CENTRAL SCREW PRODUCTS

ERROR-PROOFING OPERATORS WITH INTELLIGENT PROBING ROUTINES

ENGINEERING CASE STUDIES 05

PROBING WITH POKA-YOKE SAFETY GATE REDUCES DOWNTIME

Manufacturing Mastery Since 1924

Central Screw Products Company (CSP) is a 3rd generation machining company, founded in 1924.

CSP leverages the latest in robotics and automation technology to achieve one of the machining industry's most efficient engineering to production ratios. The result is mastery and control of the manufacturing process, maximum customer value, and unparalleled quality.

We machine Titanium, Inconel, and other hard materials to precise tolerances for the most demanding industries such as defense, medical, aerospace, and automotive.

Our global supply chain provides a reliable single source for diverse secondary operations and value added logistics.

CSP is ISO 9001:2015 Certified, AS 9100 Compliant, ITAR Registered, and a proud recipient of a number of industry and OEM supplier quality awards.

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A poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The mis-loading of stock is the most common user error at any machine cell. In the few cases where a Fanuc robot is not available or applicable, Central Screw Products looks for ways to use automated technology to error-proof workflows.

Using physical safety gates is an effective method for error proofing the human process in lean manufacturing. The probing routine ensures the part is loaded safely to avoid risk to the manufacturing cell. This procedural "safety gate" is a fast, automated, and reconfigurable way to reduce cost and maintain on-time delivery.

At CSP, we use Renishaw and Blum probes at every milling machine on our shop floor.While familiarity with probing technology has increased throughout modern manufacturing, its application is often resisted due to cycle time contribution. Concise probing routines using both Renishaw and Blum Probes in sequence demonstrate efficiency improvements with only marginal cycle time increases.

Despite the marginal cycle time increase, we create more value on our floor with increased efficiency and fewer operator errors. We developed a simple macro routine for probing stock location to ensure operators follow procedure and eliminate non-conforming part production.

PROCESSING RISK AND REWARD

CSP employs a wide array of custom tools to simplify complex part geometries. Our tools are typically solid carbide to stand up to the rigors of process and materials.

Although a $1200 tool can be re-sharpened many times over to increase lifespan, a single minute error at the machine cell can damage the tool irreparably.

In addition to lost tool value, there are sunk-costs of machine downtime and potentially long lead-times for replacement, as well as localized damages to the work-holding or tool holders.

In the case of some of our Inconel parts, an optimistic measure for recovery of an 8-hour shift could mean the loss of $4,368!

This case study focuses on the application of a Renishaw Probe to create a suppressor tube for a major firearm OEM. The geometry and size of the suppressor tube require large jaws in the loading process. Theoretically, if the suppressor is improperly loaded, the part could be located out of position almost 1.75 x OAL (overall length)!

This specific operation requires large drills and a custom solid-carbide reamer to achieve aggressive material removal rates. We purchased a total of three drills at $821 each, a total of $2463 in tools, with a six-week lead-time to replace. We don't want to slow our feeds, but also can't afford to miss customer delivery dates due to damaged tooling.

Instead, we used advanced probing to verify the location of the part.

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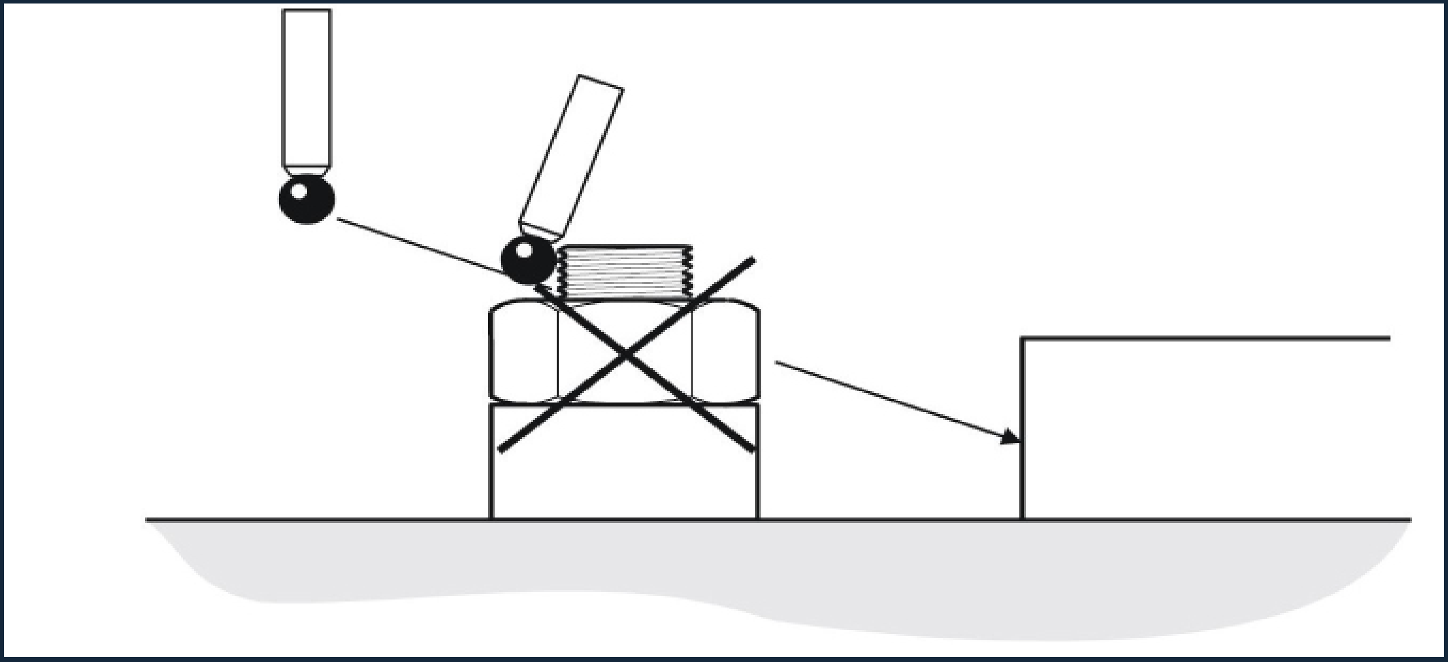


