Hardness Testing of Automotive Crank Pins and Journals

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Introduction

This article presents a case study where automation saved a significant amount of operators' time when making and measuring indents in three specified locations of automotive crank pins and journals, compared to manual testing.

The automation approach translated into fewer data transcribing errors, less part manipulation, and lower variability between operators carrying out the tests.

Hardness Testing of Automotive Crank Pins and Journals

A major automotive manufacturer sought to examine how automation provides potential time savings operators were required for each shift, with two shifts per day, seven days each week.

Tests are carried out in three given locations - one perpendicular to axis and two at 45° off axis. The given locations are critical, because if the locations are missed the manufactured parts are likely to be quarantined until the part information can be further validated.

Another major issue is that failed parts that were accidentally passed for installation can eventually lead to disastrous failures. Errors in data transcription are yet another source of concern. If part information is not correctly fed into an individual database, then mismatched data of lot number can occur, which would ultimately lead to extended quarantine of parts until further confirmation can be performed.

The overall scrap cost is a significant factor and hence, trained operators are required for testing purposes. Operator variability is determined with round robin testing. Compared to the usual operation analysis rate, the testing rate increased by as much three to five times when qualifying new lines were put into production.

Observation

Current Process Observation

To determine a time baseline for the existing process, a time evaluation to make and measure Vickers indentation on automotive crank pins and journals was subsequently established. A standalone manual system is used in present testing procedures, along with operator time to make part alignment as well as to make and measure the indents.

The parts are then fixed in a similar orientation to make sure that measurement of the 45° axis remains close to speed up testing and reduce testing errors. Before physical testing, part alignment should be considerably manipulated to ensure a high level of accuracy.

It was seen that the most testing time (60%) was taken up by the operators' set up time for indent locations, with the measuring indents and making indents taking the second and third largest amounts of testing time at 30% and 10%, respectively.

While the overall amount of indents of each pin and journal differed, 18 indents were averaged for each section, with 6 in each location. The overall amount of indents for a crankshaft; journals being determined along split; and pins being determined bottom dead center and top dead center, was averaged to 216 indents. Nine hours with eight hours of operator interaction made up the overall analysis time to make and measure indents at the given locations on a crank.

Implemented Process

A Wilson VH3100 series Vickers Microhardness Tester integrated with DiaMet software was employed for the implemented process. The parts were fixed on a machinist vice and then loaded onto the stage without manipulating the orientation (Figure 1).

