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Part identification

Problem

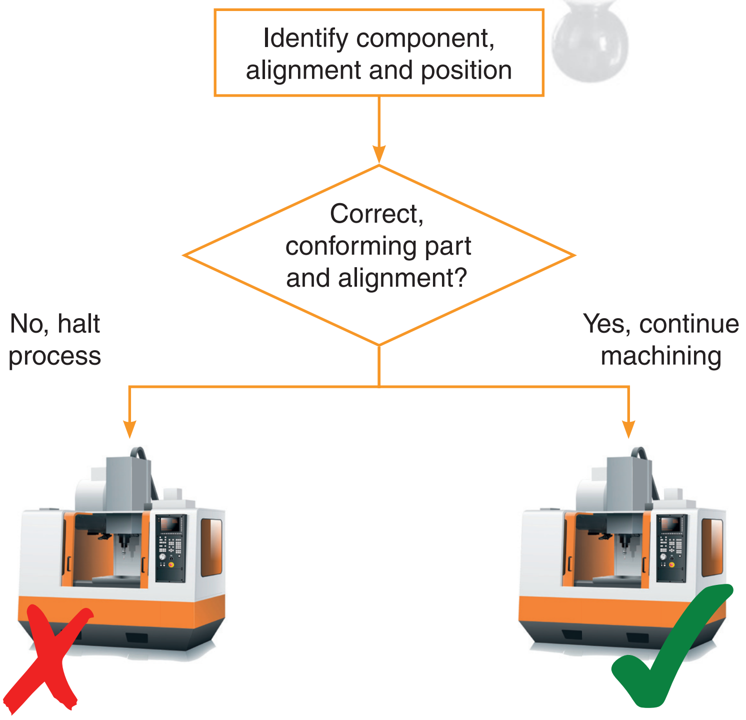
Where the placement of raw material or a semi-machined component is partly reliant on operator skill and judgement there is always the potential for manual errors. These errors can lead to poor positioning or misalignment of the material, or incorrect orientation of existing features, resulting in part deviations requiring rework or even scrapping of the component.

In some cases, incorrect alignment or positioning could result in a machine crash, leading to extensive downtime and production losses. This may be the case when the machining program does not match the material which is loaded onto the machine. Non-conforming material may also cause similar problems and the methods described to check part identification and alignment can equally well be applied to detecting non-conformances before machining.

Complex, expensive fixturing can reduce the variability of part or material loading, however certain causes of variation could still result in loading errors: operator mis-loading, swarf, debris, burrs and non-conforming material can all affect whether the part is positioned correctly for the scheduled machining process.

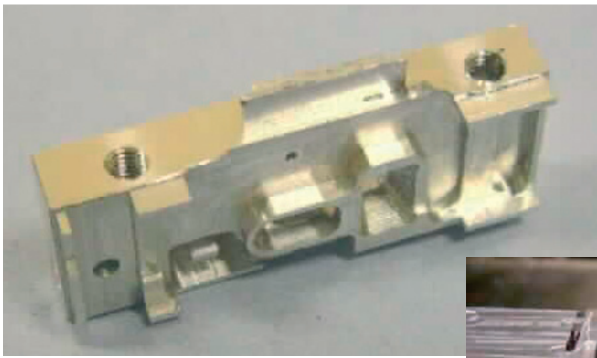
Solution

Use a spindle probe to take measurements on the raw material (or previously machined features) to determine the identity of the component, the component alignment on the machine tool, and/or to check for non-conforming material. Use the results to compare actual measurements with defined, acceptable limits. Halt the process if necessary to avoid scrap components or machine collisions; continue processing only if measurements are within the acceptable limits.

