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Integrated Test & Measurement on a CNC Dial Achieves 100% Yield

A dominant trend in high-volume automated manufacturing for years now, the capability to achieve 100% yield is finding its way into heavy-duty machining. In principle, the idea is simple: if every part can be monitored and validated in line and geometry variations automatically compensated for by the machine's tooling, the need for after-machining can be eliminated, scrap will be reduced to zero, and productivity will soar. Of course, it all depends on getting high levels of accuracy and repeatability from the machining center.

It took the high-volume challenge of machining powder metal connecting rods with a demanding "pin bore" tolerance call out, and the innovative use of a dial configuration CNC machining cell from **ATS Machine Tool Division** to make it happen.

Because on the ATS machining center each part is clamped only once, no material handling is required between stations. Accuracy and repeatability remain optimized for the long term, and since every part is validated and the necessary corrections made right on the machine, the need for batch sampling, off-line quality control and re-machining after testing is eliminated.

Asked to quote on a proposal for a fully automated manufacturing cell that could machine several critical features on the component, ATS worked with their third-party supplier base to develop a high-speed rotary transfer machining solution that would process the parts in 6.8 seconds, including the pin bore, with a $25.757 \text{ mm} \pm 20$ microns dimensional tolerance, which was maintained with a better than 2 Cpk.

The process load was distributed over a six stations using a single clamp, 2 parts up fixtures and twin CNC tool spindles at each workstation:

Station 1	Automated load/unload.
Station 2	Rough, semi finish and chamfer pin bore.
Station 3	Spot face and drill pin bore oil hole.
Station 4	Finish pin bore with compensating head.
Station 5	Back chamfer pin bore.
Station 6	Chamfer crank bore and de-burr oil hole.

Having divided the process workload into roughly equal values for each station, the challenge became how to ensure 100 % part quality, plus optimized cut time on the critical pin bore

dimension, with minimal tool change downtime, keeping in mind the abrasive nature of the powder metal material.

The problem was resolved with the help of a pin bore finish tool compensating head manufactured by Samsomatic Ltd., Plymouth MI.

This unit has three elements: - (1) the tool positioner, which moves the tool point a specified amount. (2) The controller, which computes that amount, and (3) The gauging device, which provides part measurement to the controller for tool movement computation.

The actuation of the compensating head is achieved via an air-over-hydraulic system in combination with a small hydraulic piston, which effectively deflects the tool by up to .008" or 200 microns.

A further refinement was designed to check for pin bore positional accuracy. LVDT sensors were incorporated into the air gauge station that inspected the position of the pin bore and fed the information back to the machine control so that any potential out-of-spec conditions were constantly monitored.

Load/unload operations were accomplished using a twin-lane input conveyor with an ABB 4400 Series robot, sequenced to pick from a staging nest, load into the machine and then place the finished parts into the checking fixture, which automatically transferred good parts onto the output conveyor.

Using their standard machining modules, comprising a six-station base with a Hirth-coupling index table and 5 CNC machining units, ATS designed and delivered a turnkey cell onto their customer's shop-floor in 9 months. A "copy exact" cell for increased volume was delivered in less than 8 months.

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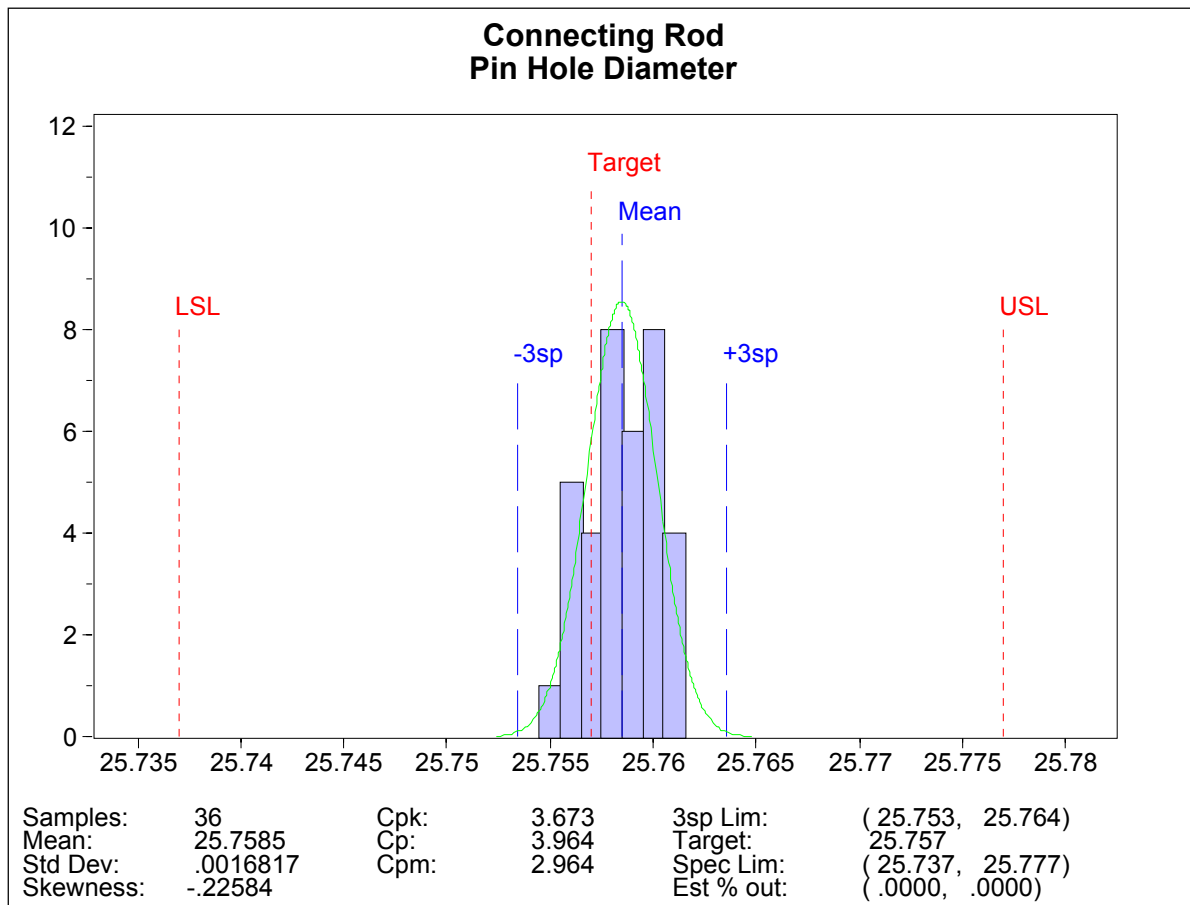
Automatic load/unload on the ATS Turn 6 LC, incorporating a twin-lane conveyor and an ABB 4400 Series robot.



