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Study of Manufacturing Feasibility of Wing Panel

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ABSTRACT

Wing panel assembly is the critical component in missile system configuration. The assembly is made of two pacts wing panel, wing skin which are joined by riveting. Wing panel is complex component involving compound angle profile made of Aluminum Alloy AA2014. The work involve to manufacturing feasible of wing panel made of rectangle plane 855L*330W*2T. The fabrication involves Abrasive Water Jet machining, rough milling, CNC milling and drilling operations. This work will target about the fabrication, Quality Inspection and assembly Process of wing Assembly for a missile.

Keywords:
Wing panel
Aluminum Alloy AA2014

1. Introduction

This growth is only because of the great availability of technology to us. In the early days, manufacturing was an artisan – oriented trade known to a very few people who would pass it on to their successors and much growth or innovation for that matter was not seen. As the economy grew, the government started expanding the industry and brought out Public Sector Undertakings. These units revolutionized the concept of manufacturing by bringing in new models of scheduling and routing, thereby ushering in extra productivity.

Manufacturing technology [1] in the industry, throughout the world in its early stages in the 20th century consisted of lathes, drilling and milling machines, specific to only one kind of operation. The latter half of the century saw the rise of universal drilling and milling machines, innovations in machine tool materials, cutting fluids and increasing the number of operations that can be performed on a particular machine. The last quarter saw the development of computers in the industry and thus came the newest kid on the block- Computer Aided Design and Manufacturing [4]. Engineers combined the knowledge of numerical methods and design to formulate the Numerical Control (NC) Machines.

At first, NC machines were run by a tape that had 8 slots on which the code was typed and fed. This was the Direct Numerical Control (DNC) methodology. Later, the code was typed into a Computer and executed, and thus, the first Computer Numerical Control (CNC) machines came into existence [5].

A CNC machine has the following advantages over conventional manufacturing machines: Reduces the number of set-ups, set-up times, tool changing and work handling time [2].

Parts can be produced more accurately even for smaller batches. Conventional manufacturing requires human skill. Because of automation and absence of human-related factors, NC machines eliminated the inconsistency and provided higher Precision and quality.

There is least requirement of operator skill and as a result, minimum errors. Operators require knowledge of tool set-ups and work set-ups only.

Having said, the CNC machines are a boon to the industry as the requirements of mass production and delivery are met within the specified time limits, with a guarantee of quality. CNC machines have decreased operator fatigue and have increased productivity. The industry increases its volumes tenfold due to the CNC machines and thus it has become a necessity to install and manufacture products on CNC machines. Aided with various modeling software's, dry runs over the 3D models can be done and thus the wastage of test components has also been reduced. Thus, CNC machines have become an inseparable part of the manufacturing industry [3].

2. CNC Milling Machines

Most New CNC systems built today are completely electronically controlled. Hereunder are the specifications of a vertical milling machine used in the shop floor of DRDL (Fig.1).

Fig 1. Vertical Milling Machine

3. The Need for Wing on a Missile

Wing is the stabilizing and guiding unit of a missile. It is an aerodynamic surface projecting from the surface of missile for the purpose of giving the directional stability. Missile is an object or weapon suitable for throwing, projecting, or directing at a target. The wing is attached to the aft end of the missile. The wing assemblies cause the missile to fall in a smooth, definite curve towards the target, instead of tumbling through air. Each wing is created in a light weight, disposable metal crate [6].

Though missile starts up straight, even small imperfections of its surface and of the motor alignment can cause it to steer off course. The wing will attempt to drive the guided missile in the direction opposite to that of the turn. You can get away with just three wings provided that they are mounted at exact 120 degree angle to each other, so that resulting forces can compensate. A larger wing creates more stabilization; however it leads to increase in mass by means of more air drag. Therefore wing design is always a compromise between aerodynamics, mass-to-power ratio and the restrictions applied by material properties. There are many types of wing plan-forms available but we have used trapezoidal plan-form with double wedge airfoil, as its cross section is very flexible with greater maneuverability as shown in the figure1 [7].

The wings on a Missile are just there to create stability. As long as there are enough to provide a restoring force against a disturbance, it shouldn't matter. But Enough means at least three, symmetrically placed, with enough area so that when the missile tips off of its path a little bit the wings provide aerodynamic force to put it straight again. If you only had two, a disturbance in the missile of the wings would not get corrected and the missile would veer off course [8].

