RAPID WIND TUNNEL MODEL MANUFACTURE AND MODEL CHANGE TECHNIQUES

J. D. Hammond
BAE SYSTEMS, Airbus UK.

Abstract

Commercial pressure continues to drive the civil aircraft industry to reduce cycle time between project go-ahead and aircraft entry into service. Model design and manufacture has been brought into focus as a critical path item. The model design and manufacture facility at Airbus UK, Filton have adopted the following techniques to meet that demand: Rapid prototyping, high performance machining and special consideration to design for quick model changes.

1 Background

The civil aircraft industry has faced increasing pressure to reduce time scales between project go-ahead and entry into service. This has brought wind tunnel model design and manufacture into focus as a critical path item. In response, the model design and manufacture facility at BAE SYSTEMS Airbus UK, Filton has utilised rapid prototyping techniques, adopted high performance machining and given special consideration to design features for quick model changes.

2 Rapid Protyping

2.1 Historical Perspective

The Filton Wind Tunnel design team first investigated rapid prototyping in 1989. Systems evaluated were 3D Systems, Cubital, EOS and DTM. Some casting trials were also carried out and some parts made on 3D systems machines were tunnel tested. The introduction of stronger epoxy resins however was a major development, increasing the number of applications for direct wind tunnel testing.

More recently, stronger metal rapid prototype parts have been produced on an EOS machine, which can sinter nickel-bronze powder directly.

2.2 Applications

Today, for a variety of model components, rapid prototyping is used as standard practice during aerodynamic development work. Parts are produced at local bureaus and components have been tested directly, in both atmospheric and pressurised low speed tunnels and at the transonic tunnel at Aircraft Research Association. The rapid prototyping techniques have proved to be a valuable method to rapidly test a number of model configurations at short notice as part of the down selection process. Some typical stereolithography parts are shown in figure 1. They are the bathtub and wing-to-body fairing design for an A3XX transonic model.

Figure 1

The parts were built on an SLA500 machine in Ciba Geigy Cibatool® SL5180 resin with a build layer thickness 0.15mm at Rolls-Royce Rapid Prototyping facility, Filton.

An example of a sintered rapid prototype part is the flap track fairing shown in figure 2, which is a directly sintered nickel-bronze part. This part was manufactured on a EOSINT M250 machine, by MH Group Plc. Bognor Regis.

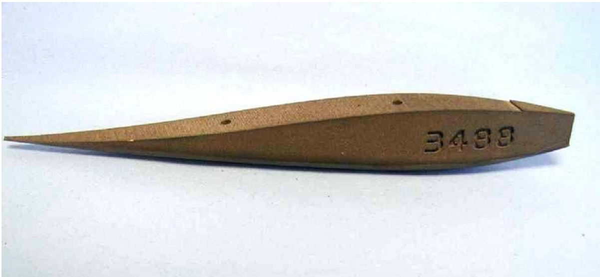

Figure 2

3 High Performance Machining

A major cycle time challenge for wind tunnel models is the manufacture of the wings. The high aerodynamic load, together with model requirements such as internal cavities for pressure plotting tubing and instrumentation, determines a material selection of high (or ultra-high) tensile steels. These steels pose machining problems.

The advancement in cutting tools with the application of ceramics and polycrystalline cubic boron nitrides (CBN) and associated developments of high speed milling machine's, offer substantial benefits to this manufacturing process. At Airbus UK, Filton, a 5 axis Starrag HX-351, machine is used for model wing manufacture. The Sturz milling technique, normally used for turbine blade manufacture, has been adapted by BAE SYSTEMS Airbus UK and Starrag to machine model wings. Wings are machined by spiral milling the parts to remove material constantly from both sides, which is important to limit potential distortion of the part. A typical machining process is shown in figure 3.

Figure 3

The maximum spindle speed is 15,000 r.p.m. and capable of both rough machining and high performance finish machining. The benefits of such a technique is fast production, reduced distortion and excellent machined finish.

4 Design for Quick Model Changes

The ability to produce wings rapidly, from high performance machining, prompted a change in transonic model design. To enable tunnel testing of several wings, with minimum model change time in the tunnel, a revised method of wing and balance adapter attachment has been derived. The patented design enables quick change of model wings in a single tunnel entry, without the need to extensively strip the model down during the test.

5 Acknowledgements

Our thanks to Starrag for the application of their expertise to the machining project and to Rolls-Royce and MHTools Ltd for the parts they produce with a consistent rapid response.

Parts of this paper were presented at an ImechE Seminar in November 1998. These elements are reproduced with kind permission of Institution of Mechanical Engineers, London, UK.