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REDUCTION IN MACHINING CYCLE TIME OF TRIM DIE OF AUTOMOTIVE PANEL

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Abstract - *To compete in today's manufacturing markets, it is necessary to have diverse product lines, which has to be manufactured and delivered to the customer in the shortest time possible. Producing a large range of products in a short amount of time is only possible through efficient and effective manufacturing practices. One way to improve the Production is to* ***reduce the machining cycle time****. This will decrease the lead-time of the product and increase the overall equipment effectiveness for the equipment used to process the product. In this thesis, strategies are described for reducing machining cycle time for CNC milling machines in a company that manufactures Dies of Automotive Panel. There are various parameters like machining time, alignment, loading time, air-cutting time, and limitations of machine, waiting time, which severely affect the overall machining time of Dies. That can be reduced by various methods like use of* ***proper time management, Advanced Clamping devices, use of Single Minute Exchange for Die, Air cutting Analysis and its reduction, Case study of tools and inserts*** *and by Standardization of Worksheet which is usually followed while machining of Die. Methods described in this thesis can be implemented to reduce the machining cycle time. Applying the discussed methods will also result in improved equipment effectiveness and reduced lead-time. Other companies can also use these methods with similar changeover to improve the efficiency and effectiveness of machining.*

1. INTRODUCTION

The time that is devoted to changeover, aligning, machining is too long. In addition, after the Surface hardening of Trim Dies, machining becomes difficult, and to maintain the quality of the product, proper machining of upper and lower Die is required. Therefore, the machining cycle time of Trim Die is quiet large. Thus, there is a requirement of reducing Machining cycle time of Trim Dies.

1.1 OBJECTIVES

To reduce the machining cycle time with available resources. To enhance competitive position of company in global market. To increase profitability. To implement new technology for improving machining cycle time. Achieve these results in a short period with minimum investment and through improved processes and the application of proven techniques and tools.

2. METHODS FOR REDUCING MACHINING CYCLE TIME

2.1. Use of Standard Work Sheet

From the daily observations of Trim Die machining process, some practical values are obtained. With the help of this, survey sheet is prepared to note proper observations, which helps to find the Red areas where difference between the actual time and estimated time for the machining process is significant when compared with the machining cycle time. It also helps us to know the reasons behind these Red areas.

Sr. No	Major Red Areas	Reason	Solutions provided
1	Loading		
I.	Setting Die on machining bed	Limitation of crane speed	SMED
II.	Clamping	Tightening of bolts manually, no standardization of applied torque	Advance Loading Devices
III.	Aligning+ Set origin	Use of conventional aligning system (dial gauge)	Laser Sensor
2	Air machining	Extra stock assumed	Icam Software
3	Less depth of cut	Due to machine rigidity and limitation of tool	Tool Improvement

4	Less feed and speed	Due to machine rigidity and limitation of tool	Tool Improvement

Table 1 Major Red Areas of Improvement

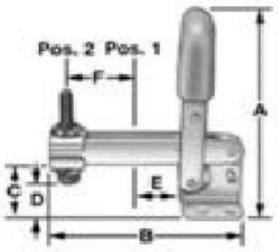
2.2. Advanced Clamping System

2.2.1 Fast clamping devices

Machine cycle mainly consists of loading and unloading of Die, it is necessary to look at quick fastening devices that can speed up cycle. One way to reduce clamping time is to eliminate the need of removing nuts from the studs. This is possible by use of the pear shaped hole method and the swing C washer. With these methods, the nut need not to be removed from the stud. Quick nuts can be used so that the operator can slip the nuts down the stud and snug it up to the fixture with the pneumatic drill. Another easy way to eliminate excess turning of nuts is, simply shorten the length of the studs. Perhaps the best way to reduce clamping time is to eliminate the need of tightening screws at all. This can be possible with the use of a toggle clamp.

Hydraulic and pneumatic clamping devices are also good options for clamping purpose. Die is fixed on all clamping positions simultaneously and evenly fixed at the touch of a button without any effort. It will help to reduce clamping time in machining cycle of Trim Dies.

