# A Study on Process Development & Machine Time Optimization of Edge Insert

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***Abstract-*** *Process planning is a task comprising a broad range of activities to design and develop an appropriate manufacturing process for producing a part. Interpretation of the part design, selection of manufacturing processes, definition of operations, operation sequences, machining datums, geometrical dimensions and tolerances are some common activities associated with the task. Process planning is also "the link between product design and manufacturing" with the supplementary commission to support design of competitive products. In this project machining time and delivery schedule for "EDGE INSERT" was fixed by customer which was taking more time with the initial manufacturing process. After detailed discussion by technical committee revised manufacturing process has designed, with new customized cutting tools and fixtures machining time has controlled within the time given by customer. With revised manufacturing process the finished jobs are delivered to customer within due date.*

*The research has been performed in an industrial environment at a scientific Industrial Organization recognized by SIRO for high volume manufacturing of aerospace part "EDGE INSERT". Though EDGE INSERT manufacturing has many distinctive features, the methods and results presented in this project are generally applicable to precision manufacturing of many kinds of mechanical parts*

***Keywords***- Edge Insert, Process Planning, etc.

## I. INTRODUCTION

In a complex satellite sandwich panel more than 800 inserts can be found. In the design of spacecraft structures weight & stiffness are critical design parameters and as a result composite sandwich panels are often used. In a complex satellite sandwich panel more than 800 inserts to mount the equipment can be found. A typical communication satellite has more than 5000 inserts.

Mechanical joints and fasteners are essential elements in joining structural components in mechanical systems.

- Honeycomb or aluminium foam construction, typically the sandwich honeycomb plates are used widely in satellite structures on which the electronic equipment is mounted, the instrument unit and the propulsion part and others.
- In sandwich structures applications, mechanically fastening panels with inserts is one of the most important parts of the design.
- The sandwich honeycomb plates which are employed in the satellite structure requires many inserts for assembly
- Below figure shows an example of an insert schematic. The insert is attached by an adhesive potting compound to a panel consisting of two face sheets and a honeycomb or a foam core

**Objectives**

Total CNC Milling machining time should be restricted <30 min per part, and to meet the delivery schedule committed to customer.
Customer is a satellite manufacturer

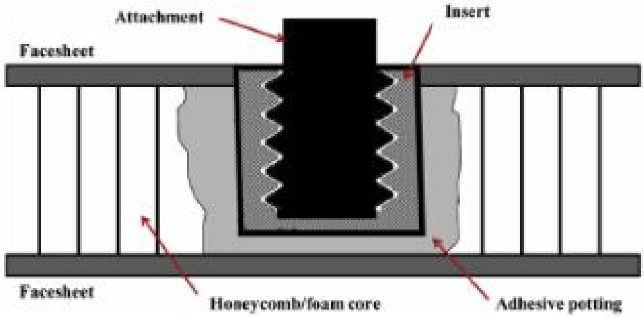


Fig 1.1 : Edge insert bonding

**Following are Critical requirements identified:**

1. 14.64+0.00/-0.05
2. DRILL & TAP, Perpendicular with in 0.05mm w.r.t Plane
   "A" ⊥ 0.05 A
3. Wire cut surfaces marked with *. (refer fig 1.2)

4. Helical tapping to be checked by go & no go gauge while fabrication

**General Requirements:**

- General Tolerance & machining finish as per drawing and IS 2012 medium
- Raw Material: AA2024 T351 (Aluminium)
- General characteristics: Good machine inability and surface finish

Uses: Aircraft fittings, gears and shafts, bolts, clock parts, computer parts, couplings, fuse parts, hydraulic valve bodies, fastening devices, veterinary and orthopaedic equipment, structures

