Institution: University of Northampton

Unit of Assessment: 12 - Aeronautical, Mechanical, Chemical and Manufacturing Engineering

a. Context The Unit's research activities involve staff working in a multi-disciplinary research group with strengths in dynamics, vibration and control, with particular applications in vertical transportation systems; intelligent systems and neural networks; materials and corrosion engineering, non-destructive testing, leather and biomaterials science. As far as impact is involved this research engages two specialist user groups: the Lift (Elevator) Industry and the Leather Industry. The Unit holds a unique position relative to those industries worldwide, offering a complete suite of research and postgraduate programmes in Lift Engineering (LE) and Leather Technology (LT) which are closely linked to the needs of the Lift Industry and the Leather Industry, respectively. These programmes attract and engage key users and facilitate the Unit-user interactions. The impact relevant to the UoA12 research in the Unit involves: **(1)** informing the industry research and development (R&D) strategy and practice, e.g. through expert advice to the R&D senior management and technical staff; **(2)** improving the performance of companies, e.g. through assisting in the development of new technologies and providing training programmes informed by research for technical staff; **(3)** delivery of professional consulting services, e.g. new /improved lift engineering practices have been adopted by ThyssenKrupp Elevator (TKE) corporation, research into new generation leather technologies have informed current practices at Lanxess and Buckman.

b. Approach to impact

Interaction and engagement with users and beneficiaries. The Unit has adopted a strategy for engagement and interaction with non-academic users and potential beneficiaries through specialist postgraduate and research programmes. The members of staff have been active in extensive consulting activities and in delivering specialist research and postgraduate programmes (MSc and PhD/MPhil) in the area of LE and LT, working closely with the lift and leather industries. Those programmes are unique not only in the UK but also in Europe and worldwide, with staff engaged in cross-disciplinary research, consultancy and research-informed postgraduate training activities. The programmes receive strong support from leading national and international companies, from the UK Lift and Escalator Industry Association (LEIA) as well as from the BLC Leather Technology Centre and SATRA of UK. Engagement and interaction with non-academic users have involved a broad range of activities, including preparing technical articles for the general, commercial lift and leather readership and presenting the work at national (UK) and international conferences e.g. Germany, PR China, Spain, USA, attracting industrial practitioners and R&D technical staff from all over the world. The ICLT has also a strong relationship with the whole of the leather supply chain of UK, regularly interacting, both formally and informally, with the leather and fashion industries, when the benefits of creative and forward technical thinking are passed on.

The Unit staff delivers the MSc LE postgraduate course which involves the study of the advanced principles and philosophy underlying LE, and aims to provide a detailed study of engineering and related management issues, together with a higher-level qualification for persons employed in lift making companies and allied industries. The majority of students enrolled on the MSc programme are employed within the industry and sponsored by their companies. Furthermore, the Unit's research programme has provided an opportunity for the MSc graduates to continue their studies towards higher research degrees (PhD/MPhil). The MSc and research degree programmes in the area of LE have been attracting the attention of senior management and technical staff from within the industry. For example, ThyssenKrupp Elevator (TKE) AG, a leading international passenger vertical transportation company, has adopted a range of the MSc-covered subjects for the company's R&D Accelerated Engineering Training (ACCENT) programme for their R&D technical and management staff. At national level, the Unit engages with the UK Lift Industry through consulting activities and research projects carried out within the Knowledge Transfer Partnership (KTP) scheme. Furthermore, senior technical and management staff have used the opportunity to study on the PhD/MPhil programmes.

Similarly, the MSc LT is the only one of its kind in the world providing cutting-edge leather technology training and postgraduate education in the theory and practice addressing the needs of the leather industry. Large proportions of students on the MSc LT are employed and/or are sponsored by, the leather industry. Furthermore, tailor-made courses with distance learning content are available to individual companies by negotiation, to suit their specific requirements in

developing young technologists and R&D staff. Those research-informed postgraduate courses have provided an excellent platform for interaction with key beneficiaries to develop impact from the research carried out in the Unit.

