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FAST & FURIOUS: FITTING DIE MAINTENANCE WITH OPERATIONS

When a die for a production part needs maintenance finding the least-cost fix in the shortest time is critical. Origin International examines how tooling engineers achieved time savings of over 80% and avoided costly die rework by using new software to simulate the iteration process.

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For tool maintenance as well as part launches, the process is similar:

1. Measure and review dimensional data of a few sample parts.
2. Agree on data interpretation
3. Make a best estimate of the root cause
4. Identify fix options.
5. Make adjustments and re-run the process.
6. Repeat steps 1 to 5 until the process seems to be in control and capable.
7. Manually create charts and graphs to document results for a buyoff report.

We have found that there is significant potential to improve this process when engineers are certain the process is in control, and what the limits of process capability are. Three factors are critical:

- Data validation. That is, reconciling CMM, scanner, gauge and CAD nominal data.
- Isolating root cause. Identifying whether the process is in control and the limits of its capability.
- Simulation: The ability to simulate changes without having to run additional parts.

A NEW GENERATION OF ROOT CAUSE SOFTWARE FOR PROCESS ENGINEERING

New software reduces the number of steps in tool maintenance and accelerates the process.

Launch Step	*Root Cause Software Impact*
Measure & validate data	The software streamlines measurements of multiple parts, regardless of source – CMM, gauge or scanner – and correlation with CAD nominals.
Isolate root cause	Engineers want to isolate features that are not capable and in control. Problem features and process capability are visible at a glance on screen.
Identify the fix options	The team applies its skills and experience as usual.
Simulate and choose	Simulation in root cause software replaces physical iteration. Each simulation takes a few minutes. Knowing the process is in control and its capability engineers can be more aggressive.
Buyoff report	The software generates graphics and other data for buyoff reports.

Seven steps are reduced to four. Graphic displays convert reams of tabular data to salient details that engineering teams can grasp at a glance. Simulation in software replaces most of the iteration of actual parts and assemblies. Much of the manual labor of assembling data for buyoff reports is automated. The tools leverage the skills and experience of engineers. In sum: tool maintenance can fit much more easily in the fast and furious world of operations.

APPLYING THE PRINCIPLES

Let's look at how these principles applied to a typical maintenance situation: a takeover tool at Pridgeon & Clay. It is based in Grand Rapids Michigan and operates additional facilities in Europe and Mexico. Pridgeon & Clay is one of the largest independent, value-added manufacturers and suppliers of stamped and fine blanked components for the automotive industry. The full-time workforce is over 1,300 worldwide.

The problem. For a takeover part the OEM requires a sample submittal and process capability of critical features of 1.67. Parts are to be to print and process capable prior to moving to Pridgeon & Clay, but the previous supplier is shutting down and lacks the resources to repair the tool. The part is already in production. Fortunately, the part is produced by a progressive die in several operations at different stations. This allows a more creative approach than if the parts were produced as a single draw between one cavity and one core. The first run of parts failed the gauge checks. Gauge and CMM results also disagree.

Validating data. **Figure 1** shows the CMM results of several sample parts in Origin's Launch-Rite window. The deviations seen in the CMM results do not agree with what is being seen at the gauge.

The first step is to eliminate this confusion by simulating the gauge as shown in **Figure 2**. Using the fit algorithms we are able in a few moments to get the CMM results and the gauge to agree. That is, the oval plane is canted. All the internal measurements of the cone transition area are undersized. There are also some problems with datum A, but what is indicated is that Transition area datum C hasn't completely formed.