Close-tolerance machined features on powder metal connecting rods are automatically measured, and the data sent to the controller which computes the tool movement.

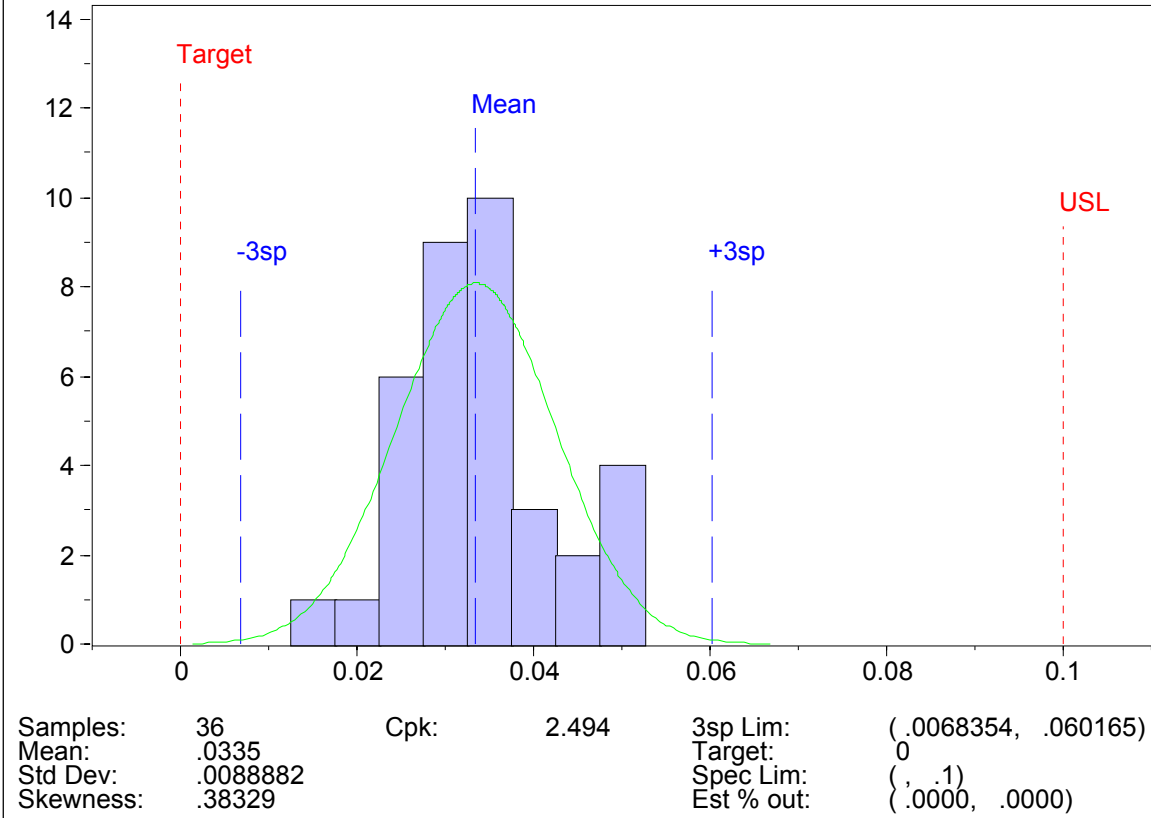


Single clamping on the ATS Turn 6 LC CNC dial machine provides high accuracy and repeatability for the high-volume machining of these powder metal connecting rods.



Shop Floor Run-off Acceptance Testing: Integrated test & measurement enabled the ATS Turn 6 LC to achieve a Cpk of better than 3 on connecting rod pin hole diameter.

Connecting Rod Pin Hole Position



Shop Floor Run-off Acceptance Testing: Integrated test & measurement enabled the ATS Turn 6 LC to achieve a Cpk of better than 2 on connecting rod pin hole position.