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COST REDUCTION AN AIRCRAFT ENGINE PART OF TURBINE DISC MANUFACTURING

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ABSTRACT: *Widely used in Aircraft gas-turbine engines with features and a very special super alloys materials, latest technology and the process of developing manufacturing methods that work to reduce cost of a special operation is to be done. Superalloys are produced based on their iron, nickel and cobalt content and they are very resistant to high temperature applications. But with today's gas-turbine engines are usually due to superior qualities who are nickel-based is used. In this Project RENE 88 DT – based a nickel super- alloy with a disc of lathe operation conditions have been checked and made of a work to reduce cost.*

KEY WORDS:*Super alloys , Lathe , Insert*

1.INTRODUCTION

Matching the most suited cutting tool material (grade) and insert geometry with the workpiece material to be machined is important for a trouble-free and productive machining process.Other parameters, such as cutting data,
tool path, etc. are also vital for a successful result:

Cutting tool materials, such as cemented carbide, ceramics, CBN, PCD, etc.

Workpiece materials and classifications from a machinability point of view.

2.PRODUCTIVITY AND COST

There is a general imbalance between the cost development and what the market is willing to pay. In order to bridge that gap, there is a need to continuously increase efficiency and productivity. To help us improve our efficiency and us to lower the cost per piece of methods used by the project;

- Selection of machining method and tool path
- Choice of tool, insert geometry and carbide grade
- Cutting data (speed, feed and depth of cut)
- Fewer tool changes - more machining time

2.1 Increased Cutting Data Reduce Costs

Increased cutting data and process improvements can dramatically reduce the cost per component and thereby increase a company's profitability. In most cases, it is by far more profitable to increase cutting data than to increase tool life. Likewise, it is much more profitable to use cutting tools that can withstand high cutting data than to use low quality tools.Tool life and tool costs have minor effects on the component cost compared to cutting data. The exact effect on component costs depends on the machining process parameters and the company's cost structure.

In order to improve profitablity, it is important to study the process in detail. There are many methods for improving processes and each situation is different.

3. MACHINABILITY

Machinability of disc-materials increases in difficulty according to the following sequence: iron based materials, nickel based materials and cobalt based materials.

All the materials have high strength at high temperatures and produce segmented chips during cutting which create high and dynamic cutting, forces. Poor heat conductivity and high hardness generate high temperatures during machining. The high strength, work hardening and adhesion hardening properties create notch wear at maximum depth of cut and an extremely abrasive environment for the cutting edge.

3.1 Carbide And Ceramic

Carbide grades should have good edge toughness and good adhesion of the coating to the substrate to provide good resistance to plastic deformation. In general, use inserts with a large entering angle (round inserts) and select a positive insert geometry.

In turning and milling, ceramic grades ca a) be used, depending on the application Ceramic grades can be applied in a broad range of applications and materials; most often in high speed turning operations but also in grooving and milling operations. The specific properties of each ceramic
grade enable high productivity, when applied correctly. Knowledge of when and how to use ceramic grades is important for success. All ceramic cutting tools have excellent heat and wear resistance at high cutting speeds. Below you can find the most common types of ceramics used in hard and /or difficult to machine materials.

3.1.1 Cutting Parameters For Ceramics

The speed should be balanced to create enough heat in the cutting zone to plasticise the chip but not too high to unbalance the ceramic.

The feed should be selected to give a chip thickness which is high enough to not work-harden the material but not be too high to cause edge frittering.

Higher feeds and depths of cut require a reduction of the cutting speed. These boundaries will change depending upon the component material hardness and grain size.

4. OPTIMIZATION AND TOOL WEARS

The disc part used different inserts and tools in every region for lathe operation.Used in the inserts were collected for all regions. This inserts the following information is determined depending on wear.

1-) Flank wear

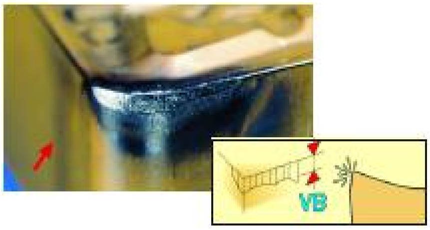

Figure 1

Rapid flank wear causing poor surface finish or out of tolerance. (Fig.1)

Cause

Cutting speed too high or insufficient wear resistance.