Next we look for long red or blue whiskers that signal major deviations. There are long red whiskers on the transition surface that draw immediate attention. This shape is formed by a stage of the die that expensive to fix. Applying fit shows that the transition surfaces

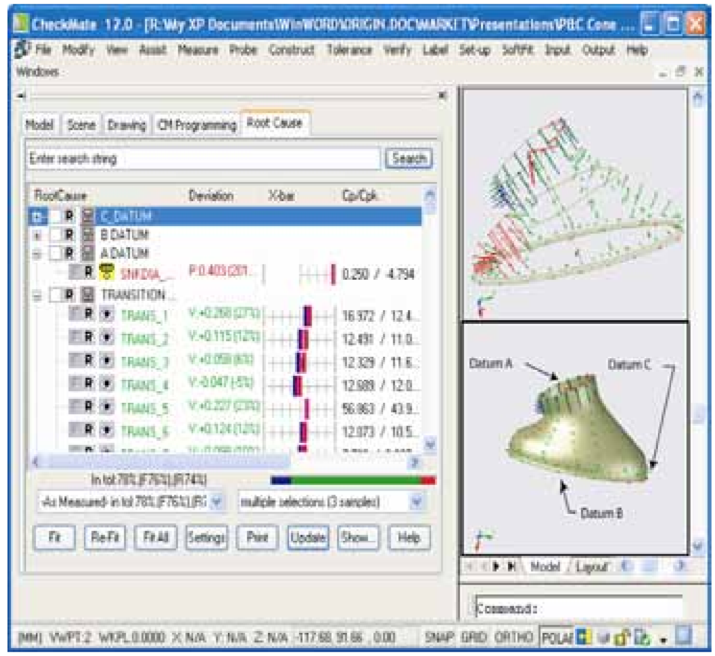

Figure 1. *Launch-Rite software provides a single, integrated view of all data needed for tool maintenance. In Launch-Rite's shaded and wireframe views red and blue whiskers flag problem features at a glance. The longer the whisker, the larger the deviation. Source data is viewable as X-bar and numeric displays. Deviations are highlighted in red type.*

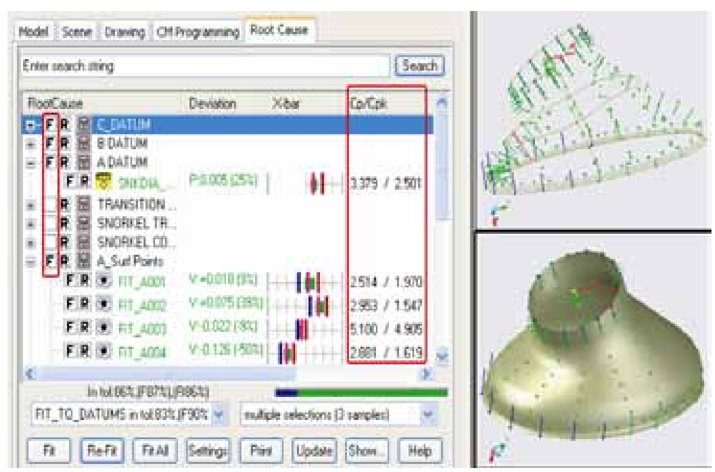

Figure 2. *The "F"s in this screen grab show Launch-Rite's fitting algorithm in use. This cuts the time-consuming process of resolving conflicts between CMM or scanner data and gauge results.*

are good. It would have been easy to conclude that the transition surface was the problem, correct it, and make the problem worse. Similarly the hits on the end of Snorkel, i.e. its edge, are showing a deviation in blue. This late hit indicates it is too short.

The final data validation step is to re-check for process capability. Any feature that we will fit and apply offsets to must be stable. Launch-Rite provides Cp/Cpk for each feature. **Figure 3** shows high Cp values – 1.33 and above – in the Transition area. So if we use these features in the fits and offsets, and others with similarly high Cp values, we can feel comfortable that using the average part will only require one change or iteration.

*Isolating the root cause***.** To fix Datum C is difficult; it is the die plane so the goal is to move the error else ware. The easiest fix is to raise the steel at that die station. This will cause the cone draw further over the steel. This will have the effect of extending Datum C lower and flattening it to the die plane. And it will correct transition features in the form portion of the part.

*Determining the fix***.** Data validation reveals a best-fix scenario that would not be evident otherwise. Because we know the process is capable and each simulation takes a few minutes we are more aggressive. We make multiple changes simultaneously in each simulation.

