



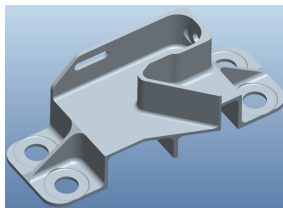
**International Cooperation in Aeronautics with China, MG.1.10-2015 under Horizon 2020. Project number 690725.**

**Title: Efficient Manufacturing for Aerospace Components Using Additive Manufacturing, Net Shape HIP and Investment Casting (EMUSIC).**

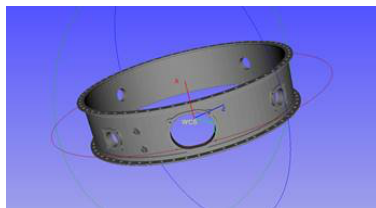
### **Summary mid term report**

**Introduction.** EMUSIC was launched on March 31 2016 to assess the potential of several net shape processes for manufacturing components for aerospace. The 18 partners in the consortium, have the ability between them of manufacturing demonstrator components, of improving the overall control of the processes via modelling, of assessing microstructure and properties and finally of assessing the cost for each process for the identified components.

**Problem being addressed.** Current manufacturing is focussing on net shape processes and the problem addressed in this project is to compare the quality and cost of a number of selected components, made using different net shape process routes, so that industry could make an informed choice of which route is most suitable for these components. The selected components are illustrated below, which were identified by the end users, who also defined the mechanical properties, the surface finish and accuracy of the components and the process-routes they wished to assess.



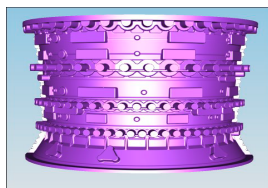
*Component 1 A Guide groove for COMAC from Ti6Al4V*



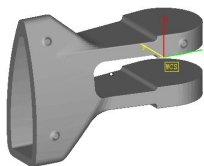
*Component 2. Outer casing for ACAE from IN718*



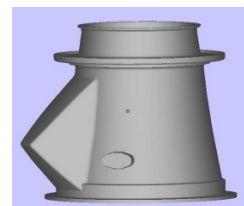
*Component 3. Gimbal for UTAS from Ti6Al4V*



*Component 4 A compressor casing for RR from Ti6Al4V*



*Component 5 A frame connector for RR from Ti6Al4V*



*Component 6 A bearing hub for ITP from IN718*

Figure 1 illustrating the 6 components to be manufactured during EMUSIC

**Importance to society.** Efficient low waste manufacturing is of paramount importance today with the ever-increasing pollution associated with inefficient manufacture. Net shape manufacture is a very important approach to improve the environmental impact of manufacturing.

**Overall objectives.** To investigate a range of net shape manufacturing processes with the aims of reducing waste, improving properties and reducing cost of aerospace components.

**Progress beyond state of the art.** At the halfway stage initial trials have been carried out to manufacture these components, with strong interactions between the modellers and the processors aimed at optimising the process-routes and reducing costs by making shapes as near as possible to net shape and thus minimising post-process machining. Examples of the current state of manufacture are shown in figure 2 for the gimbal. The process-routes used in this figure are laser powder bed and wire feed AM before and after machining. In both cases modelling has been used to optimise processing conditions.

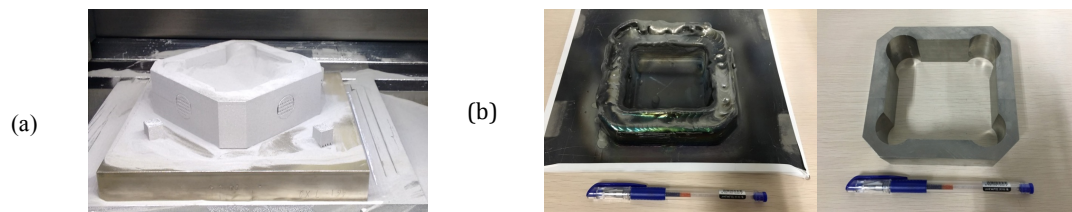


Figure 2 Gimbal manufactured using (a) laser powder bed and (b) wire feed before/ after machining

In addition figure 3 (a) shows an example of modelling of filling when investment casting the gimbal and frame connector and the castings, which have been produced are shown in (b)

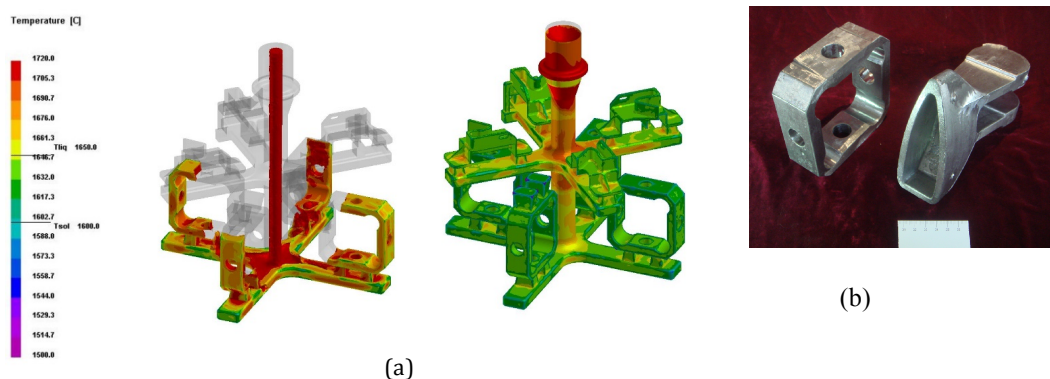


Figure 3 (a) showing modelling of filling and (b) the actual castings produced of the gimbal and frame connector after cleaning up the castings.

### **Expected results; impact and wider implications of project.**

The future work in all areas is focussed on improving the dimensional accuracy of the components and in a few cases improving the mechanical properties so that they meet specifications. When the final processing details are selected the processors will define the cost of each process route. The aim is to produce the final demonstrator components by month 33 so that the end users can assess them and report on them at the final meeting scheduled for March 2019.

If these aims are achieved the end-users will benefit and similar work should be carried out on other components so that industry is more cost-effective and causes less waste and pollution.

**Web-site addresses** EU, <http://www.birmingham.ac.uk/generic/emusic/index.aspx>

China, <http://ic.biam.ac.cn/>