In order to develop relationships with non-academic users and to facilitate interactions with beneficiaries the Unit's staff have also organised seminar and conference events that attract mixed audiences of academics and practitioners from the fields of LE and LT. Leather staff have participated and contributed to conferences organized by other technical institutes, such as the Forschungsinstitut für Leder und Kunstoffbahnen (FILK) of Freiberg Germany (2008, 2012), the International Union of leather Technologists and Chemists Societies (IULTCS, the technical arm of the global leather industry) in Beijing (2009) and Valencia (2011) and the UK Society of Leather Technologists and Chemists (2008-12). The *Symposium on Lift and Escalator Technologies* initiated by Prof. Kaczmarczyk is an annual event organized jointly with the Chartered Institution of Building Services Engineers (CIBSE) Lifts Group with keynote addresses delivered by renowned national and international industry experts. This event series brings together experts from the field of Vertical Transportation (VT) and offers an opportunity for the Unit staff to engage with the industrial practitioners. Another international conference series, which has been instigated by Prof. Kaczmarczyk and organized jointly with the Institute of Physics (IoP) Applied Mechanics Group, entitled *Mechanics of Slender Structures,* has attracted regional, national and international recognition. This bi-annual event series has been supported by a number of professional associations, including LEIA, IMechE and ASME, disseminating cutting-edge inter-disciplinary research to non-academic audiences from within LE and allied industries.

Further engagement involves writing for leading national and international LE trade journals such as *Elevation* (UK), *Elevatori* (Italy), *Elevator World* (USA) and *Asansor Dunyasi* (Turkey). For LT the Unit's staff members have been contributing to *World Leather* and *Leather International* magazines. Prof. Covington's book (*Tanning Chemistry*. *The Science of Leather,* 2009) and Prof. Kaczmarczyk's book (*System Engineering of Elevators,* 2011) generated strong interest in the leather technology and lift engineering communities, respectively.

Follow through and identifying impact. A record of evidence of follow-through from the above engagement activities has been kept by the Unit's team with an extensive data base of potential beneficiaries. This record involves senior management and technical staff from the two areas. Detailed feedback and testimonials from established partners (TKE AG, Lanxess and Buckman) and potential new beneficiaries are used to identify resulting impact. At specialist conferences/ meetings organised and attended by the Unit staff (see above) members seek opportunities to receive and to record feedback from non-academic delegates. The Unit has established and maintains annual meetings with the LE programme graduates who are employed in leading manufacturing and consulting companies in the UK and worldwide. The meetings provide detailed feedback on impact made by the LE research programme. Furthermore, Prof. Kaczmarczyk regularly attends R&D events that are organised by TKE AG R&D department, the Unit's key beneficiary in the area of LE, at their centres worldwide. The meetings, involving the TKE R&D senior management, offer unique opportunities to assess and to record research impact as well as to gather data. All data gathered are then analysed and acted upon to inform research plans and developments to maximize research impact in the future.

Support to achieve impact. The Unit staff have been supported and encouraged to develop research activities that led to impact. The Department of Engineering and Technology (DoET) developed research strategy with emphasis on commercial research and consulting projects involving industrial partners. The strategy involved attracting projects supported by Technology Strategy Board (TSB) such as Knowledge Transfer Partnerships (KTP). A series of meetings with the regional KTP Adviser to provide guidance for staff have been arranged in support of these activities. The Unit secured £7,300 from the University's REF Investment Fund specifically to support impact activities. This funding was used by Dr Bennecer and Prof. Picton to develop specialist facilities in the area of Non-Destructive Testing (NDT) to carry out projects involving the British Institute of Non-Destructive Testing (BINDT) to facilitate interactions with non-academics.