In the course of three simulations the following changes are made:

- **Datum C** is fixed by shimming the die station 0.750mm in along the –X-axis
- **Datum B** is forced to the die plane, a fixed parameter. Forcing Datum B onto the die plane forces corrections elsewhere
- Using the new Datums B and C we are able to move the die stations that form the Snorkel feature 0.350 mm in the Y-axis, and fix **Datum A** and the **Snorkel**.

The results of all these simulations are shown in **Figure 4**.

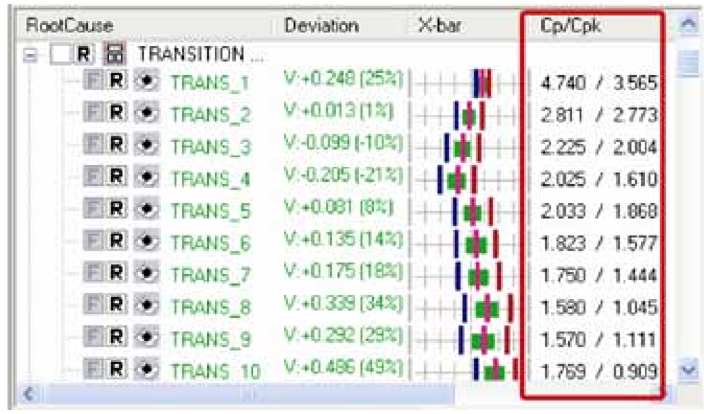

Figure 3: *Features that you will fit and apply offsets to while iterating fixes must be stable. Launch-Rite displays Cp/Cpk information for each feature.*

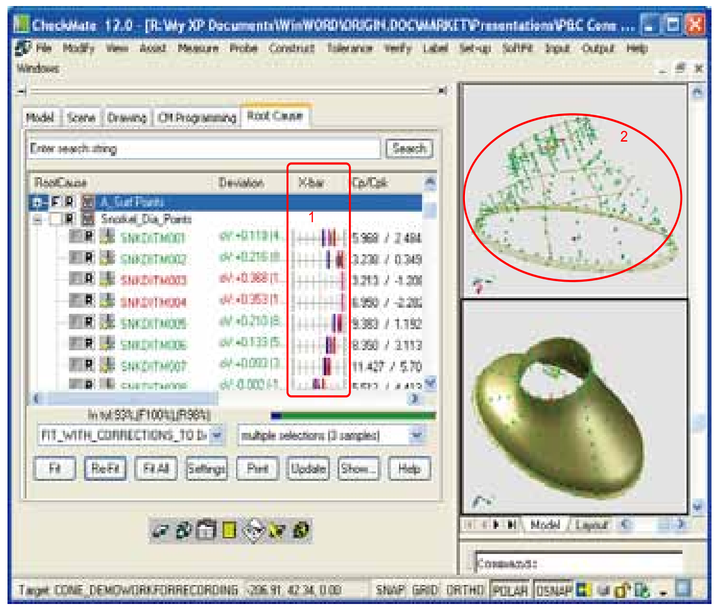

Figure 4: *After three simulations the X-bar display shows that the snorkel points are capable and in tolerance. The wireframe view shows only two small red whiskers, an acceptable deviation. Actual corrective action: shim a die station plus a little welding and grinding. Total time for simulation and corrective action: 5 hours.*

Results. In total data validation and corrective action took five hours. Using the manual method this maintenance cycle would have taken 5 days.

Simulation eliminates the need for additional part runs, measurements and analysis. Corrective actions are minor. Some welding and grinding were required on the die, and shimming of one die station. The software generates a Capability Report, PPAP and other data needed for buyoff. And we have a robust tool that withstands several years of process variations, including steel, lubrication, press speed, etc., without further maintenance.

While the focus here is on maintenance this software is also being used to improve the part launch process. For complex stampings the time savings are substantial. In addition you improve cash flow by deferring gauge construction. Gauges are rarely available when the first buyoff samples are run. Because you can simulate a gauge in software you can build gauges after the process is stabilized and corrective action on the die is implemented.

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