Solution

a. Reduce the cutting speed
b. Select a more wear resistant grade.
c. Select an Al_2O_3 coated grade.
d. For work-hardening materials, select a smaller entering angle or a more wear resistant grade.

2-)Notch wear

Notch wear causing poor surface finish and risk of edge breakage. (Fig.2)

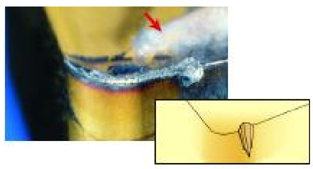

Figure 2

Cause

a) Oxidation
b) Attrition

Solution

a)Select a cermet grade
b) Reduce the cutting speed.
(Whenmachining heat resistant material with ceramics, increase cutting spee

3-)Crater wear

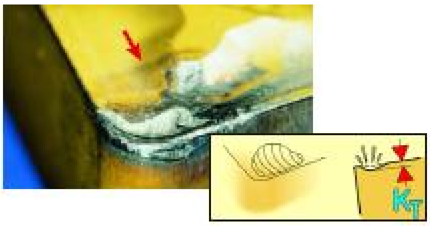

Figure 3

Excessive crater wear causing a weakened edge. Cutting edge reakthrough on the trailing edge causes poor surface finish.
Risk of insert breakdown. (Fig.3)

Cause

Diffusion wear due to cutting temperatures that are too high on the rake face.

Solution

a) Select an Al_2O_3 coated grade.
b) Select a positive insert geometry.
c) First, reduce the speed to obtain a lower temperature, then reduce the feed.

4-) Plastic deformation

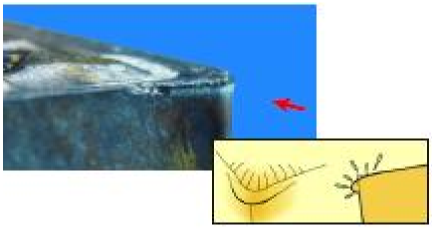

Figure 4

- Plastic deformation.
- Edge depression or flank impression.
- Leads to poor chip control and poor surface finish.
- Risk of excessive flank wear leading to insert breakage. (Fig.4)

Cause

a) Cutting temperature is too high, combined with a high pressure.

Solution

a) Select a harder grade with better resistance to plastic deformation.
b) Edge depression – reduce feed.
c) Flank impression – reduce speed.

5-) Built-up edge (B.U.E.)

Figure 5

Built-up edge causing poor surface finish and cutting edge frittering when the built-up edge is torn away. (Fig.5)

Cause

Workpiece material is welded to the insert due to:

a) Cutting that is too low.
b) Negative cutting geometry.
c) Adhesive workpiece material.

Solution

a) Increase the cutting speed or cool heavily.
b) Select a positive geometry. Reduce feed at the beginning of the cut.
c) Select a thin coated PVD grade and a positive geometry.

6-)Chip hammering

Figure 6

The part of the cutting edge not in cut is damaged through chip hammering. Both the top side and the support for the insert can be damaged. (Fig.6)

Cause

a) The chips are deflected against the cutting edge.

Solution

a) Change the feed.

b) Select an alternate insert geometry or change to a tougher grade.

7-)Frittering

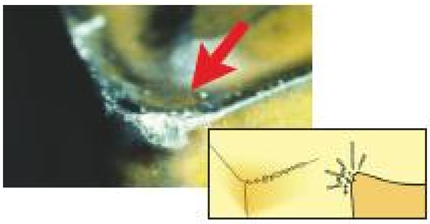

Figure 7

Small cutting edge fractures (frittering) causing poor surface finish and excessive flank wear. (Fig.7)

Cause

a) Grade is too brittle
b) Insert geometry is too weak
c) Built-up edge

Solution

a) Select tougher grade.
b) Select an insert with a stronger geometry (bigger chamfer for ceramic inserts).
c) Increase the cutting speed or select a positive geometry.
Decrease the cutting speed and coolant.
Reduce feed at the beginning of the cut.