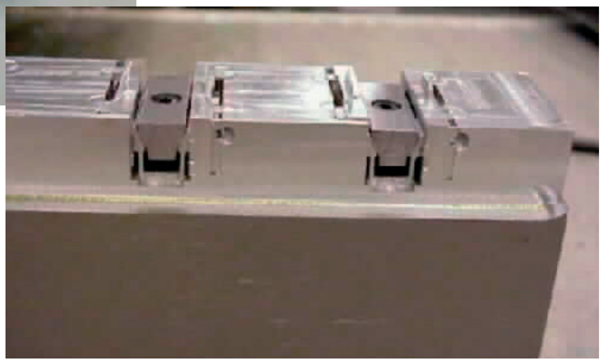


Benefits

- Reduction in scrap rates and machine crashes due to operator error when loading parts to the machine
- Allows the use of simple, lower cost fixturing. This is particularly relevant to low volume/high variety manufacturing
- Captures 'special cause', infrequent errors such as swarf underneath a component, material non-conformance, or burrs on a billet/component



Renishaw encoder readhead body prior to second machining operation



Multiple readhead bodies mounted in fixture

Case study

Manufacture of a small, high production volume optical encoder body requires two machining operations. Placement of the pre-machined part into fixturing for the second operation is dependent upon face-to-face contact between the previously machined features and the fixture faces.

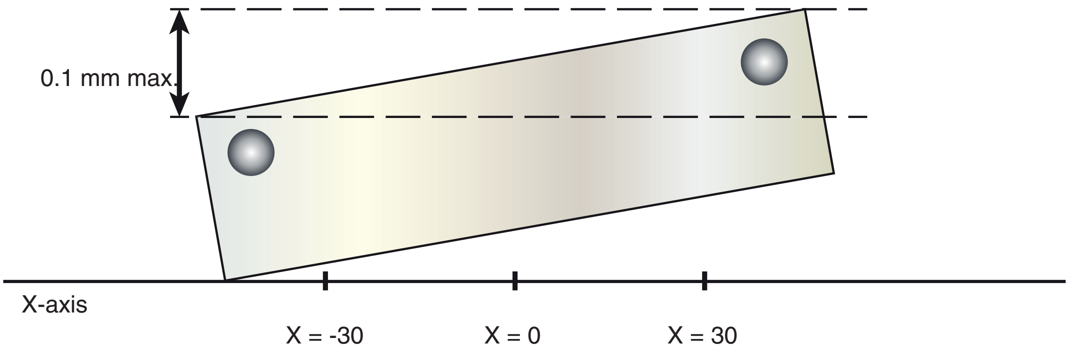
Multiple parts are loaded into each fixture and machined in sequence. The physical size, ambiguity of orientation, and low mass of the part introduce opportunities for variation in loading.

The accuracy of placement is affected by the following causes of variation:
- Operator skill and dexterity
- Cleanliness of part and fixture
- Burrs on the previously machined part

The probe is used to determine the position and alignment of the part in the fixture.
- Poor positioning can be corrected through work offset adjustment
- Misalignment cannot be corrected and the process is stopped to allow the operator to realign the part and re-try

Example 1: alignment check

Component checking in a fixture along the X-axis using two Y points measured at X = -30 and X = +30. Compare against the misalignment tolerance of 0.1 mm and stop process if the component is poorly aligned.



Sample Productivity+™ probe software program

Inspection Cycle: CheckAngleDeviation Measured Line: Line1	Probe a 2 point line to determine Y1 and Y2.
If: Line1.Point1.Y LT Line1.Point2.Y - 0.1 Then: Goto: Part_OutOfTolerance ElseIf: Line1.Point1.Y GT Line1.Point2.Y + 0.1 Goto: Part_OutOfTolerance Else: Goto: Part_InTolerance	Logic compares Y1 and Y2 data. If alignment is out of tolerance (difference between Y1 and Y2 is less than -0.1 or greater than +0.1) program jumps to Part_OutOfTolerance label, a machine alarm is raised and the part is not machined. If alignment is within tolerance, program jumps to Part_ InTolerance label and machining takes place.
Label: Part_OutOfTolerance G-Code Block: Alarm_OutOfTolerance Label: Part_InTolerance G-Code Block: MachinePart	Labels marking 'jump to' positions followed by G-Code for subsequent action: machine alarm or component machining (based on the outcome of the logic statement).

