Institution:
University of Central Lancashire

Unit of Assessment:
UOA 15 General Engineering

a. Context

Research in General Engineering at University of Central Lancashire (UCLan) resides in the School of Computing, Engineering and Physical Sciences and is presented under two themes: Digital Engineering, comprising Applied Digital Signal and Image Processing (ADSIP) and Advanced Digital Manufacturing Technology (ADMT), and Mechanical Engineering, comprising the Jost Institute for Tribotechnology (JIfT) and Energy

Research in General Engineering at UCLan delivers impact through a range of mechanisms including: improvements in the understanding of fundamental processes, developments in product performance, increased efficiency, production and exploitation of patents, dissemination of knowledge through publication, training of research students who then go on to industry. A range of non-academic user groups benefit from these impacts as described below.

Research in **Digital Engineering** focusses on bridging the gap between technology and application. The main users of **ADMT** research are manufacturing companies, particularly aerospace primes and their supply chains, and the beneficiaries include world leading technology providers. The applied research on aerospace non-destructive evaluation (NDE) has not only improved manufacturing competitiveness by reducing inspection time and costs, but also benefited aircraft safety by increasing defect detectability and assessment reliability. The technologies developed for aerospace NDE have now been extended to the submarine sector, and form the basis of the world's first Tele-immersive Digital Manufacturing (TiM) facility as a distinctive factory of the future in partnership with world-leading manufacturers and digital technology providers. In the health sector, **ADSIP** research has provided a new set of tools to clinicians and demonstrated significant benefits to arthritis, cancer and stroke patients; improving the efficacy of assessment and monitoring of conditions and treatments. Finally, users of **ADSIP** research in radiation effects and instrumentation include aerospace companies managing effects of cosmic radiation on avionics, radiation effects facilities (especially STFC in development of the ISIS neutron source), and NASA in solar observation.
In **Mechanical Engineering** the majority of funding for research in the **JIfT** comes from industrial sources and generally supports research to investigate product behaviour, optimise performance, or gain knowledge to inform approaches to component design. The main direct beneficiaries are the sponsoring companies, many of which are able to engage in product development as a result of the knowledge gained. Examples of such collaborations include: Goodrich Engine Control Systems/Rolls Royce Goodrich Control Systems Ltd. and AVL Technology (Austria). UCLan also holds patents developed by **JIfT** who work closely with the UCLan Knowledge Transfer Unit to seek opportunities for patent exploitation. **Energy** research is also industrially focussed providing innovative solutions to energy management challenges. In addition, KTPs within the area of energy management have been delivered for Tellereal Trillium and the Eric Wright Group. Staff working in wind-energy research are currently the recipients of an industry-focussed ERDF grant to support SMEs to develop an additional income stream in energy generation, enhance energy security in remote locations, and generate new products. Research on behalf of the nuclear industry has led to the development of a new vortex amplifier (VXA) and has in turn influenced medical practice. Modelling of sutured and coupled micro-vascular anastomoses has employed techniques first developed in VXA research and has influenced practice in surgical techniques at Royal Preston Hospital.

b. Approach to impact

In **Digital Engineering**, the impact approach for **ADMT** has been to exploit the geographical proximity to manufacturing primes and technology providers through development of the world's first TiM facility to demonstrate the factory of the future, with the former providing application scenarios and the latter providing the state-of-the-art hardware/software infrastructure. Further

impact on SMEs continues through ERDF funded projects in partnership with public and private sector organisations.

For **ADSIP** research in health, the approach to impact is through cross-disciplinary collaboration with clinicians to pioneer new techniques for quantitative medical diagnosis for individualised treatment of major diseases. The European network led by **ADSIP** has generated a flow of knowledge, people and data among the 24 participating academic and clinical institutions in Europe and influenced the research direction of future oncology in Europe. Close collaborations with neurologists and rheumatologists have led to two clinical trials with exciting results. One pioneers the use of dynamic 3D optical scans of facial articulation for quantitative assessment of stroke via measurement of changes in facial symmetry and weakness; the other has successfully discovered the biomarker related to joint degeneration based on acoustic emission profiles from joint movement. In radiation effects and instrumentation, the approach to impact is through close links with world-leading facilities and international collaborators. Work in radiation effects has influenced design optimisation of future avionics systems, international standards, and the development of neutron test facilities. Collaboration with NASA has led to the highest ever resolution images of the solar corona (reported in Nature and leading to improved understanding of solar dynamics, with implications for understanding of space weather).

