BBMF fighter pilots Flt Lt Giles Croft (left) and Sqn Ldr Mark 'Disco' Discombe discuss proceedings whilst Sqn Ldr Mark Long flies the Spitfire Flying Training Device "simulator" in the BBMF hangar, with Hurricane LF363 beyond. (Photo: BBMF)

BBMF's virtual Spitfire

The BBMF's newest 'Spitfire' is proving itself not only as a PR and STEM device, but now also as a Spitfire emergencies trainer for pilots.

PR and STEM

Public engagement is a key element of the mission of the BBMF and at many airshows the Flight's PR Team is on hand, chatting to supporters and explaining more about the BBMF, its historic aircraft and what they represent.

The BBMF embraces new technologies to enhance its engagement with the public, in order to share a deeper experience and understanding of its historic aircraft. An example of this is the 360-degree Lancaster experience available at the BBMF's PR stand at air shows with a virtual reality (VR) headset.

This has been so well received that the BBMF decided to create something far more ambitious, in the form of a fully immersive Spitfire simulation experience based on the Flight's own Spitfire Mk IX MK356. This would not only be enjoyed by the public at air shows, but also had great potential for inspiring young people with Science, Technology, Engineering and Mathematics (STEM) careers, something which, as a highly technical service, is at the heart of the RAF's ethos.

Simulator cockpit

The VR simulator software for Spitfires already exists as an add-on for the popular Microsoft Flight Simulator program, but it was clear that a physical cockpit would enhance the overall experience. This was a task which was taken up by BBMF technician Corporal Rich 'Boycey' Boyce and other members of the BBMF Engineering Team.

A small business specialising in replica Spitfire cockpits was found in the North of England, and by April 2022 the BBMF's collection of Spitfires had an additional 'cockpit'. The Spitfire cockpit shell came with some crude controls, which arguably would have been fit for purpose given the intended users of the simulator and the fact that its 'pilots' would be wearing a VR headset. However, the dedicated engineers of the BBMF are not known for making compromises when it comes to authenticity and there was a strong consensus that a more authentic set of controls was needed. With original spares being expensive and rare, the problem was how the team could source them without completely blowing the budget.

> "The BBMF embraces new technologies to enhance its engagement with the public"

An AuthentiKit 3D-printed Spitfire "Chassis" undercarriage lever alongside the real thing in one of the BBMF's Spitfire cockpits. (Photo: BBMF)

Ever resourceful, Boycey immersed himself in the various online communities of flight simulation to find out what others were doing. He discovered a group which was building almost complete sets of Spitfire cockpit controls at home, using 3D printed parts, and he tracked this back to a non-profit project called AuthentiKit.

AuthentiKit

AuthentiKit has a mission to design replica flight simulation controls that can be made on a cheap domestic 3D printer and assembled at home without engineering skills. The primary focus of AuthentiKit at that time was the Spitfire Mk IX and the designs were being shared freely online.

Boycey reached out to Phil Hulme, founder of AuthentiKit. It was agreed that AuthentiKit should become an official sponsor of the BBMF, enabling Phil to join the simulator team, donating his time and resources to helping the BBMF.

All parties were especially keen that the cockpit controls should be exact replicas, with correct placement in relation to the pilot's seat and functioning as a Spitfire pilot would expect. An intense daily dialogue was struck up over the next few months discussing matters such as materials strengths and trim wheel calibrations. The aim was to recreate a Spitfire cockpit experience that was as close as possible to MK356.

There was a huge amount to achieve to ensure the cockpit was equipped with a set of controls and ready for public use, despite a particularly busy 2022 display season. To compound matters the team had two deadlines looming. Firstly, it was decided to launch the BBMF Spitfire Experience to the public on 1st October 2022 at the BBMF Members' Day. Secondly, within a week of that day, Boycey would be leaving the BBMF to move on to his next posting.

Members' Day 2022

The challenge was taken up eagerly by the team. And, with much midnight oil burned, the project came together as planned. Whilst externally similar to the cockpit that had landed in April, on the inside it was a complete transformation with a great many fully functional controls for the virtual pilot.

The public response at the BBMF Members' Day was universally positive. Visitors of all ages queued to take part in this rare opportunity to experience a flight in a Spitfire. Throughout the day Boycey, assisted by Corporals Dan Cunningham and Ken Dowling of the BBMF engineering team, were kept busy teaching members of the public how to fly a Spitfire!

This first outing for the Spitfire simulator was a success on many levels. In addition to giving members of the public an almost visceral experience of flying a Spitfire, the team had set up displays to explain some of the engineering behind the project. The most popular was the 3D printing display, where visitors could watch the BBMF's 3D printer manufacturing a Spitfire rudder trim bias, layer by layer, before their very eyes.

All in all, it was a fine accomplishment and a tremendous legacy for Corporal Boyce to leave behind as he moved on to his next post. He readily acknowledged that the progress made would not have been possible without the expert knowledge and equipment supplied by Phil Hulme and AuthentiKit, as well as the hard work and dedication of the whole team."

