A sense of realism

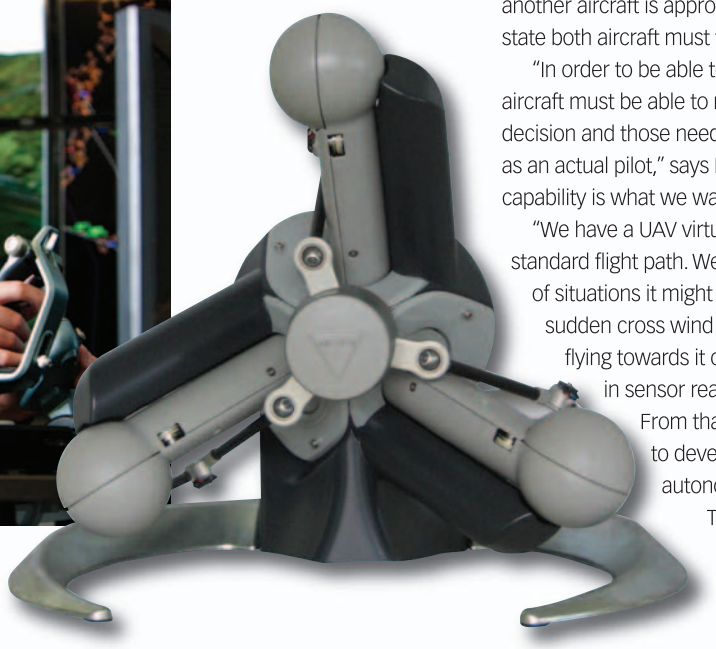
The virtual world is being increasingly exploited for engineering advantage. Justin Cunningham travels to the Virtual Engineering Centre to see how it is being deployed.

Virtual engineering is becoming an increasing part of the design process. Engineers are spending more and more time in the virtual world, which is becoming ever more complex and realistic.

A recent visit to the Virtual Engineering Centre (VEC) shows just how far things have come, but more interesting is just how useful it's proving for UK industry. The centre was established by the University of Liverpool, along with project partners, BAE Systems, Morson Projects, STFC and NWAA. It is part funded by the European Regional Development Fund (ERDF) and the Northwest Development Agency (NWDA) and is based at the Science and Technology Facilities Council (STFC) Daresbury Laboratory in Cheshire. It supports both SME's and larger organisations to maximise the benefits of adopting virtual prototyping and immersive visualisation technologies and supports its implementation into organisations across the whole product life cycle.

One of the most unique things about the centre is its virtual engineering simulation laboratory, which focuses a lot on autonomous operation of unmanned aircraft and developing the systems needed to make them a reality.

"The idea is that manufacturers can bring along, for example, their sensor technology and find out how they might work in real life applications," says the Virtual Engineering Centre executive director, Tony Robotham. "At the moment we have dynamic models of the UAV but to add realism we put in things like lags, filters and noise and see how a sensor might behave."



To demonstrate that certification of a UAV is possible the group have developed a realistic computer model. Firstly, the environment is modelled. In this case, it is the UK with topography, the same airspace as well as physical environmental properties such as wind, rain and humidity. The second thing is an aircraft that is modelled to fly and behave like the actual aircraft would. Its specific flight properties such stall angle, lift to drag ratio's, and weight all play a part in the aircrafts relative performance and control.

These two models are then integrated with avionics that includes a suite of sensors and also the artificial intelligence to allow it to function autonomously. One of the biggest challenges is getting the aircraft to comply with 'the rules of the air'. For example, when an aircraft is simulated flying in civil airspace along a flight corridor and another aircraft is approaching, the rules of the air state both aircraft must turn to the right.

"In order to be able to fly in civilian airspace the aircraft must be able to make an autonomous decision and those need to be the same decisions as an actual pilot," says Dr Robotham. "So that capability is what we want to demonstrate.