Several mechanisms have been used to support and enable impact. At the university level, the Innovation and Enterprise team provides assistance in IP management and exploitation (including a patent application for a novel neutron spectrometer, with IPR subsequently transferred to STFC under a revenue sharing agreement), commercially funded research and consultancy (including innovation vouchers to support SMEs), and engagement with stakeholders (including specialist appointment of an Advanced Manufacturing Champion). Funding and release from teaching for research staff has supported networking and committee activities to widen impact. Examples include: participation in the Lancashire Manufacturing Strategy Group to maintain the world class manufacturing sector in Lancashire, the North West Autonomous Systems Programme Steering Committee to establish the North West as the centre of excellence in unmanned aerial vehicles (UAVs); the BINDT Aerospace Executive Committee to influence future NDE, the IET Vision and Imaging Network Executive Committee for public engagement in image processing technology; IEC Technical Committee 107 (developing international standards for Process Management for Avionics) and international conference programme/organising committees.

In **Mechanical Engineering**, most **JIfT** projects are industrially funded and focus on problems within commercial systems/components, often aiming to achieve functional improvements. A restricted level of output from these projects is normally published while specific results of the work are used for commercial product development by the company. An example of this is a project in association with Goodrich Engine Control Systems/Rolls Royce Goodrich Engine Control Systems Limited. A range of environmentally-friendly component coatings with the potential to reduce environmental contamination in the life cycle and improve product performance were studied. This work was commercially sensitive, but parts were published and the company is now working towards incorporating one of these materials into aircraft components. In other cases, where exploitable IP is realised and owned by UCLan, the innovation and Enterprise team has assisted in protecting IP through patents and in finding organisations to exploit that knowledge. This is illustrated by patents that have been developed and granted for an active lubrication control system. We are currently developing a demonstration system for cylinder lubrication in large marine engines and seeking industrial partners to develop and commercialise this invention. In other cases useful discoveries are placed directly into the public domain by publication, training courses and other processes to bring general awareness. The best example of this is a major discovery leading to the development of guidelines to prevent “self-loosening” of bolts. **JIfT** is working with Bolt Science Ltd. who distribute this knowledge through training courses.

In **Energy** research, pump priming funding has been acquired from industry and the University. Research contracts from BAE Systems have supported programmes of immediate interest to the company. These include efficient energy use in the context of UAV operation and building use, leading to intelligent UAV simulators and building management systems for industrial use at the Samlesbury manufacturing site. Our strategy has been to deploy technologies developed with BAE Systems into other sectors. The first example is a project with United Utilities addressing intelligent

data handling. Internal funding has supported research in topics related to the nuclear industry connected with plant operation. Detailed studies have been made to improve the operation of vortex amplifiers (VXAs), enabling new geometry to be identified and installed on commercial sites.

c. Strategy and plans

The success of research in General Engineering has led to further future investment by the University to establish an Engineering Innovation Centre (EIC) to extend the reach and significance of the impact. In **Digital Engineering**, the main plan for **ADMT** is to extend its research collaboration with manufacturing primes to manufacturing SMEs by utilising the wide relationships that were established via the DigitME project funded by ERDF. The main plan for **ADSIP** is to extend its research collaboration with leading hospitals to Primary Care clinics via NIHR (National Institute of Health Research), and to extend the European network globally. The strategy for radiation effects and instrumentation is to leverage our existing international collaborations, especially with STFC ISIS and NASA, commercialising radiation instrumentation and developing solutions to protect advanced technology systems against cosmic radiation and space weather.

In **Mechanical Engineering, JIfT** plans to maintain research on the current spread of engineering applications involving: space tribology, automotive tribology, bio-tribology the application of hard coatings (eg in manufacturing processes). The main new strategic thrust will be directed towards developing research in active tribology (tribotronics) involving partnerships with European academics and global suppliers to develop demonstration projects for this new area which will also reinforce the ambitions of the EIC at UCLan.

Our **Energy** research will develop via knowledge exchange with industrial partners and income generation through the commercialization of research and technology. We plan to exploit IP rights, filed patents and consultancy contracts. On low carbon technologies and resource efficiency, we aim to be a primary contact with industrial partners in the North West of England and around the campuses associated with UCLan overseas. This will build upon the existing strategic partnerships UCLan has with Atkins, BAE Systems and National Nuclear Laboratory to engage companies such as Cuadrilla Resources. Finally, appointments of part-time staff with an industrial background have been made to broaden the research base associated with nuclear energy. This provides a mixture of professional and academic expertise in this area which is intended to support an expansion of research in Nuclear Regulation and Policy to supplement engineering based research.

d. Relationship to case studies

A case study is selected from each research theme. In **Digital Engineering** the case study highlights not only the impacts achieved based on the impact approaches, but also the impacts achieved by cross-fertilisation of ideas, exchange of results, and integration of approaches between two different sectors. In **Mechanical Engineering** the case study arises from research conducted into threaded fasteners (i.e. nuts and bolts). A relatively simple engineering component with almost ubiquitous presence in engineering applications. It demonstrates how improved fundamental understanding has contributed to significant enhancements in safety and performance across a number of engineering sectors.