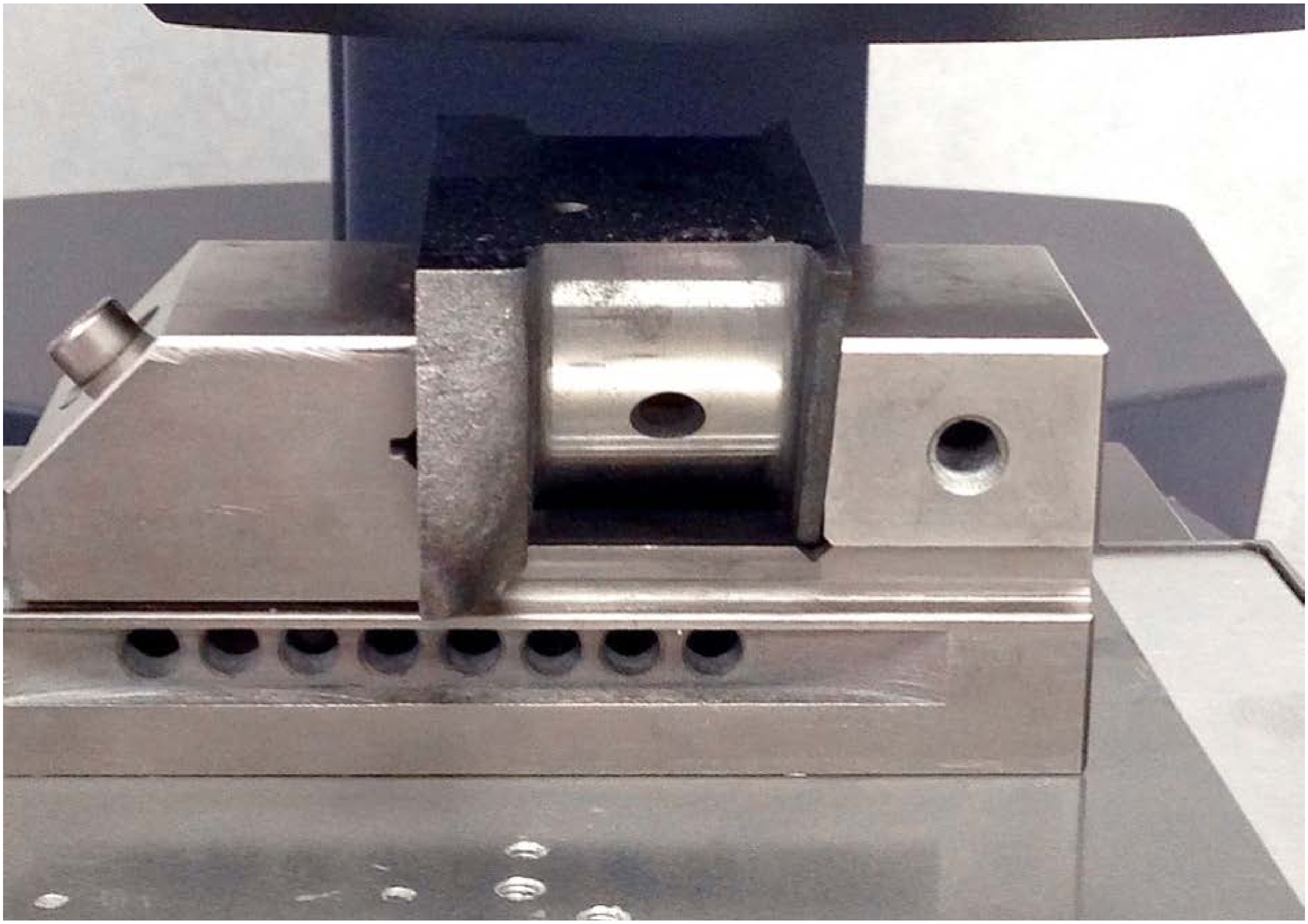

Figure 1. *Crank pin held in machinist vice*

In order to produce a template of the part to be tested, trace function was used with the overview camera (Figure 2). This reduced the setup time required for the indent locations. The template reduced the location setup time to 45 seconds in the three areas - one perpendicular to case and two at 45º.

