MORPHEUS

Project Partners: Oxsensis, Parker Aerospace

Project details:

MORPHEUS set out to develop novel optical sensors for monitoring aircraft fuel system equipment by the measurement of fuel pressure and/or flow, pump shaft speed and continuous valve position indication. Non-electrical sensors have the dual benefits of Electro-Magnetic Interference (EMI) immunity in an increasing electrically actuated environment and being intrinsically safe.

The project was a collaboration between Oxsensis Ltd and Parker Hannifin Manufacturing Ltd, with Oxsensis providing the optical system concept, design and manufacture and Parker providing the aerospace standard system definition, validation, and future route to market.

At the outset, the project planned to identify and verify optical sensor solutions for aircraft fuel delivery pump systems in particular. It did this and then focused on progressing a lead sensor application (pump pressure indication) to a sufficiently mature point that it can now be considered for bid onto aircraft programmes, both for new build and for drop-in replacement or retrofit into existing aircraft programmes. This project also represents an early product opportunity for airframe customers to allow all participants to build their experience of optical sensor systems.

"The MORPHEUS project additionally helped Oxsensis to build its profile in the Aerospace sector and, alongside its other product development work (some including ATI programmes) to position itself appropriately within the supply chain" Ian Macafee, Chief Executive Officer, Oxsensis Ltd.

Table 1: Summary of the project grant details

Project	Funding	Lead Partner	No. of Partners	Partner Composition	Duration
MORPHEUS 101797	Total: £2.26m Grant: £1.22m	Oxsensis Ltd	2	1 Large company, 1 SME	Jul 2014-Jun 2018

Table 2: Summary of the project focus areas

ATI Value Streams		ATI Enablers		ATI Attributes		Strategic Horizon	
Whole Aircraft		Aerodynamics		Safety	X	Secure	X
Structures		Manufacturing	X	Cost	X	Exploit	X
Propulsion		Materials	X	Environment		Position	
Systems	X	Infrastructure		Fuel Burn			
		Process and Tools	X	Operational Needs	X		
				Passenger Experience			

Technology Achievements:

The MORPHEUS project has successfully demonstrated the application of optical sensors for the measurement of Valve position, Fuel Pump pressure and Fuel Pump shaft speed. By focusing MORPHEUS after initial customer feedback, the project has also delivered TRL4/5 pump pressure indication equipment which is now ready to be bid into flight applications. Discussions are now in progress with an airframe OEM to allow fuel system rig test of MORPHEUS pressure switches to evaluate performance and reliability.

The MORPHEUS pressure switch technology presents numerous benefits to the aircraft operator and manufacturer over the current technology. By increasing the reliability of the fuel pump monitoring, the technology can reduce instances of erroneous fuel pump failure events, the resulting interruption to the aircraft operation, and the maintenance operations to rectify the issue. Having been designed as a drop-in replacement for the existing technology, with no change to aircraft configuration, the pressure switch is able to address existing issues on today's aircraft fleet.

For future platforms, whether these are incremental developments of existing aircraft designs (e.g. for increased range or gross operating weight) or are all-new designs, adoption of the technology can potentially reduce aircraft weight and build cost through the elimination of specialist pipe work and fittings which are no longer required. Such benefits are highly desirable across the industry, as production rates ever increase to fulfil higher demand from the market for new airframes. The MORPHEUS product is expected to reduce fuel system and wing assembly costs, by simplification of installation.

Finally, the MORPHEUS technology opens the door for wider adoption of optical sensor technologies on the airframe. The use of photonics and fibre optic technologies allows sensors to be installed in challenging environments throughout the aircraft, in explosive atmospheres such as fuel tanks where existing electrical sensors must be carefully designed and managed to eliminate explosion risks. This matches growing airframe customer interest in optical instrumentation in wing and engine applications.

Oxsensis has developed AS9100D manufacturing infrastructure in its new facility near Harwell, in the UK to deliver its Aerospace and Power generation optical instrumentation products.

Table 3: Summary of the technology achievements

Project	Performance Improvements	TRL Progression
MORPHEUS 101797	Optical system demonstrated in a relevant environment	Fuel Pump Pressure Sensor TRL2 to TRL5
	Optical sensor demonstrated in a laboratory environment	Fuel Pump Shaft Speed Sensor TRL2 to TRL4
	Optical sensor demonstrated in a laboratory environment	Valve Position Sensor TRL2 to TRL4

Economic Impact:

The value of this, if product programmes are achieved, could be based on 500-1,000 ship sets of instrumentation per annum, representing several $m pa, and over 25 years this could be a $50m - $100m opportunity based on potential volumes on new civil large platform applications. MORPHEUS is part of Oxsensis expected manufacturing loading and through the project to date it has created at least one job and is part of protecting the overall 25 strong Oxsensis workforce. It also advances the optical system agenda and makes subsequent sensor introduction easier.

Oxsensis 30 strong workforce is currently growing and as part of a portfolio of opportunities, this supports the growth of the business – it is complementary to our aero engine and fuel gauging activity. Manufacturing volume for MORPEHUS will add to early production volume, within the AS9100D quality management system environment, and extends through Oxsensis to include our supply chain. In short this is good experience for the direction of development travel of Oxsensis.

Spill over effects include building Oxsensis credibility in other supply chains e.g. to land-based gas turbines for power generation, as the company starts to deliver more product into the demanding Aerospace environment. We also intend to exploit the sensor technology in process industries, to lower the burden of safety and to learn how to partner effectively. Communication of the programme progress will be undertaken via dissemination events.

For new aircraft designs, this technology offers the opportunity to reduce installation weight and removes a key element of unreliability – the pressure feed line to a formerly remote mounted sensor. This improves initial aircraft level competitiveness and helps with through life reliability/availability measures – operational interrupt reduction, no-fault-found.

Table 4: Summary of the economic impact

Project	Value created	Employment
MORPHEUS 101797	Market opportunity could be worth up $50m - $100m over 25 years	Jobs created: 1 Safeguarded: 25

Next Steps:

Next steps include customer rig testing of MORPHEUS systems during the second half of 2018, and active business development to identify bid opportunities. We will look out for drop-in replacement, retrofit as well as incremental development and all new aircraft programme opportunities and we will disseminate MORPEHUS progress appropriately throughout the rest of the programme.

Exploitation will commence with our partner Parker Aerospace identifying bid opportunities and then we will arrange to bid accordingly. Where we need local service or distribution, our business partner Parker can usually assist

Future projects are being assessed and a number of relevant and viable alternatives are being worked on, building a programme team to suit the application; the theme continues to be the development and then exploitation of advanced harsh environment optical instrumentation in flight applications. MORPHEUS is being commercially developed in parallel with several flight products, with the intention of building a securing a portfolio of programmes within this sector. The MORPHEUS technology has 'industrial mirror' potential applications in hazardous environments such as process, and petrochemical industries. Oxsensis intends to exploit these in parallel with the Aerospace applications.