8-)Thermal cracks

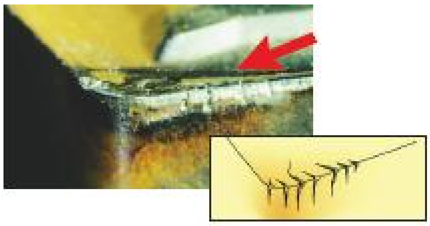

Figure 8

Small cracks perpendicular to the cutting edge causing frittering and poor surface finish. (Fig. 8)

Cause

Thermal cracks due to temperature variations caused by:

a) Intermittent machining
b) Varying coolant supply

Solution

a) Select a tougher grade with better resistance to crack propagation
b) Coolant should be applied copiously, or not at all

9-)Insert breakage

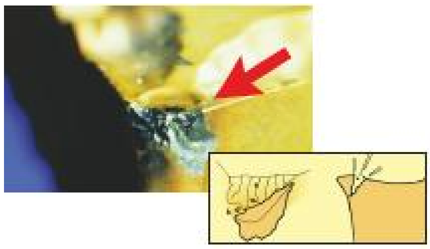

Figure 9

Insert breakage that damages not only the insert but also the shim and workpiece. (Fig.9)

Cause

a) Grade is too brittle
b) Excessive load on the insert
c) Insert geometry is too weak
d) Insert size is too small

Solution

a) Select a tougher grade.
b) Reduce the feed and/or the depth of cut.
c) Select a stronger geometry, preferably a single-sided insert.
d) Select a thicker/larger insert.

10-)Slice fracture – ceramics

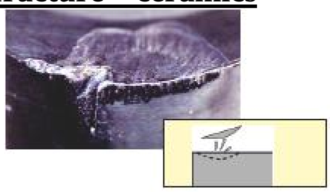

Figure 10

Cause

a) Excessive tool pressure

Solution

a) Reduce the feed

b) Select a tougher grade

c) Select an insert with a smaller chamfer, or use another geometry to change cutting force direction

5. PREPARATION FOR CUTTING AT LATHE MACHINE

5.1 Fixture Setup

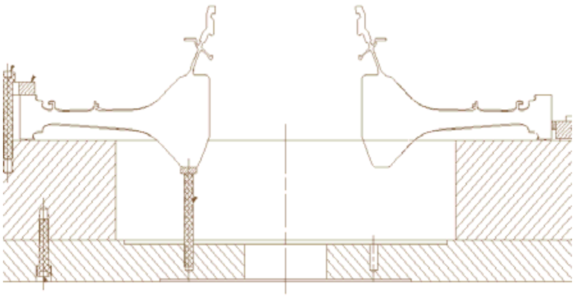

Figure 11

It is connected to Fixture. Tool and fastener elements are check is as clean.Inner diameter rotary control run-out and face run-out control. (Fig.11)

5.2 Part Setup

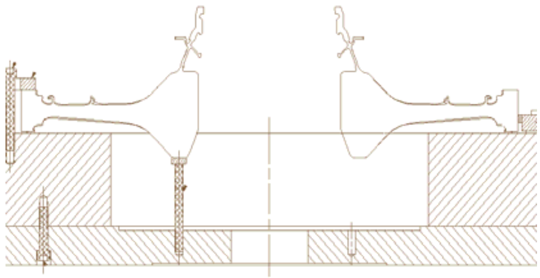

Figure 12

Part run out are control on lathe machine than check are reference dimensions. (Fig.12)

6. CHANGE INSERTS THE CUTTING AREAS

Using special form insert has been removed in these area. In stead of carbide ınsert used in these area. (Fig.13)

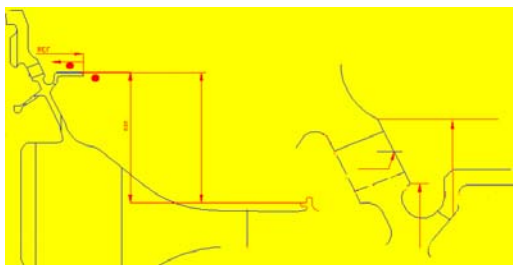

Figure 13

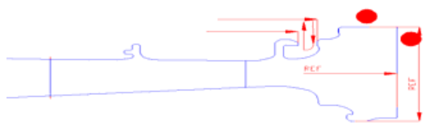

Figure 14-a

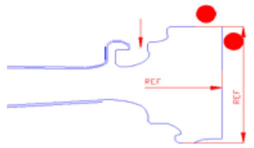

Figure 14-b

Special form carbide insert used in these areas has been removed.Ceramic insert using in these area. (Fig. 14 a and b)