Quick Thread Nuts



Toggle Clamps

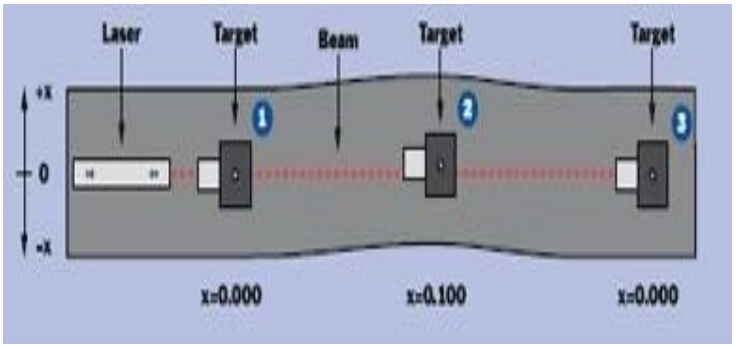
Swing C-Washers

Push Button Hex Nuts

2.2.2 Reduction of alignment time of Die

While new job is set on machining bed, job must be aligned in straight line. For this process instead of conventional method like using, dial gauge. Digital sensor should be use. Its shows that whether Die is aligned in straight line or not in milliseconds. E.g., laser sensor. Conventional methods generally takes minimum 10-15 minutes. First, they pick highest curved point on one dowel pin then match with second if not, he has to change the position of Die and again check the aligned position.

Initially a Die is placed on bed. Then LASER aimed beam on one of the dowel pin, which is fixed in the one of the reference hole. Sensor blocks, placed on first reference point and second reference point senses LASER beam. After analyzing, computer gives deflection between first block and second block. Figure explains the working of sensor. As figure shows, the second block is not in straight line it shows deflection. Similarly, we can apply for Die aligning system by using LINE Sensor.



2.3 Methods for Reducing Air Cutting Time:

2.3.1 Use of ICAM Software

Smart CUT

Detects positioning (i.e. RAPID) or high-feed motions that cut into the in-process stock and in addition give warning to the NC programmer, will automatically reduce the feed-rate. Similarly, when leaving the material, Smart CUT will detect RAPID motions that cut the stock when leaving the part and will automatically slow down these cutting motions to the last programmed feed. Smart CUT provides other settings that can ignore air-cutting paths less than a specified length; enforce a minimum safe distance on air-cut positioning motions; and define minimum safe positioning approach and exit feed distances.

Smart CUT and Smart PATH

When used together can significantly improve NC programs containing time wasting air-cuts. Smart CUT will detect the start point and subsequent endpoints of air- cut

segments as normal, but instead of increasing the velocity along the programmed path, it will use Smart PATH to compute the fastest path to the start of the next cut. Smart PATH takes into account the current state of the in-process stocks well as part, fixtures and machine components, when computing the shortest path to the start of the cut.

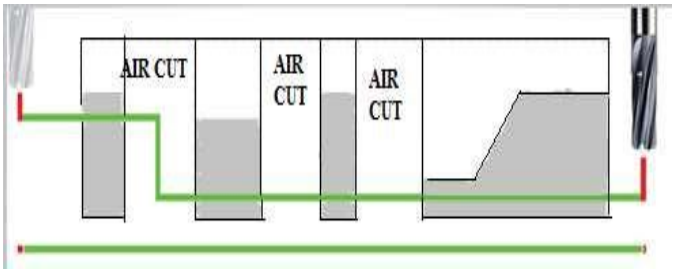


Figure 2 NC Code without Smart CUT

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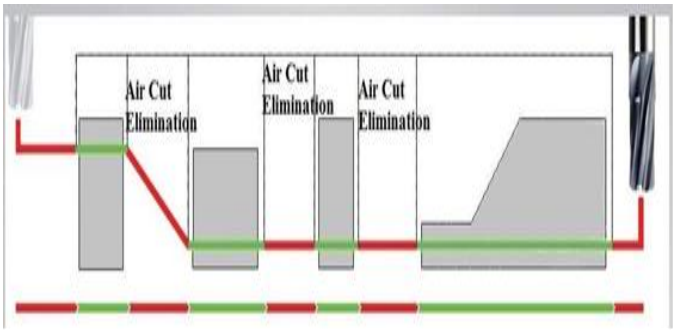
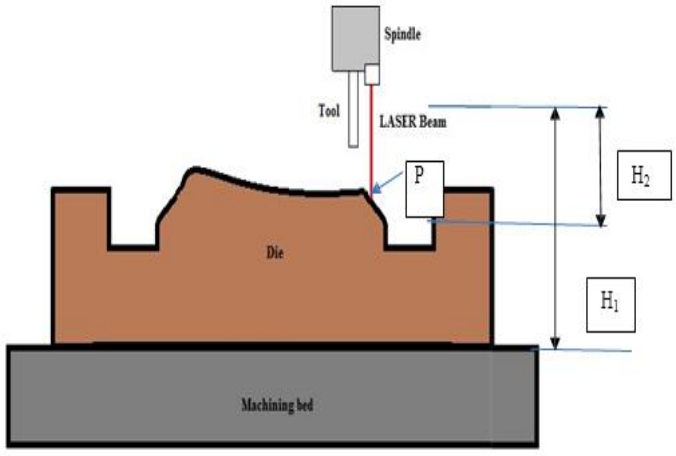


