**Institution: University of Northampton**

**Unit of assessment: UoA 12 - Aeronautical, Mechanical, Chemical and Manufacturing Engineering**

## a. Overview

The submission covers research that has been conducted in the Department of Engineering and Technology (DoET) and in the Institute for Creative Leather Technologies (ICLT), with both sub-units belonging to the School of Science and Technology. This interdisciplinary research programme integrates a diverse range of topics falling within the scope of UoA12.

Research in the DoET is focused in the area of modelling, simulation, prediction, testing and monitoring of the performance of engineering systems, structures and materials. This involves staff working in a multi-disciplinary research group with strengths in dynamics, vibration and control, with particular applications in vertical transportation systems/ lift engineering; intelligent systems and neural networks; materials and corrosion engineering and non-destructive testing.

On the other hand, in the ICLT, a research centre unique not only in UK but in Europe and worldwide, staff are engaged in cross-disciplinary research in biochemical engineering / leather, environmental impact of leather manufacture and biomaterials science. This involves investigations into the fundamental mechanisms underpinning the manufacture of leather and associated biomaterials, aiming to take leather to extremes of thinness, lightness and grip, as well as fire, cut and impact resistance for high-added-value applications. The outcome is an understanding of protein stabilization, which is leading to a new generation of process chemicals from the industry.

## b. Research strategy

The strategic aim has been to create and sustain an active research environment so that staff members are able to engage in research activities of international quality at the highest possible level, with national and international research partnerships being the top priority. This approach is consistent with the overall research strategy adopted by the DoET, and in many aspects follows the strategy applied during the RAE 2008 assessment period.

**2008-2013 Strategy**. For the RAE 2008 the main research was carried out within the Centre for Research on Leather and Materials Science (CROLMS) and the submission made involved UoA29 (Metallurgy and Materials). In this submission, which achieved an overall rating of 1.65 including 55% at $2^*$ and $3^*$, the focus was on applied collagen biomaterials research alongside interdisciplinary research on surface modification/ coating of materials and analysis of the efficacy of such modification/coating in providing protection. Furthermore, the submission covered interdisciplinary research in the area of lift (elevator) engineering, and in particular, work concerning the dynamic characteristics and behaviour of slender structures such as heavy duty ropes and cables deployed in deep mine hoist technology and used in vertical transportation systems in buildings and civil structures.

Since 2008 the Unit has been fully committed to creating a dynamic research environment and to producing research excellence with a powerful impact. During this period the Unit has enjoyed significant expansion in research infrastructure and activities, aligned with the University's "Raising the Bar" strategy. This progress has been demonstrated as follows:

- The main strategy has been to create and sustain an active research environment so that all Unit staff members are able to engage in research activities at the highest possible level based on qualifications and research experience in their respective areas of expertise.
- During the census period the Unit vigorously sought support for their activities and all opportunities created within the University were used to facilitate research activities and to enhance the research infrastructure and environment. For example, the Unit won £21,500 from the University REF Investment Fund to support the staff activities that have contributed to Outputs, Environment and Impact.
- Staffing strategy in the School has closely followed and has been linked to the Unit's research strategy and its physical infrastructure. This has involved strategic appointments of new research active staff in the area of non-destructive testing (NDT) and funds to support a Research Associate (RA) in the area of dynamics and vibration (D&V) engineering. For example, Dr S Mirhadizadeh was appointed as RA in 2011 and this appointment facilitated a significant development of research activities linked to the D&V research programme, including

attracting new projects and forging new collaboration links. Furthermore, Dr A Bennecer and Dr A T Perez were appointed to the posts of Senior Lecturer in 2012 which led to the development of research activities in the area of NDT and automatic control, respectively.

- Strategic key thematic directions were to support areas with distinct links to industry and involved the field of applied dynamics and engineering vibration, with particular applications in Lift Technology, and collagen biomaterials research in the area of Leather Technology.
- Within the above key themes international collaborations have been strongly encouraged and supported. For example, in the area of Lift Technology the Unit facilitated a Strategic Partnership for Cooperation in Research and Innovation with ThyssenKrupp Elevator (TKE) AG, a leading international passenger transportation company. The partnership created a platform for the Unit and TKE AG to expand long-term joint research and development projects.

**2013 Onwards**. In the broader context of the University strategies, the Unit's strategic research objectives for 2013 onwards have been identified as follows:

- To build interdisciplinary research in the area of modelling, simulation, testing and prediction of behaviour of mechanical systems. This will involve the School's 3D modelling and simulation centre (NVision) with its unique Virtual Reality and Immersive Technology facilities.
- To develop research into monitoring and testing of engineering systems and structures. The exisiting facilities include a well equipped vibration testing and monitoring laboratory. Further development and upgrades of this laboratory are envisiged. A new state of the art non-distructive testing (NDT) laboratory will be created to facilitate postgraduate research training and projects in this area.
- Following on from the development of Link-Lock theory of collagen stabilisation to create new theoretical models of the mechanisms of tanning, to translate the understanding into new processes and reagents.
- To enhance and develop national and international research collaboration partnerships in the areas of the Unit expertise.
- To pursue bids to the European and UK research funding platforms, such as FP7, EPSRC and The Technology Strategy Board (TSB), in order to build a strong portofolio of national and international projects.
- To continue to seek opportunities to work with key national and international industrial partners and to exploit research outputs through industrial partnership agreements, Knowledge Transfer Partnerships, spin off companies, and the licensing of patented technology.