Sample Inspection Plus software program

N10 G65 P9810 X-30.0 Y-10.0	Protected positioning move to point Y1
N20 G65 P9811 Y0	Single surface measure point Y1
N30 G65 P9834	Store 'Feature to Feature' data
N40 G65 P9810 X30.0	Protected positioning move to Y2
N50 G65 P9811 Y0	Single surface measure point Y2
N60 G65 P9834 Y0 H0.1	Calculate Y-axis difference. Expected deviation 0 (zero) Apply tolerance of 0.1 Alarm if out of tolerance
N70	Continue machining process

Example 2: machine update

Update G54 Y work offset by the average of Y1 and Y2.

Sample Productivity+™ probe software program

Inspection Cycle: PositionPart Measured Line: Line1	Probe a 2 point line on the component.
Machine Update: UpdateCS_FromMidpoint	WCS update applied based on line 1 midpoint (Y1/Y2 average).
G-Code Block: MachinePart	Machining takes place using updated WCS data.

Sample Inspection Plus software program

N10 G65 P9810 X0 Y-10.0	Protected move to mid point Y1/Y2
N20 G65 P9811 Y0 S1.	Single surface point Y1
N30	Continue machining process

Example 3: positioning check

It is also possible to check the absolute position of the points. In this example, the maximum position error from either point is 0.2 mm.

Sample Productivity+™ probe software program

Inspection Cycle: CheckMaxDeviation Measured Line: Line1	Probe a line on the X surface to determine Y1 and Y2
If: Line1.Point1.Y GT 0.2 Then: Goto: Part_OutOfTolerance ElseIf: Line1.Point1.Y LT -0.2 Goto: Part_OutOfTolerance If: Line1.Point2.Y GT 0.2 Then: Goto: Part_OutOfTolerance ElseIf: Line1.Point2.Y LT -0.2 Goto: Part_OutOfTolerance	Logic determines whether the positioning is within tolerance. If positioning is out of tolerance (Y1 or Y2 is greater than 0.2 or less than -0.2), program jumps to Part_OutOfTolerance label. The part is skipped and the sequence jumps to the end of the program. If positioning is within tolerance, program jumps to Part_InTolerance label and machining takes place.
Goto: Part_InTolerance Label: Part_OutOfTolerance G-Code Block: SkipPart Goto: EndOfProgram Label: Part_InTolerance G-Code Block: MachinePart Label: EndOfProgram	Labels marking 'jump to' positions followed by G-Code for subsequent actions: skip part and move to end of the program, or component machining (based on the outcome of the logic statement).

Sample Inspection Plus software program

N10 G65 P9810 X-30.0 Y-10.0	Protected move to point Y1
N20 G65 P9811 Y0 M0.4	Single surface point Y1 Apply true position tolerance of 0.4
N40 G65 P9810 X30.0	Protected move to Y2
N50 G65 P9811 Y0 M0.4	Single surface point Y2 Apply true position tolerance of 0.4
N60	Continue machining process

Example 4: machine rotation update

Measure component feature, apply co-ordinate system rotation around Z.

Sample Productivity+™ probe software program

Inspection Cycle: AlignPart Measured Line: Line1	Probe a line on the component.
Machine Update: RotateCS_fromLine	Rotation update applied around Z.
G-Code Block: MachinePart	Machining takes place using updated WCS data.

Sample Inspection Plus software program

N10 G65 P9810 X0 Y-10.0	Protected move to midpoint Y1/Y2
G65 P9843 Y0 A0 D60.	Angle measurement, span of 60 mm
G68 X0 Y0 R#139	Rotate co-ordinate system about X0 Y0 by angle found by O9843 cycle
N20	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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