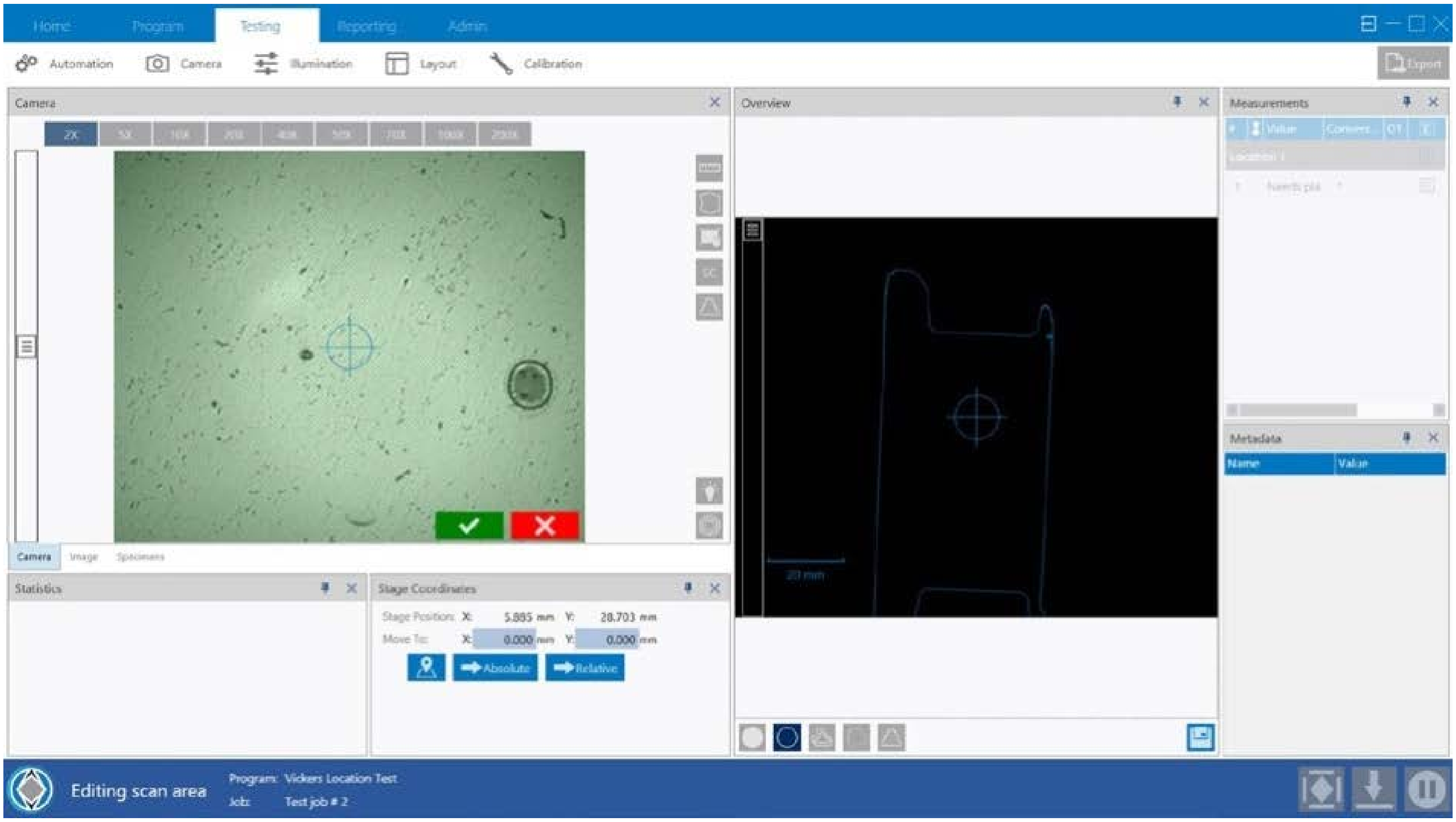

Figure 2. *Trace function template for ease of indent locations*

The template to the part at the given location was captured by the DiaMet software, and the location was confirmed by operators. Observation of the set up time was 10%; making indents was 50%; and measuring indents was 40%. 216 indents on an average was the total amount of indents for a crankshaft, taking 1.25 hours with 15 minutes of operator interaction. Figure 3 shows the automatic making and measuring of Indents.