"We have a UAV virtually flying along a standard flight path. We can simulation a variety of situations it might face. For example a sudden cross wind or have another aircraft flying towards it or put noise and distortion in sensor readings to see how it reacts. From that we can work with SMEs to develop the sensors and autonomous capability."

This virtual environment

that tests aircraft and the corresponding flight systems are modular. This enables different aircraft and flight characteristics to be tested, with different sensors and software, in any combination, to see what the performance is, and critically, if flight certification can be met.

At present it is up to manufacturers to provide models of their sensors, failure modes, performance with signal to noise ratios and performance with external g-force and vibration. However, the VEC is looking at ways of putting hardware in to the virtual system and actually stimulate it so the sensor is taking a real reading. This could be done in combination with a device that induces typical flight vibration and shock loads in to the sensor to see how it responds.

"We want to develop these virtual test beds so we can use it in the conceptual phase and to run thousands of 'what if' scenarios," says Robotham. "For example, we could see what happens when the aircraft flies faster and therefore ask the question would the sensor need twice the range if the aircraft is going twice the speed?

"The point is what might be a valid robust solution for one aircraft might not translate into another environment. We want to be able to use this analysis in the conceptualisation of new sensors so you can specify the requirement and that is going to drive future specification."

Virtual Reality

The VEC is also very much about using virtual reality to offer an 'immersive experience' to those that use its facilities. Perhaps the centre piece for all of this is its 6.0m x 2.1m active wall which allows visualisation on a 1:1 scale with things as large as Bentley cars and even aircraft wing spars. The entire system was supplied and installed earlier this year by Cheshire based Virtalis.

The active stereo projection system is synchronised to 3D glasses to give depth perception to the models which offer engineers a very realistic perspective of what it is they are trying to create. Bentley Motors sent the VEC the CAD data for one of their cars and a physical mock up of its seat and a steering wheel. By tracking the position of seat, steering wheel and the 3D glasses the virtual and real worlds can be integerated so that the onscreen image moves with the movements of the user's head. Additionally the index finger is tracked. The result is that by sitting in the chair, engineers can very accurately project where the dashboard dials should be, the sunroof controls, and radio controls.

"The designers wanted to be able to rest their hand on the gearstick and be able to touch the centre console button," says Robotham. "This allows them to exactly design that in, and visually see it was achieved, before it was ever built.

"When you sit in the seat you get a sense of looking across the car, the size of the cabin inside, the wing mirrors; we have found that engineering decisions and interpretation are greatly aided through advanced visualisation. Bentley has even used it to tune the intensity of the LEDs in the dashboard and have used that data to actually drive the LEDs they've ordered."

To further aid the immersive experience, the VEC is using haptic devices to interact with CAD models. Its desktop mounted device by Haption, the Virtuose 6D Desktop, uses three articulated branches attached in parallel to a cylindrical handle to provide six degrees of freedom, all with force-feedback. The device is in a separate laboratory and is used to check component clashes and also for other manual tasks.

"What we found was that the small desk mountable device was easier to use in a desktop setting with a head mounted display," says Robotham. "The tasks it is used for need to be close up with very fine controlled movements. We are getting cyber gloves which are wireless gloves to allow control and interaction of the virtual hand models on the large active wall."

The VEC's link to the Daresbury Science and Innovation Campus allows it access to high performance computer power. That means that it can perform 1000's of simulations. But critically it also gives them the means to display, visualise, and explore the findings. The result is a virtual world where possibilities can be measured and tested, ideas developed, and concepts forged.

The power of modern virtual simulation might one day completely do away with physical testing. But for the meantime advanced simulation and immersive virtual reality means that more ideas can be explored early in the conceptualisation phase so that when manufacture does come round the product will be right first time. One thing is for sure, virtual engineering is here to stay and will continue to become more realistic and play an increasing role in helping engineers innovate.

www.virtualengineeringcentre.com
www.virtalis.com
www.haption.com