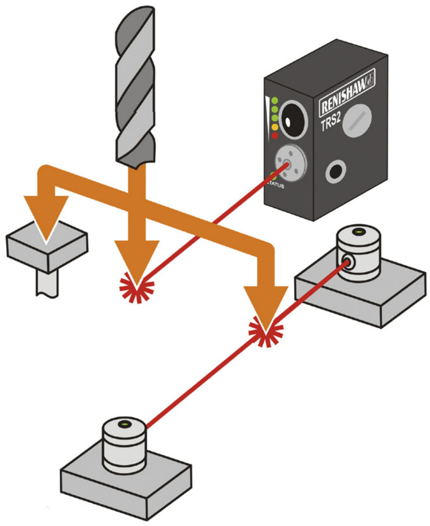

Figure 3: broken tool check

* a list of related modules which may also be of interest is provided at the end of this document.

Summary

Tool setting helps to:

- ensure accurate dimensional measurement of tooling
- eliminate incorrect tool loading and manual setting errors
- compensate for thermal growth in the machine spindle and tool
- automate tool offset calculation and correction
- adapt for tool run-out and wear

Broken tool detection or **recognition** helps to:

- prevent broken or chipped tools cutting air
- reduce scrap
- reduce labour requirements

Related modules for further information:

- TE510 Tool setting technology
- TE511 Renishaw's non-contact laser tool setting technology
- TE512 Renishaw's tool recognition technology
- TE513 Renishaw's contact tool setting technology
- TE520 Renishaw's tool setting products
- AP204 Tool setting
- AP304 Tool condition monitoring

This page is intentionally left blank

Renishaw plc

New Mills, Wotton-under-Edge,
Gloucestershire GL12 8JR
United Kingdom

T +44 (0) 1453 524524
F +44 (0) 1453 524901
E uk@renishaw.com

www.renishaw.com

RENISHAW
apply innovation™

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:

- **Dental CAD/CAM scanning and milling systems.**
- **Encoder systems for high accuracy linear, angle and rotary position feedback.**
- **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 (co-ordinate measuring machines).**
- **Styli for CMM and machine tool probe applications.**

Renishaw worldwide

Australia
T +61 3 9521 0922
E australia@renishaw.com

Austria
T +43 2236 379790
E austria@renishaw.com

Brazil
T +55 11 4195 2866
E brazil@renishaw.com

Canada
T +1 905 828 0104
E canada@renishaw.com

The People's Republic of China
T +86 21 6180 6416
E china@renishaw.com

Czech Republic
T +420 548 216 553
E czech@renishaw.com

France
T +33 1 64 61 84 84
E france@renishaw.com

Germany
T +49 7127 9810
E germany@renishaw.com

Hong Kong
T +852 2753 0638
E hongkong@renishaw.com

Hungary
T +36 23 502 183
E hungary@renishaw.com

India
T +91 80 6623 6000
E india@renishaw.com

Indonesia
T +62 21 2550 2467
E indonesia@renishaw.com

Israel
T +972 4 953 6595
E israel@renishaw.com

Italy
T +39 011 966 10 52
E italy@renishaw.com

Japan
T +81 3 5366 5316
E japan@renishaw.com

Malaysia
T +60 3 5631 4420
E malaysia@renishaw.com

The Netherlands
T +31 76 543 11 00
E benelux@renishaw.com

Poland
T +48 22 577 11 80
E poland@renishaw.com

Russia
T +7 495 231 16 77
E russia@renishaw.com

Singapore
T +65 6897 5466
E singapore@renishaw.com

Slovenia
T +386 1 527 2100
E mail@rls.si

South Korea
T +82 2 2108 2830
E southkorea@renishaw.com

Spain
T +34 93 663 34 20
E spain@renishaw.com

Sweden
T +46 8 584 90 880
E sweden@renishaw.com

Switzerland
T +41 55 415 50 60
E switzerland@renishaw.com

Taiwan
T +886 4 2473 3177
E taiwan@renishaw.com

Thailand
T +66 2 746 9811
E thailand@renishaw.com

Turkey
T +90 216 380 92 40
E turkiye@renishaw.com

UK (Head Office)
T +44 1453 524524
E uk@renishaw.com

USA
T +1 847 286 9953
E usa@renishaw.com

For all other countries
T +44 1453 524524
E international@renishaw.com

H-5650-2022-01

Issued 0411 Part no. H-5650-2022-01-D