Figure 3NC Code with Smart CUT

2.3.2 Use of LASER SENSOR



By using a DT20-P214B Sensor, It will emit the laser first. Sensor will sense the distance and hence it will calculate the distance H2.

H2= Distance between the top surface of Die and sensor with the help of LASER.

H1 = Distance between the bed and Sensor.

We can calculate the actual work piece height: H1 – H2

By knowing, the Actual Work piece height in (Z-Direction) program can be edited before the start of actual machining. The machining can starts with actual point P rather than Q (Which is given by the programmer). This will reduce the air machining by knowing the actual material available on Die. We can also reduce the air cutting by giving the spindle axis limit during the machining.

2.4 Analysis and Improvement of tools

Machining of Trim Dies is performed in four stages i.e., roughing, semi finishing, finishing and hard cut finishing. Bull nose cutters are used for roughing cycle. Ball nose cutters and End mill cutters are used for semi finishing, finishing and hard cut finishing of Trim Dies.

The technology in material properties of cutters is developing day by day, leading to more advanced cutters, which can perform with high machining parameters. Thus, there is a need to update the cutters time to time. Hence, the study and comparison of cutters in terms of different parameters like Depth of cut (Ap), Width of cut (Ae), Feed speed (Vf), Material Removal Rate (MRR) will help to get the best tool among all the tools available in the market. Tool with higher MRR is preferred because, higher the MRR lesser is the machining time. This in turn will help to reduce the machining cycle time by using the best tool for machining of Trim Dies.

Here mostly Ball nose cutters and End mill cutters are used for the operation of finishing. Finishing process consume larger time as compared to semi-finishing and roughing due to less depth of cut. Therefore, the best tools should be selected from the market for finishing cycle. Thus, the case studies and analysis of Ball nose cutters and End mill cutters for finishing cycle and of Bull nose cutters for roughing cycle are done.

Material Removal Rate is given by,

MRR= (Ap * Ae * Vf)/1000

D = Diameter of tool (mm)

Ap = Depth of cut (mm)

Ae = Width of cut (mm)

2.4.1 Comparison of Ball Nose Cutters

D=8mm	Dijet	Hitachi
N	3200	3200
V_f	220	600
A_p	0.8	0.56
A_e	2	1.68
MRR	0.352	0.564

Table 3 Case study of ball nose cutter

2.4.2 Comparison of End Mill Cutters

D=8mm	Dijet	Hitachi
N	1200	2389
V_f	240	105
A_p	12	12
A_e	0.16	0.24
MRR	0.46	0.302

Table 3 Case study of end mill cutter

3. CONCLUSIONS

This project has explored the four methods to tackle the high machining cycle time of Trim Dies.

First method is Use of Standard Worksheet. From the standard survey sheet, we are able to find out the Major Red Areas, which are responsible for increase in machining cycle time of Trim Die.

Second method is, Advanced Clamping System. It is observed that, time required for loading of Die is quiet large. This can be reduced by use of advanced clamping devices, which include devices such as Pneumatic Clamps, Quick Nuts etc.

Use of LASER aligning sensor reduce the time of alignment of Die and increase the accuracy as compared to conventional method.

Third Method is the analysis of Air Cutting. The actual stock is detected by the use of LASER sensor. Stock measured by sensor is compared with the stock suggested by programmer. According to result of comparison, machining is started at the point where the difference is negligible. By using ICAM software, feed rate can be increased during the period of Air Cutting. It also optimizes the tool path, which helps to reduce the machining cycle time of Trim Die.

Fourth method is analysis and improvement of tools. Analysis of tools with different machining parameters (depth of cut, width of cut, feed and speed), has been done by comparing Material Removal Rate (MRR) with each other. Tools with higher MRR will take less machining time. Hence, based on the comparison for finishing cycle, we can conclude that Ball nose cutters of Hitachi are better than that of Dijet and End mill Cutters of Dijet are better than that of Hitachi. We conclude that with the above said methods, we can reduce 3 hours in machining time of Trim Die.

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