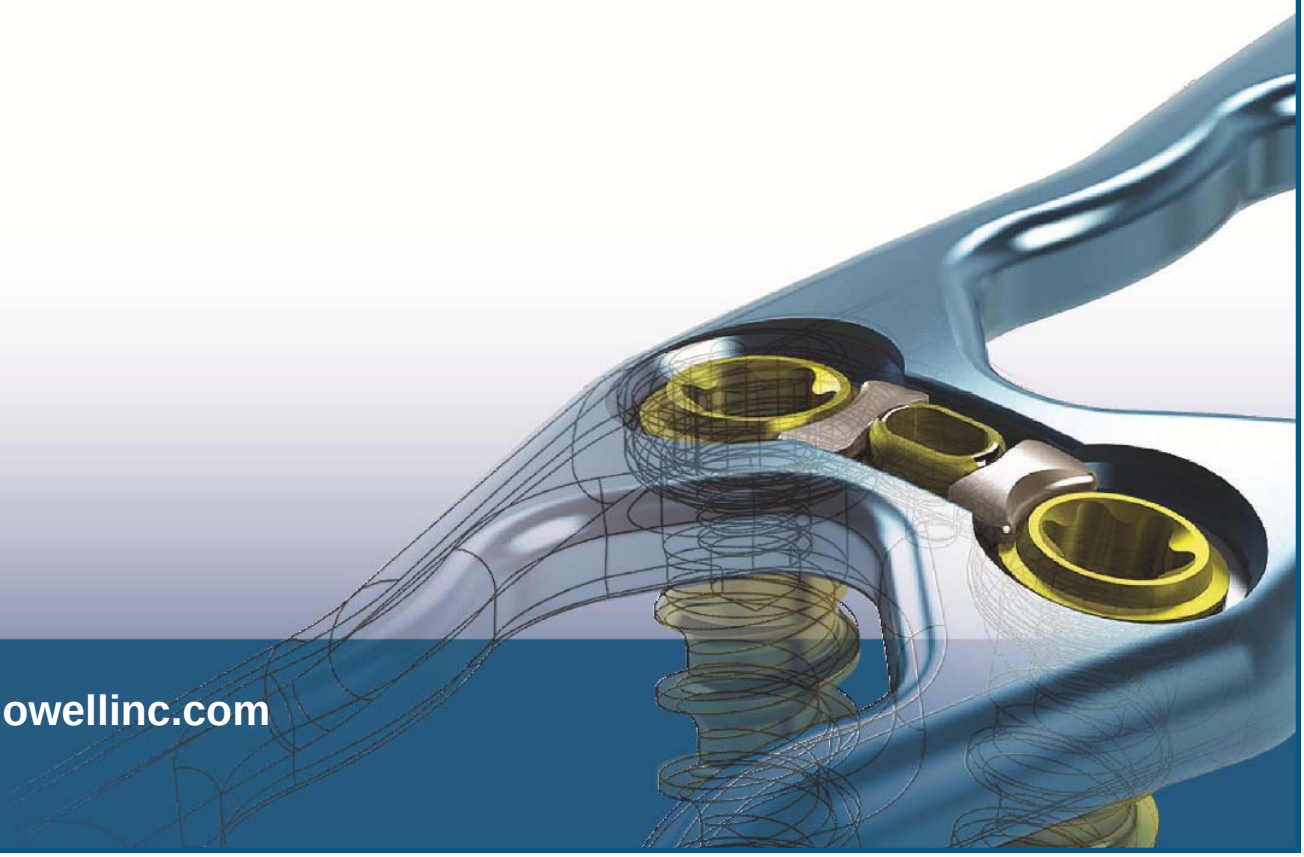
LOWELL

WHITE PAPER

THE CUSTOM TOOLING PROCESS AT LOWELL, INC.



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LOWELL'S CUSTOM TOOLING PROCESS AND PRECISION GD&T

Lowell Inc. of Minneapolis, MN uses CNC machines to make hundreds of different variations of critically dimensioned parts that must conform precisely to their design drawings. A key aspect of the process is the custom tooling we use to make the parts. Since the performance of the custom tooling with their small arc radii and small surface areas affects the success or failure of every part, getting the fabrication and qualification processes for the tooling under control was very important to us. We attribute SmartProfile® interactive Fitting and GD&T software to ten-time improvements in the useful lifetimes of the hundreds of custom tools Lowell uses to make our customers' parts. Tools that used to last for 50 parts now produce thousands.

Like any manufacturer with its focus on the end products, Lowell initially concentrated our energies there and had tooling made by outside suppliers. These intricate tools have tolerance radii of 0.0008", 0.0005", and 0.0002" and thickness of the tool profile geometries of 0.015" to 0.020". Numerous problems with tooling performance including breakage and inconsistency in production of conforming parts forced us to bring much of our tooling production in-house.

