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Job set-up

Problem

Before beginning the metal cutting process for any component it is essential that the machine tool be updated to identify the local zero point and orientation of the component. This is usually configured in a work offset (datum shift), or a work co-ordinate system (WCS).

Traditional, manual methods of determining a WCS rely on the use of slip gauges and dial test indicators. The operator must use these devices and then perform a manual calculation to load offset information into the machine tool controller. This manual method is prone to error:

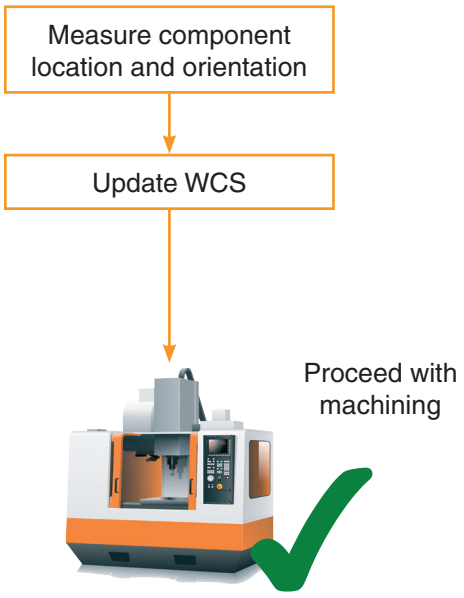
- Operators must manually calculate the desired update based on reported feature dimensions. A bad calculation, transposition of data, or an offset value mistakenly loaded into the wrong position can cause significant deviation from the expected result: a particular risk when operators are working under time pressure
- Operator skill and consistency can cause a variation in the level of control being applied. For example, the use of a slip gauge is subject to an individual operator's 'style' of working and it is possible that different operators may record different results. Additionally, different operators may make different judgements of what is 'close enough', and this introduces unpredictable errors into the process, resulting in much greater batch variability

Manual setting of a component also introduces a time penalty for subsequent operations:

- Downstream processes must be designed to cope with any variation in the accuracy of the initial set-up. This may result in an excessive amount of stock remaining on the component prior to finishing operations, or unnecessary air-cutting operations
- The ability to manually set a component may be limited by the number of skilled operators: delays on each component whilst 'awaiting set-up' may become significant if sufficient operators are not available

Solution

Use a spindle probe to automatically measure the location of the component and update the relevant offset. Where appropriate, also use the probe to update the orientation of the component using a controller function or a rotary axis.

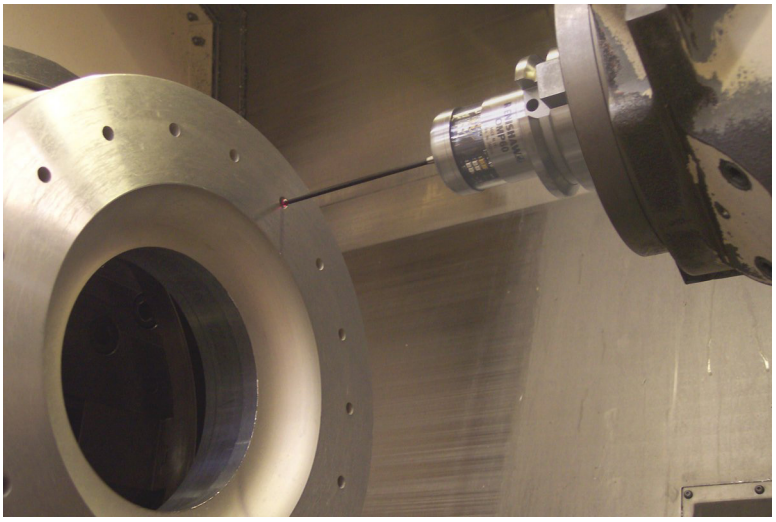


Benefits

- Eliminates manual set-up operations providing consistent and accurate results
- Subsequent operations can be designed to work with reduced variation
- Cycle time becomes much more predictable as the machine is no longer ‘awaiting operator’

Case study

The use of Renishaw probe systems in the machining of aircraft wheel forgings allows machine identification of component position and material condition. A spindle probe is used to set the co-ordinate system for each part by finding the position of a pre-drilled hole. Deviation in forgings can be monitored and settings adapted to ensure parts are correctly loaded and fresh-air cuts are eliminated. The use of a spindle probe during job set-up reduces costly errors and cycle time.