Some of the team in the BBMF hangar during development work on the Spitfire simulator. Cpl Ken Dowling is on the left. (Photo: BBMF)

Project X

With Boycey posted there was no loss of continuity as Corporal Ken Dowling took over the responsibility of support and development, and the simulator soon took on another educational role. In November 2022 the BBMF took the virtual Spitfire to RAF Waddington for the finale of Project X 2022, a STEM event for Lincolnshire Schools. Students from six schools took part and the simulator was integrated into the activities that took place during the final event.

Pilot training

By the end of 2022 the Spitfire simulator had proved itself as a PR and STEM educational tool, but now it was suggested that it could go a step further and support BBMF fighter pilot training.

RAF simulators with high levels of realism and fidelity are built by recognised defence industry companies with large budgets, adhering to a plethora of detailed regulations. It is for this reason that the BBMF's Spitfire cockpit trainer will never be known officially as a "simulator".

However, by the end of 2022 many of the Flight's new and experienced Spitfire pilots had tried the VR cockpit and given very favourable feedback. Inevitably, there were requests for improvements and changes, which the team felt were all achievable.

Former BBMF fighter pilot and OC BBMF for the 2019-2021 display seasons, Squadron Leader Mark 'Disco' Discombe, rejoined the Flight as a volunteer fighter pilot for the 2023 season to fill a gap and bring his seven years of BBMF flying experience to the team. Disco quickly recognised the potential to simulate emergencies, such as engine failures and forced landings during a display sequence, which are impossible to set up for real in the air. A Spitfire with an engine failure has a rate of descent of around 2,600 feet per minute, meaning that the available

BBMF Spitfire Mk IX MK356 is the basis for the virtual simulator. This is MK356's actual cockpit. (Photo: Andy March)

The cockpit of the virtual Spitfire simulator. Some additional items have been fitted since this photo. (Photo: Clive Rowley)

Students at the Project X STEM event at RAF Waddington enjoying the Spitfire simulator. (Photo: BBMF)

BBMF fighter pilot Sqn Ldr Mark 'Disco' Discombe flying the Spitfire virtual reality "Flying Training Device". Disco has been instrumental in developing the "simulator" as a BBMF fighter pilot emergencies training device. (Photo: BBMF)

time to complete drills and make the correct decisions is minimal and, in most cases during a display, the aircraft will be back on the ground, one way or another, in about 40 seconds.

A fresh set of requirements was rapidly drawn up with everyone mindful of a new deadline, the BBMF fighter pilot pre-season ground training day on Friday 14th April. This would be a key training event for the 2023 season fighter pilots when they would, for the first time, be able to practise serious emergency procedures, "flying" them in the newly named "Spitfire Flying Training Device" (FTD).

"The BBMF Spitfire FTD has instantly proven its worth"

The extra complexity this time was that the simulation software needed modifying as well as the controls and physical configuration. Fortunately, Phil from AuthentiKit was able to provide a crucial contribution again through his good relationship with the owners of Flying Iron Simulations (FIS), the Spitfire Mk IX software developers. This required an iterative development process over several weeks, testing and retesting versions of the software. The Spitfire software was soon updated with much improved ground handling and performance characteristics, as well as new features which the BBMF pilots would need for displays such as an accelerometer.

The BBMF fighter pilots found the training session engaging and educational, as they took turns to trigger failures on each other during various points of their low-level displays. As Disco explained: "The BBMF Spitfire FTD has instantly proven its worth. Being able to 'fly' a low-level display and react to an emergency in real time is fantastic training. It has allowed the pilots to better understand the time they have, related to the aircraft's energy state, to conduct a successful forced landing. It also reinforces the training that you may not always make it back to the runway. Making the safe decision to land on the grass or in a field next to a runway, instead of crashing on it, has been proven to be extremely hard. The first emergency I was given led to me having to do this, and the subsequent play back and pilot debriefs showed it was the correct option at that time. Following a real warbird crash near Duxford the pilot, who had previously used a simulator at Goodwood, told everyone at the following Warbird Safety Symposium that he partly attributed the simulator training he had received to the successful outcome of his forced landing. I hope the training conducted in the BBMF Spitfire FTD will never be needed for real, but if one of us finds ourselves in trouble we'll now have the best training possible."

Sharing the fun

The BBMF was more than happy to allow FIS to use the new Spitfire Mk IX performance model in their public software as a thank you for their support. So another key beneficiary of the work carried out at the BBMF was the community of people who use flight simulators at home. They can be assured that the latest Spitfire Mk IX add-on for Microsoft Flight Simulator flies almost exactly like BBMF's MK356.

The BBMF Virtual Spitfire Team

The BBMF's current 'custodian' of the Spitfire simulator project, Corporal Ken Dowling, says: "Being involved with the development of the Spitfire Mk IX "simulator" has been an amazing experience, none of which could have been achieved without Flying Iron Simulations, the ground crew and aircrew at BBMF, and the dedication and hard work from Phil Hulme. Wherever we take the simulator, its reception is overwhelming and gathers so much interest. Maybe in the future we could think about a Lancaster simulator."

BBMF's newest 'Spitfire'

The BBMF's newest 'Spitfire' has proven itself not only as a PR device, but also as a STEM training device and as a pilot emergencies trainer. More roles are being considered too, such as helping to train BBMF engineers in ground running procedures.

Words: Clive Rowley with thanks to Phil Hulme and the BBMF Virtual Spitfire Team