2.1 Choice of Aluminium as wing material

Since, the bracket is not subjected to high values of stresses, and the effective weight of the components is to be reduced, steel alloys are not preferred. Generally aluminium alloys are preferred for making such parts as:

- The flexibility of aluminium is more than that of steel; therefore it can act better as a vibration dampening structure by absorbing the vibrations.

- Aluminium alloys have a very high value of machinability, the aluminium brackets can be made in almost any shape directly, without any welding. A solid aluminium bracket is always stronger than a steel bracket formed by welding smaller pieces together.
- The total weight is a very crucial constraint for manufacturing the launch vehicle components. Aluminium brackets are usually used as an aluminium bracket weighs only a third of the weight of steel brackets.

All the above mentioned characteristics are used to select a suitable aluminium alloy i.e.AA6351 for the manufacture of our component.

Table 1. Properties details

PROPERTY	DETAIL
Composition	Aluminium – 97.8% Silicon – 1% Manganese – 0.6% Magnesium – 0.6%
Density (kg/m3)	2600
Poisson's Ratio	0.33
Elastic Modulus (GPa)	80
Tensile Strength (GPa)	250
Yield Strength (GPa)	150
Form of Aluminium	Wrought
Shear Strength (GPa)	200
Thermal Conductivity (W/m-K)	176

3. Stages in the Manufacturing of a Wing Panel

The following are the stages in the manufacturing of the fin panel [10].

- Generation of 2D engineering drawings via AutoCAD.
- Generation of part model in Solid Works.
- Importing of IGES file into Pro/Engineer interface to test for manufacturing.
- Generation of part program through Pro/Engineer post-processor.
- Dry run in Master CAM.

3.1 Dual-stage turbocharger with wastegate

The waste gate configuration is placed across the low pressure turbine in this configuration to limit the available power to the low pressure compressor. With this configuration, a relative small low pressure turbocharger can be used compared to the bypass valve configuration. The scaling forecast found in the matching are 0.72 and 1.29 for high pressure compressor and low 48 pressure compressor, respectively. Compared to the scaling factors found for the bypass valve configuration, 0.58 and 1.72, the compressors are relatively similar in the size and both are utilized evenly throughout the entire operating range [9].

3.2 Generation of 2D engineering drawings via AutoCAD

Simple tools like line, circle, fillet, offset, move, copy are used to generate the 2D engineering drawing which will be used as the foundation for the part model in Solid Works. The engineering drawings of the panel are given in the annexure behind.

3.3 Generation of part model in Solid Works

Solid Works is fine software to generate the part model with the added contours. The generation of the contours makes it easy to work with Solid Works than CATIA.

Tools used: Line, circle, fillet, extrude, pocket, smart dimension.

3.4 Importing the IGES File into Master cam for manufacturing tryout

Master cam, CNC Software's main product, started as a 2D CAM system with CAD tools. Master cam's name is a double entendre: it implies mastery of CAM (Computer-Aided Manufacturing), which involves today's latest machine tool control technology.

Master cam's comprehensive set of predefined tool paths including contour, drill, pocketing, face, peel mill, engraving, surface high speed, advanced multiaxis, and many more enable machinists to cut parts efficiently and accurately.
IGES stands for Initial Graphics Exchange Specification. It helps the transfer of a part model from one interface to another. Here, we import the file from Solid Works to Pro/Engineer.