c. Strategy and plans

Strategy. The strategy for achieving impact forms an integral part of the overall research strategy which has been described in the Unit's Environmental template (REF5) and is aligned with the University's "Raising the Bar" strategy. This involves working closely with industrial partners, both national and international, who have been identified as beneficiaries and key users. The main

strategic points have been as follows:
(1) To create and sustain an active research environment so that the Unit is able to engage with potential users and beneficiaries in Research and Knowledge Transfer projects. For example, the applied research activities in both strategic areas (LE, LT) require specialist equipment and tools. Funding has been sought from internal and external sources to upgrade the existing equipment in the laboratories at the DoET and in the Institute for Creative Leather Technologies (ICLT). In the case of LE, the Unit was able to use the National Lift Tower facilities for research projects that require full-scale testing equipment needed for commercial research involving industrial partners.
(2) To raise awareness of research activities and to disseminate research results through organizing specialist conference events involving industrial practitioners and partners. In the case of LE this has been achieved through the *Symposium on Lift and Escalator Technologies* series initiated by Kaczmarczyk jointly with the Chartered Institution of Building Services Engineers (CIBSE) Lifts Group. The University's Marketing Department has provided support to disseminate information about the events and the Unit with the CIBSE co-organizers developed a dedicated website for the conference series (http://www.liftsymposium.org/).
(3) To participate and contribute to conference meetings and trade exhibitions organized by other technical institutes/ associations. The Unit staff from ICLT participated in a number of specialist LT events (see previous section) and the LE group participated in an international lift trade fair in London (LIFTEX, May 2013), organized by the UK's leading lift trade association - the Lift and Escalator Industry Association (LEIA).
(4) To form strategic partnerships with key beneficiaries in the current specialised areas (LE and LT). Following this strategy the School of Science and Technology and TKE have agreed to establish a strategic partnership for cooperation in research and innovation. This has extended the existing relationship between both institutions and will form a platform for developing long-term R&D plans.
(5) To support regional and national businesses wanting to improve their competitiveness, productivity and performance by offering the knowledge and expertise available within the framework of opportunities available through Technology Strategy Board (TSB) such as Knowledge Transfer Partnerships (KTP). During the census period the Unit staff, involved both in LE (Kaczmarczyk, Su) and LT (Covington, Antunes), have been successful in negotiations with the UK based partners to run future KTP projects.
Plans. Future plans are to sustain the impact activities carried out so far and to develop new routes to impact. The examples are demonstrated by the following main points:
- To sustain the existing strategic partnerships (such as ThyssenKrupp Elevator AG) and to attract / seek new partners by offering commercial research and consulting services in new fields such as Structural Health Monitoring (SHM) and NDT. In the new fields, the BINDT has been engaged to facilitate interactions with users and beneficiaries.
- To develop further a network of visiting industrial practitioners within the University's Visiting Fellow / Professor (VF/VP) scheme and/ or Visiting Researcher (VR) scheme at the School level. During the census period Prof. M Redwood was recruited as honorary VP to support the international activities of ICLT and Drs R Smith and R Peters as honorary VFs to support the LE group. A more extensive network is needed to generate sustainable impact.

d. Relationship to case studies

The two case studies submitted by the Unit represent the selected specialised areas and have largely arisen out of the approaches described above. For example, both MSc programmes (MSc LE and MSc LT) were instrumental in the development of strong interactions with the beneficiaries.

The case study concerning the dynamics of Long Slender Continua (LSC) in VT installations has its origins in the long-standing relationship between the University and the Lift Industry through partnership with LEIA. This has led to the research / consultancy programme and the formation of the Partnership for Research and Innovation with a leading international elevator company (TKE AG).

The case study concerning the development of the 'link-lock' theory of tanning exemplifies the outcome of the ICLT's unique programme that has attracted users from within the Leather Industry. The consultancy activities with two international companies, Lanxess of Germany and Buckman of USA have had also contributed to the 'link-lock' research and the case study.