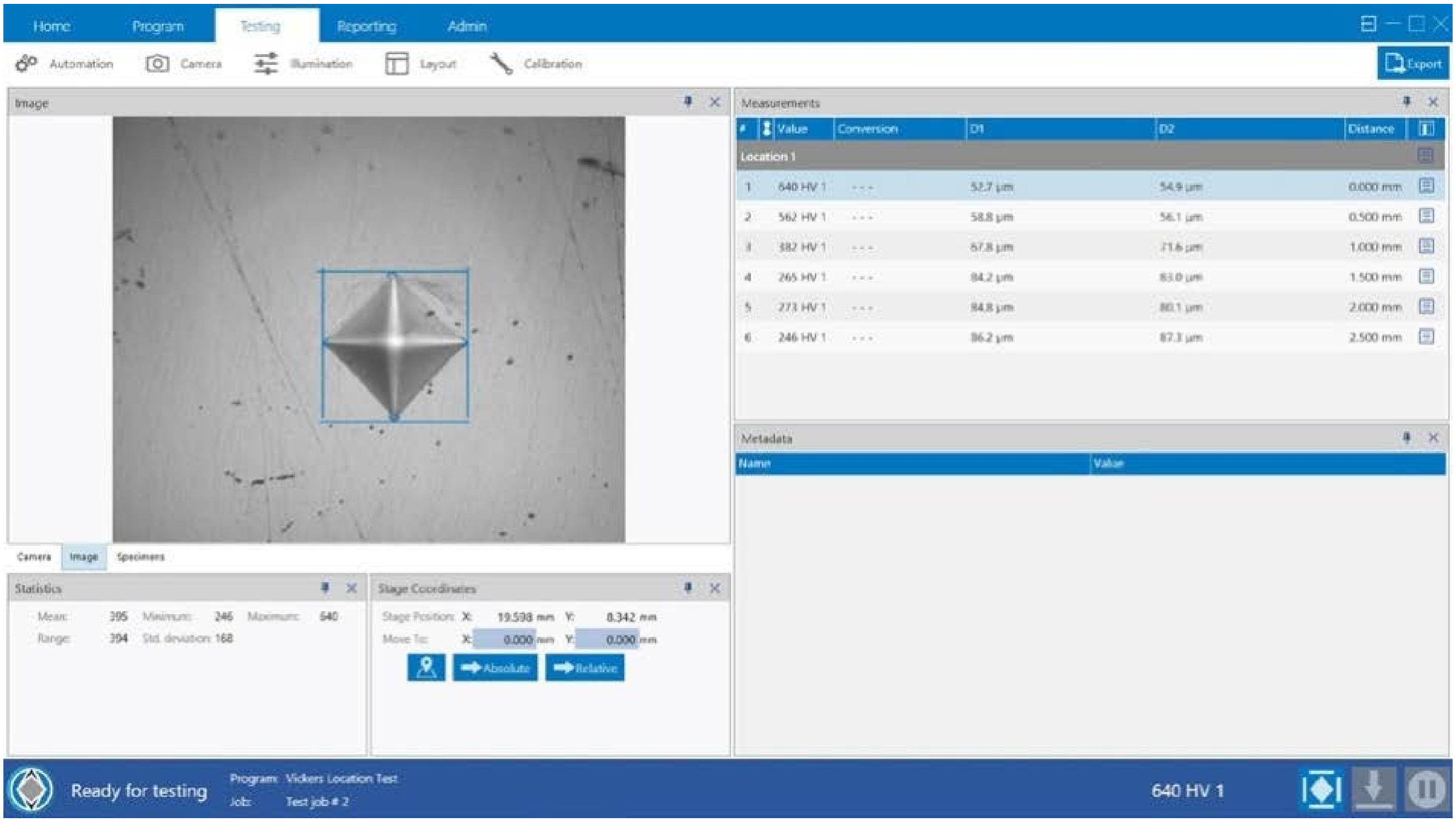

Figure 3. *Indent make and measure being performed automatically*

To each program, visual low and high threshold warnings were introduced (Figure 4). This enabled the operator to quickly evaluate the parts against the confirmation following the analysis of all crank pins and journals as done in the earlier methodology. For reporting purposes, metadata was set up to eliminate operator errors in data transcription (Figure 5).