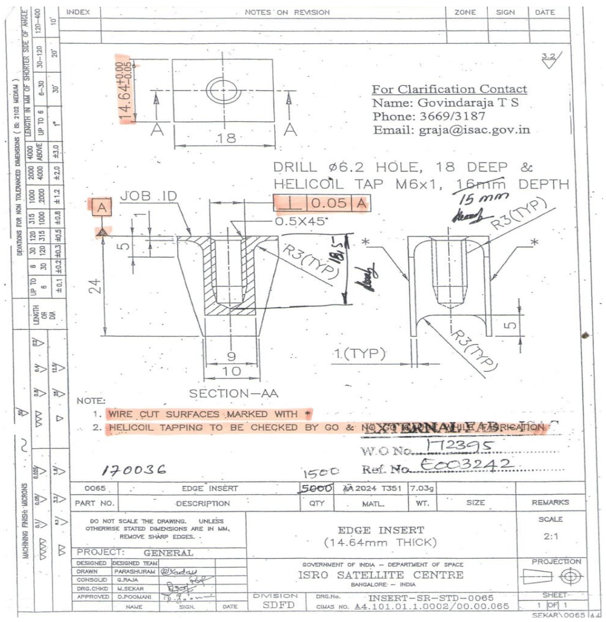


Fig 1.2: edge insert (14.64 mm thick)

## II. REVIEW OF LITERATURE

- **Prajapati [1]** have optimized the machining parameters for SR and MRR in CNC turning. SS 316 (austenite steel) work material of Ø 45 mm and length 35 mm was used in turning in dry environment conditions. In this study, the effect and optimization of machining parameters (cutting speed, feed rate and depth of cut) on SR and MRR is investigated. An L27 Orthogonal array, analysis of variance (ANOVA) and grey relation analysis is used.
- **Chandrasekaran. [2]** studied the machinability of AISI 410 on CNC lathe for SR using taguchi method. The effect and optimization of machining parameters on SR is investigated. L27 Orthogonal array, analysis of variance (ANOVA) are used in this investigation. The experiment was conducted on FANUC CNC lathe. Work material of Ø 32 mm and length 60 mm was used.
- **Benardos [3]** studied a neural network modelling approach for the prediction of surface roughness in CNC face milling. Taguchi design of experiments method is used and MATLAB version 5.3.0.10183 (R11) program was used to create, train and test the ANNs.
- **Zhang [4]** investigated the Taguchi design application to optimize surface quality in a CNC face milling operation. An orthogonal array of L9 was used and ANOVA analyses were carried out to identify the significant factors affecting surface roughness. CNC Mill: Fadal VMC-40 vertical machining center was used for this experiment and 19.1×38.1×76.2 mm aluminium blocks as a work piece. The experimental results indicate that in this study the effects of spindle speed and feed rate on surface were larger than depth of cut for milling operation.

## III. RESEARCH METHODOLOGY

1. Part design 2D Drawing & 3D modelling in Master CAM Software
2. Process Planning
3. Pre-machining (sizing)
4. NC Tool Path Generation
5. Cutting Tools Selection
6. Process Sheet (setup Sheet) preparation
7. Post processing NC programs-converting Cutter location file (CLF) to G & M Codes
8. Transferring NC programs from CAD/CAM department to scheduled Vertical Machining Centre (VMC) machine
9. Job clamping, setting datum setting cutting tools, setting datum and Execution of NC programs as per setup sheet
10. Bench work – de-burring sharp edges
11. Stage inspection
12. Parting off operation with Wire Electrical Discharge Machine (WEDM)
13. Fixture plate design- job holding for Ø6.2, hole 18mm deep machining
14. Manual Heli- coil tapping M6X1
15. Final inspection
16. Analysis of machining time and GD&T

## IV. LIMITATIONS OF THE STUDY

- Manufacturing time given by the customer should be less than 40 min, but the time taken per edge insert is 51 min.
- To achieve to results 4 VMC are required but available m/c are only 2.

- The machining time is not feasible hence alternate process is developed by group by a technical committee.

