AMRC
ADVANCED MANUFACTURING RESEARCH CENTRE

The University Of Sheffield.

Advanced Structural Testing Centre
Case Study

Advanced Structural Testing Centre completes historic airworthiness test

A bid to give Britain the capability to carry out full airworthiness tests on light aircraft after a break of 30 years has been completed successfully at the AMRC.

Top tier aerospace companies in the UK still can and do carry out the tests, but testing has become focused on their own aircraft and the capability for testing light aircraft made by independent designers has disappeared over the years.

That has all changed now that the AMRC's Advanced Structural Testing Centre (ASTC) has successfully completed tests on the Game Bird 1 (GB1), a two-seater aircraft developed by Lincolnshire-based Game Composites and designed to carry out complex manoeuvres in aerobatic competitions or simply be flown for fun.

Although GB1 has been designed and built in the UK, it looked as though Game would have to take the aircraft to the Czech Republic for full airworthiness testing until ASTC chief Phil Spiers became aware of the project.

“When I heard about the plans to design and build an aerobatic aircraft within 60 miles of the AMRC, I was determined that we should keep testing, as well as the production process, inside Britain,” says Spiers.

“We believe no one has carried out an airworthiness test on a light aircraft in the UK for 30 years, but we knew we had the skills and experience in abundance to help Game get its aircraft approved as quickly as possible.

“The whole experience has helped us grow tremendously as a test team and it is something we have all really enjoyed. It wasn’t hugely expensive, we learnt a lot and I think Game learnt a lot about what is involved in testing and the tremendous confidence it can give you in what an aircraft can do.

“It also demonstrates that we can test large, complex structures and meet the standards required by European certification agencies.”

Engineers at the ASTC designed a bespoke test rig to apply forces up to 10 times those exerted by gravity, simulating the forces the aircraft will have to cope with as it carries out high speed manoeuvres.

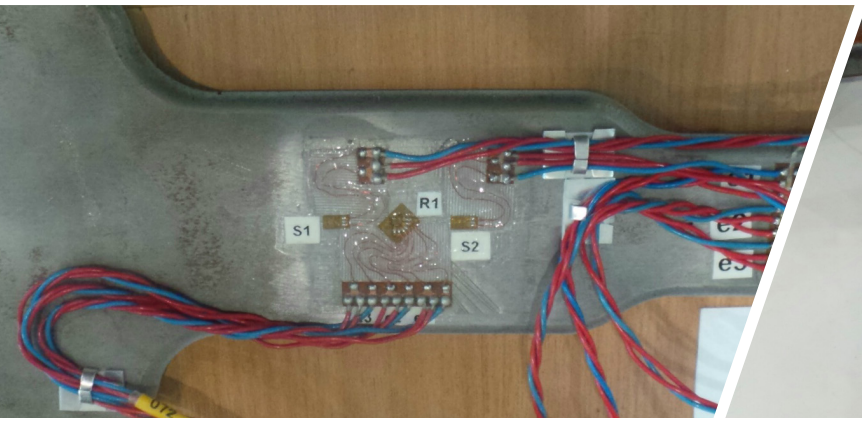
They made some of the parts of the rig, while other components were made elsewhere within the University of Sheffield Advanced Manufacturing Research Centre (AMRC).

