

Powering the More-Electric Aircraft – LAMPS

Project details:

The LAMPS project (Lightweight, Affordable Motor and Power-electronic Systems) addresses a critical part of the move to More-Electric Aircraft (MEA), creating a new generation of power electronics and motors for aircraft applications. Working together as a project team, UTC Aerospace Systems, UTC Research Centre – Ireland, Raytheon UK, Aerostanrew and International Capacitors Wrexham are developing innovative approaches to motors and drives.

This £2.7M, 2-year duration project is critical to the MEA and has delivered concepts that will lead to substantial reductions in size, weight and cost. Achieving these reductions is vital due to the increasing numbers of motors and drives required on a future MEA.

LAMPS was intended to develop ideas for these Motors and power Electronics through to TRL 2-3 in anticipation of a follow-on project to mature these innovations through to TRL 5/6.

In the medium term, it seems likely that rather than 5-10 of these key Motor and Drive Systems on an aircraft, there could be many more, perhaps as many as 50 to 100 such motors and drives. This number is heavily dependent upon air-framer architecture choices but the work under LAMPS and SMPP will be an enabler to the wider adoption of these technologies.

Table 1: Summary of the project grant details

Project	Funding	Lead Partner	No. of Partners	Partner Composition	Duration
LAMPS	Total: £2.7m Grant: £1.35m	UTC Aerospace Systems	5	3 Large companies, 2 SMEs	June 2014 Aug 2016

Table 2: Summary of the project focus areas

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

Technology Achievements:

Progress has been made across a range of technologies and tools / processes under the LAMPS project. In particular in the areas of:

- Model based design tools for motor drive systems, motor design, power component optimisation.
- Evaluation of novel motor designs at low TRL for their impact on the key project deliverables of cost, size, weight and scalability to address non-recurring costs. Innovation has taken place in both electromagnetic design and also in packaging concepts. This work has created a solid foundation for future technology maturation leading to substantial improvements in all these parameters. These motor designs are now assessed to be at TRL 4 and create the promise of >50% reduction in cost along with significant reductions in size and weight for a given performance. Two patents have been applied for relating to these technologies
- Development of a new generation of motor drive technologies aimed at low cost, size and weight, along with lower NRCs. The project has evaluated technologies expected to yield >50% cost reduction and >60% weight and volume reductions:
 - Silicon Carbide (SiC) switching modules including an advanced SiC module with integrated gate drive provided by Raytheon as part of their role in this project.
 - Power components suitable for an SiC-based controller including capacitors provided by International Capacitors Wrexham along with developing a roadmap for future improvements
 - Novel packaging / thermal / EMC management technologies including use of composites and thermally tailored unit construction
 - Evaluation of options to work with a range of aircraft power systems to ensure these MDEs will have applicability across a wide range of aircraft categories
 - Development and proving of DSPACE as a tool to accelerate the development lifecycle



Table 3: Summary of the technology achievements

Project	Performance Improvements	TRL Progression
LAMPS	Cost reduction of >50% Weight and size reduced by >60% for MDEs	Motor and Drive technologies to TRL 4

Economic Impact:

The LAMPS project was conceived as a low-TRL incubator for new technologies needed to make step changes in cost, size and weight for motors and drives. The objective was to mature these technologies to TRL 6 under the recently awarded SMPP project (Scalable, Multi-Platform Power).

Knowledge gained during LAMPS created the business case for SMPP and the associated economic benefits to the UK economy, securing high quality engineering work here in the UK for UTC and its partners. UTAS has demonstrated with its internal customers that the proposed LAMPS / SMPP technologies should be at or maybe slightly better than our estimate of future market pricing – and substantially lower than today’s pricing. On this basis, UTAS appears to be competitively positioned to exploit these technologies.

The economic impact of LAMPS falls into three main areas:

- Inward investment by non-UK parent companies into the SMPP follow-on project and subsequent product development programmes
- Securing and growing employment and skills through the SMPP project and subsequent commercialisation of the LAMPS technologies
- The development of a capable, validated vertically integrated UK supply chain for the key components of these motors and motor-drive products which is capable of exploiting their component technologies both for UTAS and other customers.

Looking at each of these in turn:

Inward Investment. The immediate impact of LAMPS is to initiate the follow-on project, SMPP, pulling inward investment totalling >>£10M from the SMPP consortium parent companies. These investments are being made with the expectation of future product sales where investment will be substantially higher. The exact level of investment will be driven by air-framer decisions on the risk of adopting these technologies. The work under LAMPS and SMPP will act to de-risk the implementation and increases the win probability.

Employment and Skills. LAMPS has provided the opportunity for the development of skills essential to the More Electric Aircraft. This is an emerging market where experience to date has been limited to a small number of aircraft platforms and the LAMPS technologies can be considered the second, substantive iteration of the technology base with associated learnings and up—skilling at all levels of the LAMPS consortium. There is the potential for a ten-fold increase in production. More importantly, each new application creates opportunity for highly skilled design engineering and manufacturing engineering roles that will grow the UK systems and electronics skill base.

Supply Chain. The LAMPS project has brought together UTAS as a Tier-1 supplier and second tier UK suppliers who each have brought distinctive technologies to achieve the TRL developments under LAMPS. These contributions have supported the overall motor and drive improvements described above and position each of the suppliers to be a trusted and capable source for the power components needed for the next generation of motors and drives. Further, these suppliers have identified further opportunities to exploit these technologies beyond the UTAS / More-Electric market.

In particular:

- Raytheon
 - Bi-directional power conversion systems
 - Hi-power solid state power distribution systems
- Aero Stanrew:
 - Modular power supply for aircraft radar systems
 - High pressure fuel pumping for jet engines
 - Rotor actuation in helicopters
 - Landing gear in business jets

Next Steps:

UTAS will continue development of the LAMPS technologies from their current TRL 4, through to TRL6 under the SMPP (Scaleable Multi-Platform Power) project which will position UTAS to supply motors and power electronics across a wide range of applications including electric flight controls, pumping, and air handling systems.

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