Using intelligent "protected moves" built into the Renishaw macros, we position the probe in any location around the tombstone and move at a speed that avoids damage to the probe even if the part is drastically out of position. Should the probe collide with anything while running Renishaw program o8810, the probe stops before damage occurs.

THE PRECISE SOLUTION: AUTOMATED

Next, we measure the stock "stick-out" relative to the vice jaws. This solution presents a more precise alternative to recording points in machine coordinate space without reference to one another.

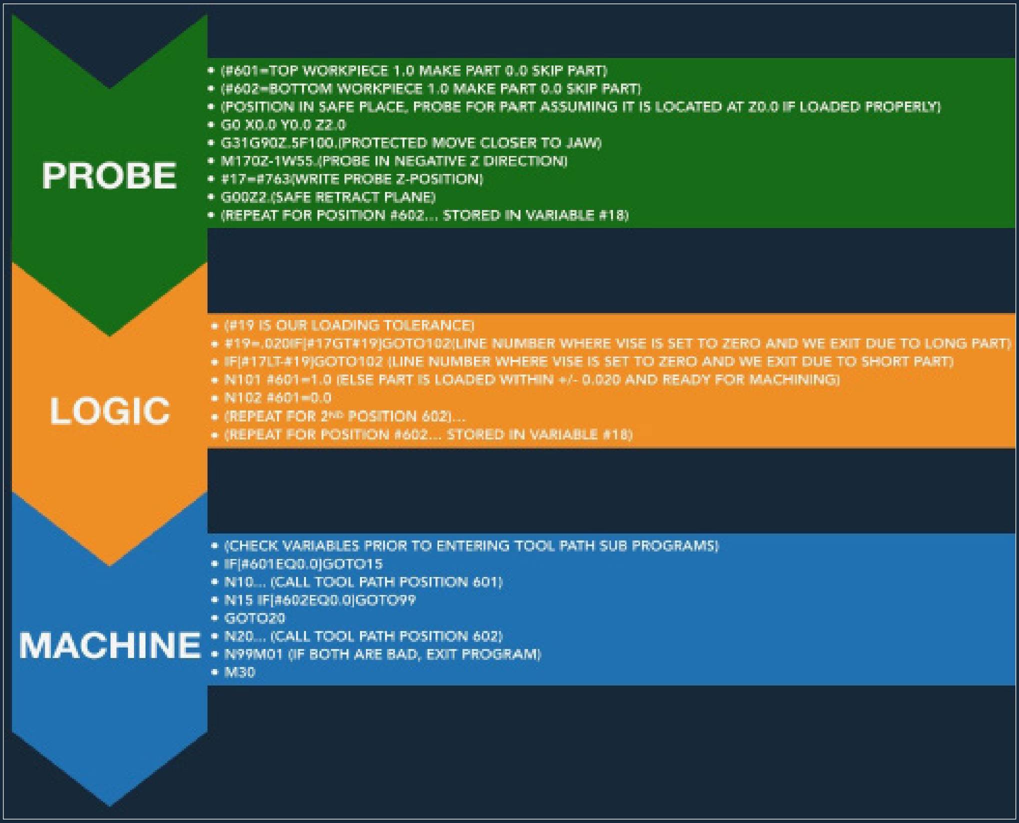
By verifying the part "stick-out" we need simple logic for automating the decision tree of the machine, instead of requiring operator input to clear alarms. Using an "If" statement, our probing routine checks if the part stick-out is greater than a static value "0.02" in this example.

If the value was greater than "0.02" our drills and reamer would collide during G0 rapid positioning moves or R-planes. Our logic: If stick-out is greater than .02, #601=0.0, else #601=1.0. This simple binary indicated that part in position #601 was loaded properly and ready for machining or not. We would replicate this elsewhere for multiple parts on a tombstone, choosing successive variables; #601, #602, etc.

We write our machining programs in the usual sequence, with one exception: as we use a specific tool at a given location on the tombstone (601), we check the stored macro variable.

Inserting an "If" statement into the program: If #500=0.0 GOTO N999. In this example, we insert N999 at the end of the g-code relating to that specific location on the tombstone. The elegance of this solution is the robust simplicity for risk reduction. For this particular project, we can load two parts per tombstone, probe each, and then have the Makino A51NX select or skip the g-code as necessary based entirely on probe feedback.

The probing routine added 30 seconds to a 210-second milling program. It is a substantial increase in cycle time, but a drastic reduction in the risks of potential value lost.



CONCLUSION: INTELLIGENT PROBING MITIGATES RISK

Time is money, but it's impossible to adequately assess the total financial consequences of failure to implement safeguards in the precision machining process. Potential losses can extend way beyond the costs of downtime, such as damaged customer relationships.

At DGW, our use of probes is not unique, but we have found that our application is more focused on customer value than the standard market perspective which suggests using machine probes in place of quality management systems.

DGW is committed to the safe and practical use of technology to meet even the most demanding customer timetable!

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RESOURCE LINKS

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