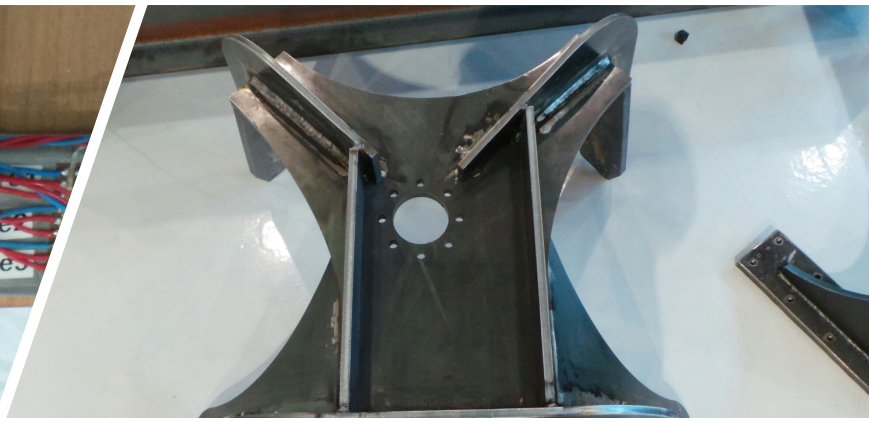
The ASTC called on the skills of welding specialists from the Nuclear AMRC and the abilities of the AMRC’s own apprentices to construct a complete “whiffletree,” which distributes test forces over the aircraft’s fuselage and wings, causing them to twist and flex as they are designed to do in flight.

Mounting the plane on the whiffletree was a big challenge in itself. The fuselage, with wings fitted, had to be lifted four metres into the air and then flipped upside down.

Engineers had to position mounting points on the ASTC’s 10 metre square ‘Strong Floor’ to within 1 millimetre, manufacture complicated loading brackets to similar accuracy and attach strain gauges precisely at 17 locations on the plane’s surface.

“If we were a few millimetres out, it would make a big difference to where the loads go, which is why we have had to create quite a complicated load fixture,” says Spiers.





The challenges didn't end there. The ASTC has also had to devise a way of heating the whole of the aircraft to 70°C while some of the tests were carried out.

The idea is to exceed the maximum temperature the airplane is likely to be subjected to – usually when it is on the tarmac in a hot country, rather than when it is flying.

Insulating the rig required the help of SIG Technical Insulation and MacGregor & Moir, subsidiaries of Sheffield-based leading European supplier of specialist building products SIG.

SIG's technical specialists suggested using an in-house laminate insulation board, more normally used to prevent heat escaping from metal ducts that are at the heart of heating and ventilation systems in commercial buildings.

"We always try to use local suppliers, wherever possible and SIG's response more than justified our choice," says Spiers.

"The laminate insulation board was the perfect solution and the level of service SIG provided was among the best I have ever seen."

Part of the testing regime involved deliberately damaging the airframe and seeing if the damage got worse under strain.

"When traditional metal airframes get a crack it becomes very apparent, but, with carbon composite you can get what is known as BVID – Barely Visible Impact Damage - damage in the carbon fibre lay up that is impossible to detect," adds Spiers.

Even with some definitely visible damage, the airframe continued to soak up the pressure and testing went so well that there was time to do a second life test – a further 72,000 cycles at room and high temperatures and even higher loads of up to 15g.

GB1 passed the second set of tests under the watchful eye of the European Aviation Safety Agency, giving it a working life of 30 years.

The experienced gained during the first life test resulted in improvements to the rig, which meant the second life test went very smoothly.

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Processing the data recorded during the two life tests – enough to fill around 1,600 Excel spread sheets.

"By that time we really understood the rig and how it worked so we could be confident about running it overnight with no one there, It took about four weeks to do," says Spiers.

The challenges didn't end there, however. Producing the final report involved processing the data recorded during the two life tests – enough to fill around 1,600 Excel spread sheets.

Having passed all the airworthiness tests, all that remains is for Game Composites to carry out a drop test, but orders are already coming in for the aircraft – including an order for a number of aircraft placed by one nation's aerobatic competition team.

The Game Bird 1 (GB1) has been designed by former German National Freestyle Aerobatic Champion and aircraft designer Philipp Steinbach and is built by Lincolnshire-based Game Composites.

It is intended to be the world's most fun to fly two-seater aircraft, weighs only 575 kg and can cruise at more than 200 knots.

GB1 has a range of 1,000 Nautical Miles on 320 litres of fuel or can carry 95 litres for aerobatics.

The aircraft is designed to be used for unlimited aerobatics, training for all levels, as well as upset recovery training, flying cross country and for pure fun. It has a front and rear seat arrangement which is intended to expand the potential market beyond hardcore aerobatic competition pilots.

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