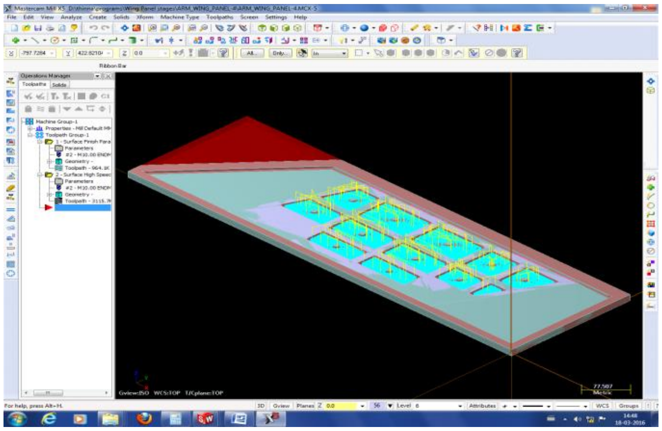

Fig 2. Initial Wing Panel

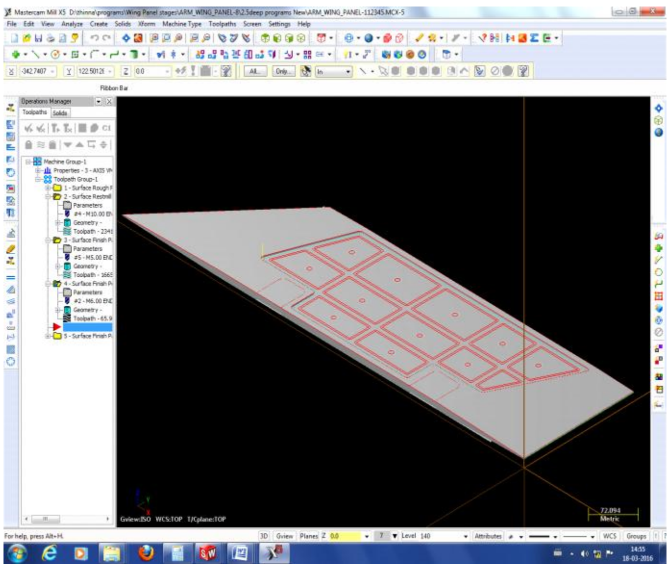

Fig 3. Final Wing Panel

4. Part Programme

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% O0001
N1001 G17 G30 X0 Y0 Z0
N1002 G30 X0 Y0 Z0
N1003 T5
N1004 G17 S3000 M13
N1005 T1
N1006 H1
N1007 S2500 M13
N1008 G0 X-11.751 Y9.693 Z25.
N1009 G1 Z5.6 F100.
N1010 X-225.924 F1000.
N1011 X-38.941 Y69.513
N1012 X-28.891
N1013 X-31.748 Y79.483
N1014 X-41.798
N1015 X-44.655 Y89.453
N1016 X-34.604
N1017 X-37.461 Y99.423
N1018 X-47.511
N1019 X-50.368 Y109.393
N1020 X-40.318
N1021 X-43.175 Y119.363
N1022 X-53.225
N1023 X-56.082 Y129.333
N1024 X-46.031
N1025 X-48.888 Y139.303
N1026 X-58.938
N1027 X-61.795 Y149.273
N1028 X-51.745
N1029 X-54.601 Y159.243
N1030 X-64.652
N1031 X-67.508 Y169.213
N1032 X-57.458
N1033 X-60.315 Y179.183
N1034 X-70.365
N1035 X-73.222 Y189.153
N1036 X-63.171
N1037 X-66.028 Y199.123
N1038 X-76.078
N1039 X-76.105 Y199.214
N1040 G3 X-78.165 Y202.291
R6.029
N1041 G1 X-78.165 Y202.291 Z1.65
N1042 G3 X-81.89 Y203.584 R6.01
N1043 G1 X-151.504
N1044 G3 X-156.156 Y201.381
R6.011
N1045 G1 X-153.349 Y209.093
N1046 X-68.885
N1047 X-131.217 Y203.584
N1048 X-151.504
N1049 G3 X-156.156 Y201.381
R6.011
N1050 G2 X-151.504 Y203.584
R6.012
N1051 G1 X-81.89
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5. Advantages

- Light weight
- High strength
- Easily machining
- High corrosion resistance
- Zero toxicity
- Good reflectivity
- Good conductivity
- Easily joining

6. Conclusion

In this work the manufacturing procedures in practice at the Defence Research & Development Laboratory, taking into account the various manufacturing and design considerations. We learnt about the conventional technologies used and the CNC technologies used.

Described in detail the CNC machine tools available on the shop floor, the specifications of those machines, the working and the tools used in these machines. We also learnt about the cutting fluids used. Using these principles and some basics of CAD we modeled a wing panel used in the missiles manufactured and tested by the Defence Research and Development Laboratory. We understood the design considerations used in manufacturing the fin panel and the necessity of using aluminium as the wing material. We also learnt the use of wing in a missile as guides.

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