Job set-up using a spindle mounted probe to inspect the position of a forging

Example 1: updating a WCS from a measured feature

Note: in this case the Z and XY update operations have been separated. It is usually considered safest to set the Z depth of a component prior to setting the XY location.

Sample Productivity+™ probe software program

Inspection Cycle: MeasureZ Measured Point: Z_Point Machine Update: Update_Z	Probe point feature in Z and use data to update WCS.
Inspection Cycle: Measure_XY Measured 2D Corner: XY_Corner Machine Update: Update_XY	Measure 2D corner feature in X and Y. Use data to update WCS.
G-Code Block: Machine_Program	Machine component.

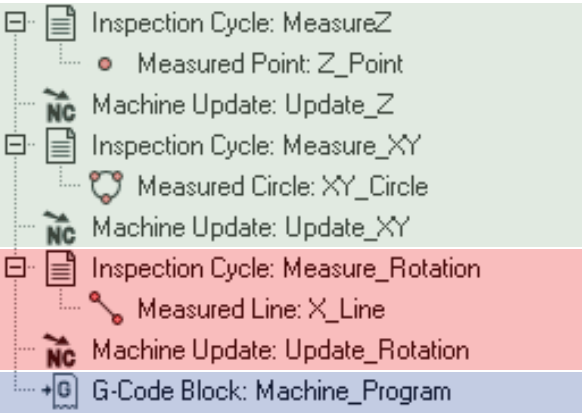
Sample Inspection Plus software program

T01 M06	Select the probe
G0 G54 X50. Y50.	Move to start position
G43 H1 Z50.	Activate offset 1 and go to 50 mm above surface
G65 P9810 Z10. F3000	Protected positioning move to Z10
G65 P9811 Z0 S1.	Single surface measure in the Z-axis. Update WCS ~ Z-axis
G0 Z50.0	Rapid move to Z50
G0X-10. Y-10.	Move to corner measure start position
G65 P9810 Z-5. F3000	Protected positioning move to Z depth
G65 P9816 X0 Y0 I10. J10. S1.	Corner measure. Update WCS ~ X- and Y-axis
G0Z100.	Return to clearance position
	Continue machining process

Example 2: updating a WCS *and* a rotation

The rotation may be performed in software (using a co-ordinate system function) or by rotating a physical machine axis.

Sample Productivity+™ probe software program

	Probe point feature in Z and use data to update WCS. Probe circle feature and update WCS in X and Y. Measure line feature in X and perform rotation update. Machine component.

Sample Inspection Plus software program

This program uses the angle of the component found to orientate the part program correctly using the G68 coordinate rotation function

T01 M06	Select the probe
G0 G54 X50. Y50.	Move to start position
G43 H1 Z50.	Activate offset 1 and go to 50 mm above surface
G65 P9810 Z10. F3000	Protected positioning move to Z10
G65 P9811 Z0 S1.	Single surface measure in the Z-axis. Update WCS ~ Z-axis
G1 Z50. F3000	Positional move to Z50
G0X-10. Y-10.	Move to corner measure start position
G65 P9810 Z-5. F3000	Protected positioning move to Z depth
G65 P9816 X0 Y0 I10. J10. S1.	Corner measure. Update WCS ~ X- and Y-axis
G0 Z100.	Return to clearance position
G68 X#135 Y#136 R#139	Set the corner position and angle of rotation
	Continue machining process
G69	Cancel rotation

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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:

- **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.**

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