Chapter 1. Industrial Users Perspectives

Cutting Molds/Dies from Scan data

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Abstract This paper discuss the state of the art technology in duplicating an existing mold or die using digitized data from Optical scanners, instead of using traditional "copy milling". Both the technical results and experience from the process to achieve these results are expressed. The main process is discussed highlighting the benefits of using new technology versus copy milling or from surface . The main process consists of :

1) Scanning : An existing mold or die is scanned using Optical scanners. The software and hardware used to scan the die/mold are described in detail with the advantages of using Optical scanners versus laser scanners.

2) Data preparation : Once the die/mold is scanned, the data is pre-processed to read to any CAD/CAM systems. An STL (Steriolithography format) file is created for cutterpath generation and section lines are created, in case if surface development is required, for other applications.

3) Creating toolpaths using CAM software : Major issues in cutting the scan data are discussed.

4) Cutting p-20 steel on CNC m/c

5) Quality Check : Checking the die/mold with the following procedures a) CMM machine, b) Using the same scanner.

In this process, we compare the dimensional accuracy of duplicated die/mold with original die/mold using Optical scanners and CMM machines. We cut one die for Chrysler Corporation using the above process and the results are very impressive.

1. INTRODUCTION

Venture Industries is a Tier-one supplier for Automotive industry, primarily focused on supplying Interior/Exterior Plastics components. Venture is a global organization with over 5000 employees and about 40 facilities worldwide

Venture uses scanning technology throughout the Engineering Process, which include :

- Concept/Show Car development
- Product Design
- Rapid Prototype
- Reverse Engineering
- Models
- Mold building

Venture uses all major CAD/CAM software's available in the market along with the scanning and cutting technology :

• Catia	• Alias	• UG	• CGS
• SDRC	• PDGS	• CAMAX	• Cadkey
• Imageware	• Polyworks	• WorKNC	• Tebis

At Venture, for our own internal use and for our customers, we are asked to scan an existing Mold or Die and either cut a duplicate Mold or Die and/or supply with class-A surface.

1.1 Why do we want to duplicate Molds/Dies from Scan data?

This happens, most of the time, when

- a) There is no CAD data for the mold/die

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- b) There are too many manual changes on the mold/die and the CAD data is no longer the same as that of the mold/die. In this case, we use scanning process, to scan the mold/die and we compare the surfaced CAD data with scan data using either Imageware's Inspection Module's or Innovmetric's Polyworks s/w.

1.2. Advantages of Cutting directly from Scan data versus Copy milling and Surface data.

- 1) The finished Mold or Die is more accurate
- 2) Faster delivery time
- 3) Versatility of the data/process : Once we scan the mold or die, we have digitized electronic data, which we can utilize for several purposes
 - a) Further surface creation
 - b) Section lines
 - c) Changing the geometry
 - d) Adding additional surfaces, etc.

2. THE PROCESS - CASE STUDY

For this case study, an existing model (made out of wood), for which there is no CAD data available at Venture was chosen.

The major steps involved in this case study are :

- Scanning the Model
- Data Preparation & Manipulation
- Toolpath preparation from STL/Scan data
- CNC Machining
- Inspection of the Finished Mold
- Using CMM [existing technology]
- Using Optical Scanners

Figure 1. Original Model used for Scanning

2.1. Scanning Equipment

At Venture, We use Optical Cloud scanners from Stienbichler. We also have Laser Scanners, which we seldom use anymore. We have 2 Optical Scanners:

Stienbichler Comet/500 : Measuring envelope 400mmx400mmx400mm cube. We use this scanner for scanning whole cars, big dies/molds (doors, hoods, I.P.'s, bumpers, etc.).

Stienbichler Comet/100 :: Measuring envelope 100mmx100mmx100mm cube. We use this scanner on small parts.

2.2. Scanning the model

We scanned the model, using Stienbichler's scanner. During the scanning process, we took several shots (pictures) to cover the entire model. During this process, we rotated our scanner in space to cover all details (fillets, steep walls).

2.3. Data preparation and Manipulation

We used Polyworks s/w to put the patches together, and to remove any overlapping areas. The data is filtered to reduce excessive points and noise. The Original model used for this case study is shown in Figure 1. The scan data is shown in Figure 2.

Figure 2. Scan data

2.4. STL file Preparation

To reduce the STL file sizes, especially for the CAM s/w packages like WorkNC and Tebis, we had to do lot of experimentation. The original STL file size is 600 Megabytes. After using filtering techniques, the STL file size was reduced to 170 Megabytes (Note : If we try to filter too much data, we end up bad fillets, which is shown in Figure 3). We had to make a balance between accuracy, quality and size of the STL file. The final filtered data is shown in

Figure 4. After the data [STL] is prepared, We developed the toolpaths to cut the duplicated mold in P-20 steel

Figure 3. Bad Fillets, as a result of too much data filtration

Figure 4. Good Fillets, after implementing better filtering techniques (part of research efforts)

2.5. Toolpath creation from STL file

We used WorkNC and Tebis software to create toolpaths from scan data. All the toolpath types are available from WorkNC to cut the scan data. Once the STL file is read in to WorkNC, the toolpath preparation process is same as that from surfaced CAD file. The toolpath calculations are slightly slower than from a surfaced CAD files. But, it is not really a bottleneck in the process, as the computers are getting faster (Pentium 500 MHz PC), we can

also develop the toolpaths in a batch mode, overnight. We prepared various toolpaths using WorkNC and only few toolpaths are shown in the pictures.

The typical toolpaths, we use are

- 1) Z-Level Roughing Toolpath : To rough solid block of P-20 steel. This toolpath is shown in Figure 5.
- 2) Planar Finishing Toolpath : This toolpath is shown in Figure 6.
- 3) Contour Remachine Toolpath : To remachine left over stock from previous bigger finishing tools. The finishing is much smoother and highly efficient. This toolpath is shown in Figure 7.

Figure 5. Z-level Roughing toolpaths

Figure 6. Finishing toolpath

Figure 7. Contour Remachine

2.6. CNC Machining

The process of CNC machining is same as that of cutting from Surfaced CAD files. The finished mold is shown in Figure 8.

Figure 8. Mold cut from Scan data

2.7. Inspection of the Finished mold

At Venture, generally, we use “Coordinate Measuring Machines” to check the quality of finished mold. Venture is in the process of developing technology to inspect the finished mold by scanning the mold and compare the scan data with the surfaced CAD files (if available) or with the Original scan data of the model.

We scanned the finished mold. We used Polyworks software to compare the scan data of the finished mold with the scan data of the original model. This technology needs to be developed further. It takes too long time. The colorplot showing the difference between Original model and the duplicated mold is shown in Figure 9. The maximum deviation of the finished mold from the model is + or – 0.4 mm.

Figure 9. Color PLOT [Inspection] Shows the difference in the Original Model and Duplicated Mold, using Scan Data

3. CONCLUSION

We cut this mold for Chrysler Corporation and Chrysler Managers were impressed with the results. We need to further develop the technology in “Inspection of finished Mold/Die using Optical Scanners”.

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