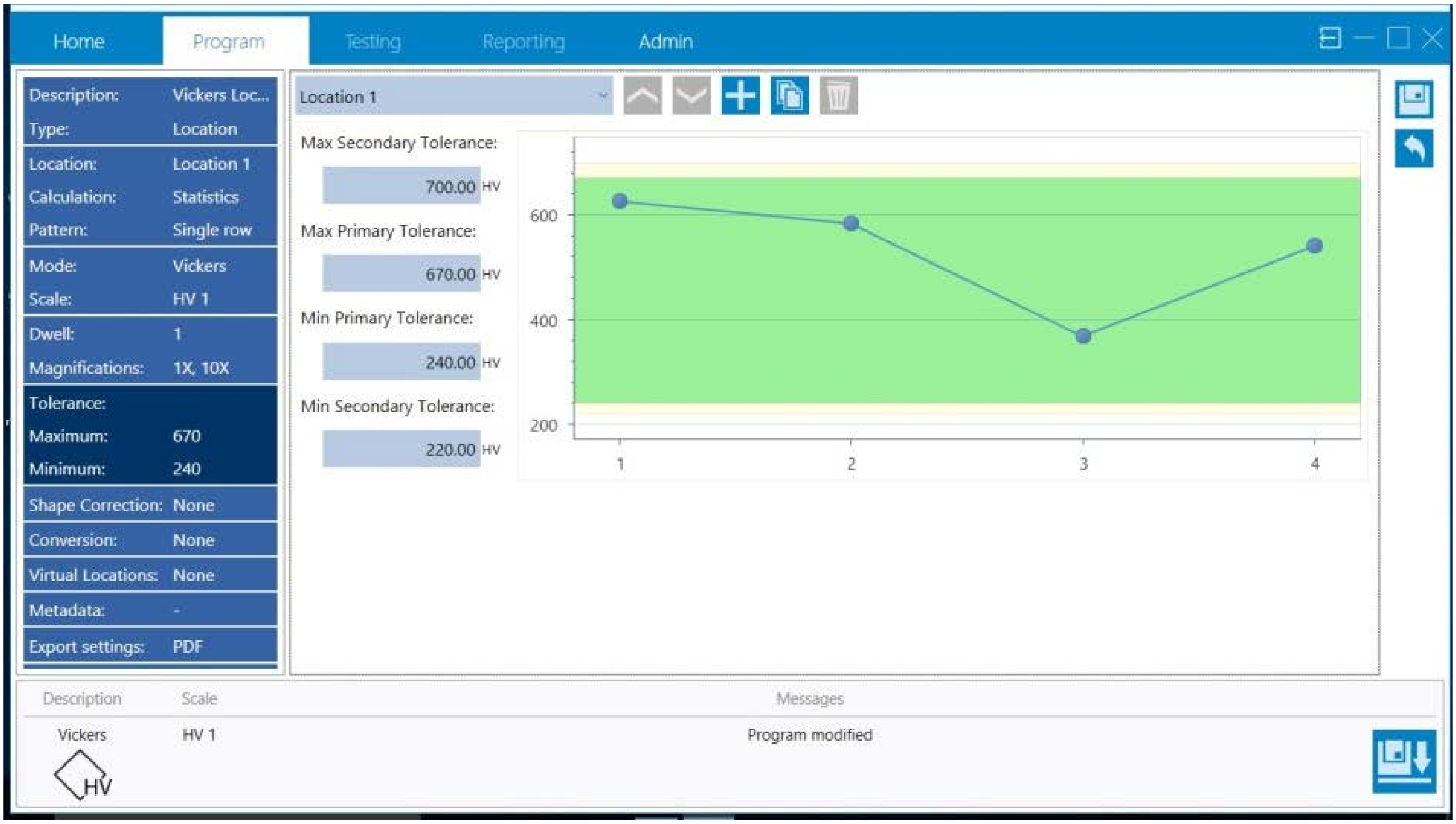

Figure 4. *Visual high low threshold warnings to alert operators of hardness thresholds*