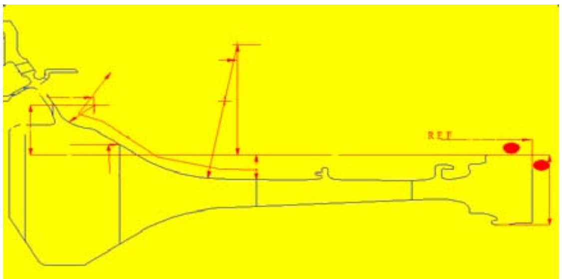

Figure 15

4V carbide insert used in these area.4V carbide insert has been removed.4V using inserts have been at grinding operation than obtained by grinding non-standart 3.5V insert using in these area. (Fig.15)

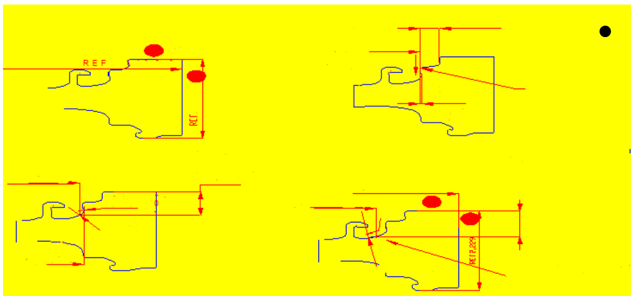

Figure 16

The combined are cutting the same area.This area was reduced to a single tool. (Fig 16)

7. CONCLUSIONS & ACKNOWLEDGMENT

In the first stage using part only lathe machine restirected the planning sheme.Required sales time to train and created difficulties in terms of quality production for lathe operation at part using adaptaston more machine. All of these adverse conditions, taking into account the results of the project operation:

- In some regions, instead of a special ceramic insert to carbide insert was obtained by using the cost-effective large profit. Ceramic inserts with changes made to the program by using the advantage of progress and time savings are obtained by increasing feed and rotation.
- HNK machines magizenes using maximum number of 12 tools, so tools number reduced 15 to 12. so that two parts can be processed at the same time. As a result relieved planning requirements and the period for tools maginez setup eliminated.
- The special form of the piece is expensive 4V insert instead of 3.5V insert using at the factory obtained by large profit.
- Places to cut as much as possible so that the same regions combined; shimset and tool data taking periods is eliminated.
- The special inserts are used for parts only, increases the cost per piece. The adoption of standard inserts are used to track a lot of stocks in the factory cost of the insert was obtained huge profits.
- Used Tool reducing at the part manufacturing is obtained by cost profit.
- Lathe operation, the workpiece 32 hours operation time was reduced to 26 hours.

REFERENCES

[1]. Serope Kalpakjian, Steven R. Schmid, Chih-Wah Kok, *Manufacturing Processes for Engineering Materials*, Pearson Education; Fifth Edition (December 15, 2007)

[2]. Hamed, A., Tabakoff, W., Wenglarz, R., *Journal of Propulsion & Power*, vol. 22, no.2 (March–April, 2006)

[3]. Roger C. Reed, *The Superalloys Fundamentals and Applications* Cambridge University Press;1edition (July 31, 2008)

[4]. Sandvik Coromant *Technical Guide and Product Catalogues* [online]. Available: http://www.sandvik.coromant.com, (January, 2013)

[5]. Seco *Teknik Eğitim Kitabı* [online]. Available: www.**seco**tools.com/tr (January , 2013)

[6]. [online]. Available: https://www.greenleafglobalsupport.com/webapp/wcs/stores/servlet/Product_10001_10001_-1_10284

[7]. Sanjay Mazumdar, *Composites Manufacturing: Materials, Product, and Process Engineering,* CRC Press; 1 edition (December 27, 2001)

[8]. Schafrik, R., and Sprague, R., *Saga of Gas Turbine Materials: Part III, Advanced Materials and Processes*, Vol. 162, (May,2004).

[9]. MEGEP (*The Project of strenght of vocational education end training – in Turkish*) Makine Teknolojisi CNC Torna Tezgahları Ankara, (2006)