The requirement for a new custom tool can come from a number of sources at Lowell. The process starts with a thorough preproduction review of the part and the geometry of its features. Engineering, Manufacturing, Programming and Tooling departments (the Associates in this group average nearly 30 years of precision machining experience) determine what tooling is needed in order to machine features that conform to print. If a standard tool can do the trick it is taken out of inventory or an order is placed with a supplier. If a custom tool is required, the Engineering team creates a detailed solid model drawing in their CAD software package. The Tooling manager and Tooling machinist or Toolmaker act as interfaces between Manufacturing, Engineering and Programming. Ideas go back and forth until a final design is committed to and confirmed. (Figure 1)

Before Lowell developed our in-house expertise, the receipt of a custom tool could take weeks. If the tool was wrong or modifications were required – even more time could be lost. Now with the process in-house, if a redesign or a tweak is needed, the tool can be reground in a matter of hours. This has been an enormous savings to Lowell in time and manpower. Most importantly, our customers benefit from faster turnarounds and parts that conform to print.

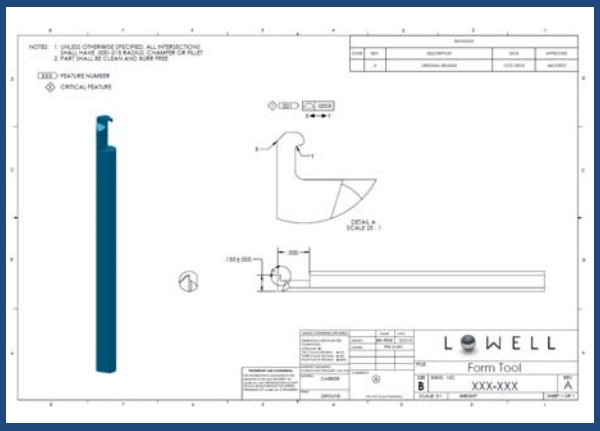

Figure 1

A Lowell engineer after consulting with the machinist and toolmaker creates a drawing and model of the form tool.

Figure 2

Ron Gardenier operates Lowell's Ewag WS11-SP custom tool grinder.

THE IMPORTANCE OF METROLOGY

Since we determined that paying more attention to tooling directly affected the quality and quantity of the devices we manufactured, the investment in better equipment and personnel for making the tooling seems rather obvious. The first step was an investment in a high end, Swiss-made Ewag WS11-SP custom tool grinder. The WS11-SP can precision grind tooling in carbide, tungsten, steel and other materials. It even allows for the grinding and measuring of cylindrical and tapered tools in a single clamping. Next, we needed to find an Associate to operate this extremely complex and precise grinder. Fortunately, Lowell has an experienced and talented workforce to draw from. The Ewag is operated by an Associate who spent 31 years as a machinist here before taking the rigorous training required to run it (Figure 2).

Finally, Lowell needed a process to determine if the custom tools conform to the design specifications - that is, to properly measure them. This is where our experience is different than might be expected. We do more than simply measure the tooling. We use a variety of measurement systems and gages, but the most important of them are for the inspection of the custom tooling. One is an OGP® Avant ZIP 400 video measuring machine and the others are a Leitz Model PMM-C 700 12-10-7 laboratory grade scanning CMM, and a Brown & Sharpe EXCEL 7-10-7 CMM. The OGP machine uses analysis of magnified images of part details to accurately measure dimensions, angles, and radii without contact. The CMMs measure larger features via touch probing. Together the systems provide the necessary measurements to confirm tool designs.

Initially, however, the interpretation of the measured data points was inconsistent. It required a skilled engineer to interpret the large number of individual measurement results for each tool. The engineer could recognize which of those measured values was important and to what magnitude, but it is the cumulative relationships of all the measurements that's important. We sought out an interpretive software package that could make complete use of the measure data. This is where the investment in SmartProfile software comes into play. It does more with the measurement data making it easier to validate tooling against the solid CAD model.

SmartProfile is a 2D/3D interactive best fitting-software application that is used in a GD&T environment where part acceptance or rejection is required. It takes point clouds of data from part measurements performed on any measurement system, merges that data with the nominal CAD model of the part with its GD&T tolerances, and automatically performs a results evaluation based on those tolerances.

As part of a project to improve our custom tooling, we created detailed solid model CAD files of the tooling. As part of its evaluation process, SmartProfile can import any number of popular CAD formats, including IGES, STEP, VDA, STL, and DXF files. Since it accepts measurement data from virtually any measurement system, in Lowell's case, OGP ZIP 400, the Leitz PMM and the Brown and Sharp CMM, SmartProfile readily fits into their custom tooling process.