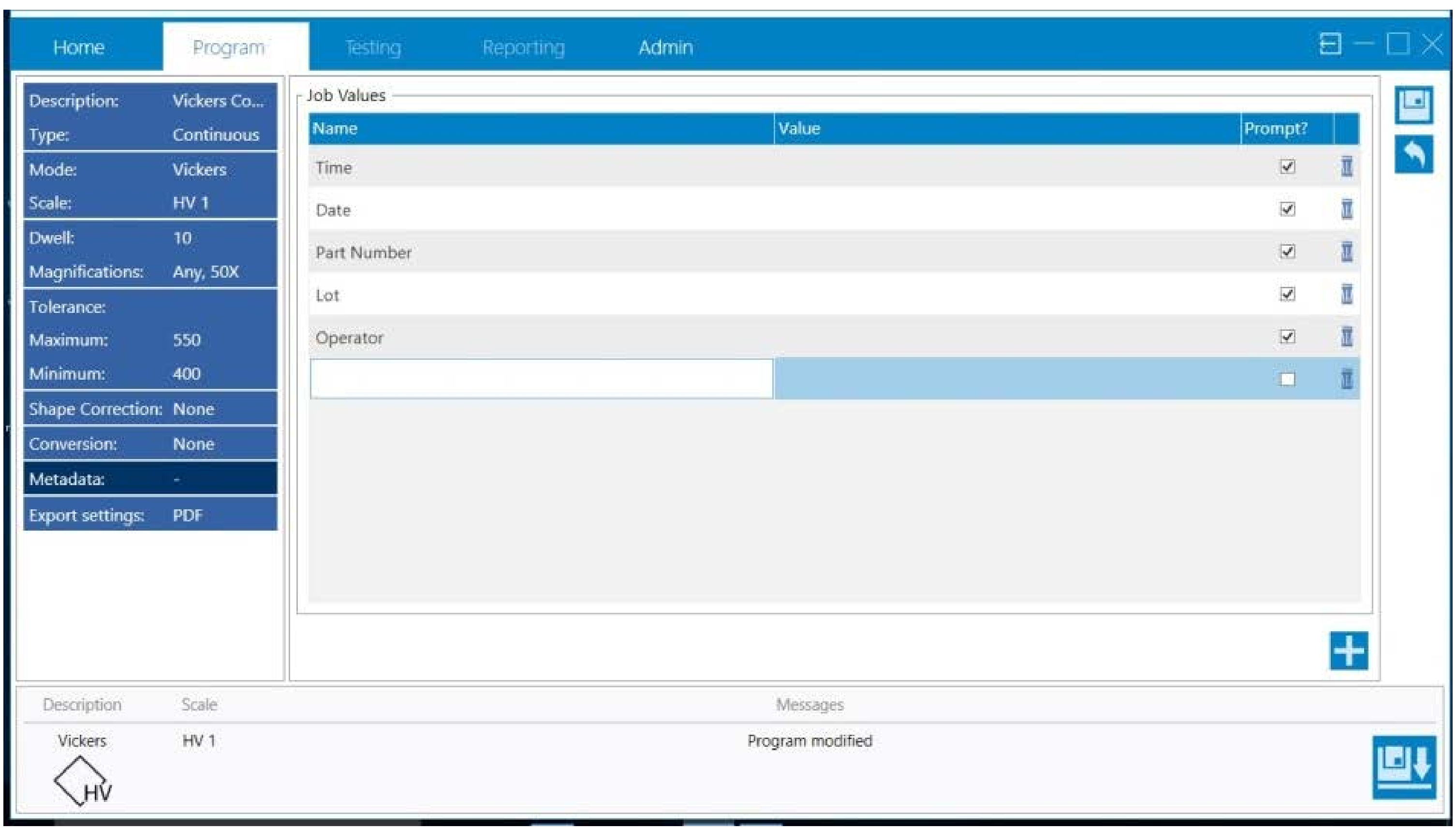

Figure 5. *Metadata setup to reduce operator input transcription errors*

Conclusion

The study shows how automation saves considerable amounts of time with regard to setup and also the time needed for making and measuring the Vickers indents. The overall amount of time spent by the operators for setting the indent profile and measuring and collating the data is reduced by as much as 86%, including the data transcribing errors.

Testing repeatability is increased from one operator to another, because inconsistency between operator judgment is completely removed. The use of trace function and templates removed operator time required for aligning parts on the stage and also reduced the risk of a lost indent profile.

The increased visibility of part failure is apparent during the measurement and allows operators to reassess an area or the entire part without the need for extended quarantine of parts for reanalysis. Data transcribing issues were eliminated using metadata fields within the Vickers testing program which would otherwise delay crank batches until further review of the records.

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Related ANSI Standards

ASTM B277-95(2012): Standard Test Method for Hardness of Electrical Contact Materials

ASTM C748-98(2015): Standard Test Method for Rockwell Hardness of Graphite Materials

ASTM E110-14: Standard Test Method for Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers

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