## V. EXPERIMENTAL PROCEDURE

### 5.1 PART DESIGN WITH MASTER CAM SOFTWARE

Mastercam v9 software is used for part designing .one of the oldest developers of pc-based computer-aided design & CAM software. The designing involves use of features such as extrude, Boolean operations, solid filleting etc. The below figure shows the use of Mastercam software for designing edge insert.

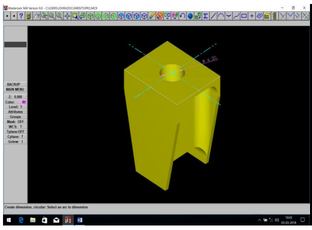

Fig : ( 5.1a)

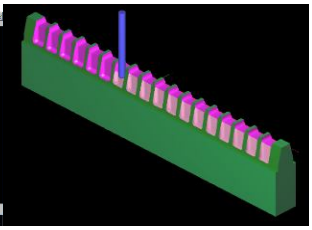

Fig : (5.1b)

### 5.2 PROCESS PLANNING

**Initial process planning:**

- Raw material given by ISRO
- Raw material planning (h=18mm, w=72mm, l=298mm)
- quantity – 3250
- Datum consideration (setting X0, Y0, Z0)
- Cutting tools used
- No of setups involved
- Machining time & feasibility

### 5.3 MACHINING TIME & PROCESS ANALYSIS FOR ONE STRIP (18 PARTS)

Table 5.1

| OPERATION | MACHINE | MACHINING TIME |
|---|---|---|
| Pre-machining | CNC Milling | 15 mins |
| Profile machining | Vertical Machining Centre (VMC) | 12 Hrs 51 mins |
| Trimming | WEDM | 2hrs 25 min |

- Total Machining Time for 18 Parts = 930 Min
- Total machining Time for 1 Part = 51 Min
- Bench Work: Centre drill, core drill and Manual Tapping = 10min per part
- Total Fabrication time per insert = 61 mins
- Total parts to be manufactured = 3250 Nos
- Total Time required for Critical machining VMC = 2320 Hrs
- Total Time required for WEDM machining = 436 Hrs

**Constraints:**

Manufacturing time given by customer should be less than 40min

To achieve top results 4 VMC are required but available m/c are only 2.

The machining time is not feasible hence alternate process is developed by group discussion by a technical committee.

### 5.4 TECHNICAL COMMITTEE MEETING DECISIONS

Total CNC milling machining time should be restricted to less than 30 min per part.

**Corrective measures:**

1. Redesign and develop Process planning for Milling operation.
2. New cutting tools need to be planned.
3. Machining (tool path) strategies, machining parameters need to optimize.
4. Helicoil Tapping operation M6X1, 15mm deep, instead of manual tapping to be done on VMC using Rigid tapping / Peck Tapping cycle (M84).
5. For Job clamping fixture plate need to be used in place of machine vice.

### 5.5 NEW PROCESS PLANNING

Since the process planning used initially for the manufacture of edge inserts for one strip (18 parts) does not meet the requirements of the customer (ISRO), the technical committee discussions have suggested for new process planning with new cutting tools planned to meet the time restriction given by ISRO to manufacture edge insert ($\leq$ 40 min/part). Figure shows new process planning layout for edge insert machining.

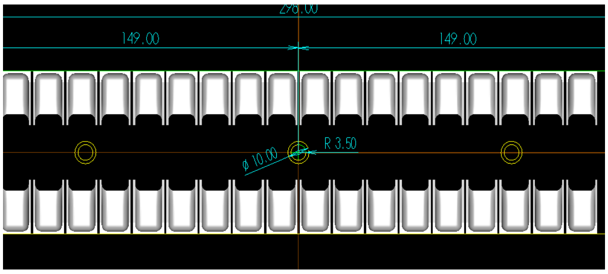


Fig 5.2 : New process sheet

1. Part are oriented as shown above
2. 36 parts are planned in a single block
3. 2 clamping holes on job for clamping on fixture plate
4. Centre hole DIA 6 at X0, Y0 for X, Y datum
5. Z0 on job top surface