A Lowell engineer at a computer workstation uses SmartProfile to dimension the CAD model, define datums, and apply GD&T tolerances. Measured data from the OGP ZIP 400 video measuring system is imported and overlaid on the model. The imported data points may be aligned to the model manually or automatically. SmartProfile then compares the measured data with the nominal model and determines whether measured features are within tolerance. Colorful graphic displays with whisker plots confirm tool quality at a glance. The key advantage of SmartProfile for us is that it can evaluate surface profiles or geometric tolerances against Datum Reference Frames, with compound datums, pattern datums, datums at MMC/LLC, and composite tolerance zones. These extensive analyses are very important to us since our intricate custom tools have numerous exacting profile tolerances for their extremely small and complex geometries. "Accurate confirmation of the tools is key to what SmartProfile provides," says Ron Gardenier, Custom Tooling Manager at Lowell. "Now I, as the toolmaker, get confirmation of what I'm making. Without SmartProfile we'd still be guessing" (Figure 3).

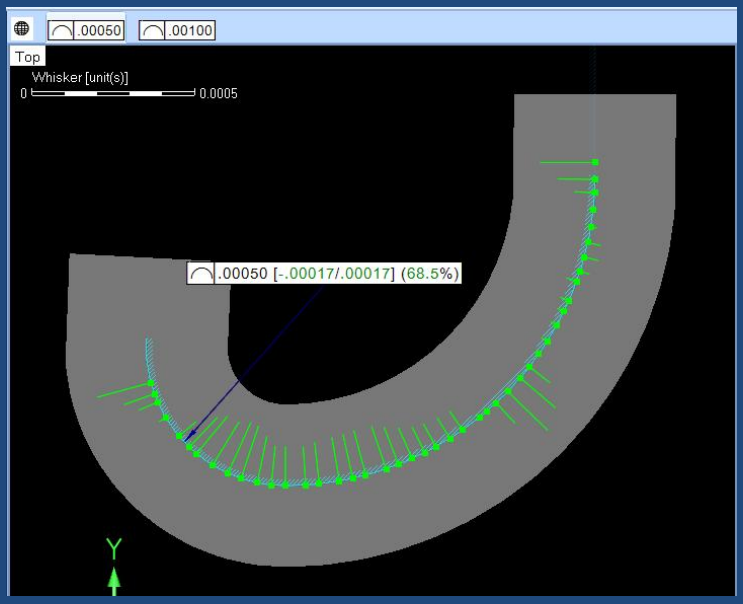

Figure 3

A whisker plot in SmartProfile used to assess the conformance of a custom tool.

Since SmartProfile compares measured data to the part CAD file, we simultaneously updated our design drawings to incorporate GD&T. The tooling design and new inspection processes, as well as the new tool grinder and toolmaker, were implemented in parallel so they came into use at the same time.

SmartProfile is now a critical part of our custom tooling process. Before implementation, only two highly trained people could evaluate the raw measurement data for every part. Today, inspections take half the time with more accuracy and are completed by a broader range of skilled and less-skilled employees. Needless to say, we are pleased with our investment in custom tooling and the software and systems to verify compliance. We are a leader in the precision machining and assembly of complex medical devices. Our commitment to custom tooling leads to conforming parts. Our customers benefit and we benefit.

To learn more about custom tooling, contact us at **requestinfo@lowellinc.com** or **763-425-3355**.

Medical device manufacturing is a partnership between the OEM and its suppliers. How can an OEM find suppliers that deliver conforming parts? Start by asking the following questions:

- Have they invested in the high-end physical metrology equipment such as a Leitz Precision Measuring Machine (PMM) and OGP Avant ZIP 400 video measuring machine?
- Do they manufacture their own custom tooling and have they invested in equipment such as an Ewag WS11-SP custom tool grinder?
- Is their Quality system rock solid and do their Associates have the years of experience required to manufacture today's complex medical devices?
- Do they have the latest in profile analysis software such as SmartProfile?
- Most importantly, is their organization committed to the manufacture of conforming parts?
- Collaborating with suppliers that understand and make investments in the process, equipment and training required will ultimately lead to the consistent manufacture of conforming parts.

SmartProfile is a product of Kotem Technologies, and is available in North America from Optical Gaging Products (OGP). Kotem and OGP are divisions of Quality Vision International, Inc. (QVI®).

ABOUT THE AUTHOR

Jim Stertz is the Director of Technology for Lowell, Inc. in Minneapolis, MN. Jim has led the technology efforts at Lowell for 30 years. He is a senior member of ASQ and serves on the Automation and IT teams at Lowell. Jim also rides a vintage BMW motorcycle that he will replace with a Harley Davidson on his 100th birthday.

You can contact Jim at jim.stertz@lowellinc.com.

This white paper is an introduction to the subject of custom tooling. Further research on the subject is highly recommended.