### 5.6 SOLID CARBIDE CUTTING TOOLS PLANNED

1. Φ10 & 6.8 drill for clamping hole
2. φ12F end mill for outer contour machining
3. φ6F end mill for counter bore & contour machining
4. Φ6 BN for corner radius finish
5. Φ6.2 special customized drill for φ 6.2 hole machining
6. M6 X1 Helicoil Machine Tap for tapping operation

### 5.7 MACHINING TIME & PROCESS ANALYSIS AFTER COMPLETING 36 JOBS

Table 5.2

| OPERATION | MACHINE | MACHINING TIME |
|---|---|---|
| Pre-machining | CNC Milling | 15 mins |
| Profile machining | Vertical Machining Centre (VMC) | 436*2=872min |
| Trimming | WEDM | 2hrs 25 min |

- Total Machining Time for 36 Parts = 872 mins
- Total machining Time for 1 Part = 24 min
- Drilling & Tapping = 1.30 +9=1.45 min per part
- Total Fabrication time per part = 25.45 mins
- Total parts to be manufactured = 3250 Nos
- Total Time required for Critical machining VMC = 1379 Hrs
- Total Time required for WEDM machining = 436 Hrs

### 5.8 RESULT:

- Total VMC time saved per part =36mins
- Total time saved for quantity 3250 Nos = 1950 hrs

### 5.9 FINAL TRIMMING / PARTING WITH WEDM

For wire cut operation, diameter 0.25mm brass wire has been used, after trimming first job, dimension 14.64-.05 has checked with digital micro meter, minor deviations observed, dimensions have controlled by spark gap adjustment for subsequent jobs.

Figure shows the WEDM operation for edge inserts 36 parts. Figure shows job after CNC milling.

## VI. CONCLUSION

Changing the process plan has reduced manufacturing cycle time and delivered the parts by maintaining delivery schedules. Process plan optimization helps techno commercially. Group discussion or technical discussion yields better results. Avoiding manual tapping and using VMC for drilling & tapping operation yields consistency and repeatability which has reduced rejection and rework. process plan optimisation helps in productivity.

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## REFERENCES

[1] Prajapati, Navneet K. and Patel, S. M.," Optimization of process parameters for surface roughness and material removal rate for SS 316 on CNC turning machine." International Journal of Research in Modern Engineering and Emerging Technology, Vol. 1, Issue: 3, pp.40-47, 2013

[2] Chandrasekaran, K., Marimuthu,P., Raja, K and ManimaranA,"Machinability study on AISI 410 with different layered inserts in CNC turning during dry condition." International Journal of Engineering& Material Science, Vol. 20, pp.398-404, 2013.

[3] Benardos, P.G. and Vosniakos, G.C.," Prediction of surface roughness in CNC face milling using neural

networks and Taguchi's design of experiments." Robotics and computer integrated manufacturing, Vol. 18, pp.343-354, 2002.

[4] Zhang, Julie Z., Chen, Joseph C. and Kirby, E. Daniel," Surface roughness optimization in an end-milling operation using the Taguchi design method. Journal of Materials Processing Technology Vol.184, pp. 233–239, 2007.

[5] Gologlu,Cevdet and Sakarya,Nazim, "The effects of cutter path strategies on surface roughness of pocket milling of 1.2738 steel based on Taguchi method." Journal of materials processing technology Vol.206,pp. 7– 15, 2008.

[6] Joshi, Amit and Kothiyal, Pradeep," Investigating effect of machining parameters of cnc milling on surface finish by taguchi method" International Journal on Theoretical and Applied Research in Mechanical Engineering, Volume-2, Issue-2, pp. 113-119, 2013.

[7] Joshi, Amit, Kothiyal, Pradeep and Pant, Ruby," Experimental investigation of machining parameters of CNC milling on MRR by taguchi method." International Journal of Applied Engineering Research, Vol.7 No.11, 2012