The above objectives have been pursued in the context of maintaining and expansion of high quality applied research activities in a number of specialist areas. In particular, these include collagen biomaterials research alongside leather research, research in the area of lift (elevator) engineering (LE) and non-destructive testing (NDT).

**c. People, including:**

**i. Staffing strategy and staff development**

The staff members engaged in research in the area of UoA12 represent a broad spectrum of expertise. Staff members work closely together on research activities, sharing laboratory facilities, attending seminars, co-supervising research students.

**Staff appointments**. For new staff appointments a proven research record is a pre-requisite. A strategy to prioritise research when promoting the existing staff / replacing staff that leave the Department has been implemented. During the census period three younger staff members have been appointed (Dr A Bennecer, Dr V Kappatos and Dr A Torres Perez) to develop research activities in the area of NDT and the strategically key promotion of S Kaczmarczyk to Professor in Applied Mechanics has been made in order to facilitate research, knowledge transfer and consultancy activities in the area of dynamics, vibration and vertical transportation engineering. Furthermore, funding has been made available by the School to recruit a Research Associate (RA). A full-time RA has subsequently been appointed. He has recently been promoted to Senior Lecturer.

In ICLT, Paula Antunes has been promoted to Associate Professor (AP), one of ten new APs in the university to be given this new title and responsibility. She is mentored by Tony Covington, Emeritus Professor of Leather Science. This promotion was made within the framework of the

Associate Professorship Development Scheme (APDS) launched by the University. The purpose of the APDS is to provide a supported development pathway for academic staff to gain a full professorial role. Dr Antunes has been instrumental in building international partnerships within the ICLT and has carried out internationally leading research in the area of leather / bio-material technology. In 2010, Professor Covington was awarded the degree Doctor of Science (DSc) by the University of Northampton for a portfolio entitled 'Studies in Leather Science'.

Each new staff members/ early career researcher (ECR) have a mentor and their objectives are agreed following the University's Personal Development and Review (PDR) process. Good care is taken to ensure that during the first year of appointment the teaching and administration loads are reduced for young staff to allow them to establish themselves in the new environment and to promote their research development.

Training is provided to all research staff with the University's Graduate School acting as an institutional-wide hub that works to provide academic leadership and administrative support in the pursuit of graduate education and researcher development. The Graduate School works closely with Schools and external organizations to ensure that researchers at all stages are supported in their academic and personal development. The Research Staff Network (RSN) has been put into place prompted by the Graduate School's launch of the Concordat to Support the Career Development of Researchers in July 2009. The RSN is aimed not only at ECRs but at all contract researchers and any staff interested in research. The RSN programme offers a mixture of formal and informal sessions throughout the year with peer led learning sessions, networking opportunities and research expertise sharing.

**Visiting Professors/ Fellows**. International collaborations have been actively encouraged and a number of international staff appointments have been made during the census period, including Visiting Fellows (VF) and Visiting Professors (VP). In order to promote international collaborations and new research activities in the area of NDT Prof. W Ostachowicz of the Polish Academy of Sciences, an expert in Structural Health and Condition Monitoring of high international standing, was appointed VP (2012). Dr R Peters of Peters Research Ltd, UK, whose expertise is in elevator traffic design and analysis, was appointed VF (2011) to facilitate PhD projects in this field and to contribute to the research programme in the area of Lift Engineering). This was followed by the appointment of Dr R Smith of ThyssenKrupp Elevator AG, as VF (2012). This appointment provided a much needed direct link with the lift industry to ssupport PhD students who enrolled on the research degree programme funded by the company. Dr A So of the Asian Institute of Built Environment (AIBE), Hong Kong was appointed VP (2012) in order to facilitate the international research collaboration programme with China and Hong Kong and this has led to the signing of a Memorandum of Understanding between the AIBE and the University. Prof. M Redwood was recruited as VP in 2012 to support the international activities of ICLT and foster relationships with industry along the leather supply chain. The VFs / VPs have actively participated in the research programmes carried out during the census period by acting as co-supervisors of PhD students, delivering research seminars and contributing to research proposals.

**International Visitors.** The Unit's international collaboration strategy has involved international visitors. During the census period a number of short-term and longer-term visits took place. Prof. S. Adali of the School of Mechanical Engineering, University of KwaZulu-Natal, South Africa, visited the Unit three times (2010, 2011 and 2013) and presented a seminar series on the optimal design of composite structures. Prof. **J. M. Balthazar of** Departamento de Estatística, Matemática Aplicada e Computação, Universidade Estadual Paulista (UNESP), Brazil, visit (2012) involved a joint workshop on dynamics, vibrations and control which led to the signing of MoU between the University and UNESP in 2013. Prof. R. Basagoiti, of Department of Engineering, University of Mondragon, Spain was on sabbatical leave in Northampton (2012) to carry out collaborative research in the area of optimization and analysis of lift traffic dispatching algorithms. Prof. S. Croll of Department of Coatings and Polymeric Materials, North Dakota State University, USA, paid a short visit (2013) to discuss collaborative research in the area of protective coating. Prof. I. Herrera Navarro of the University of Extremadura, Spain, was on a six month sabbatical leave in 2010 funded by the Spanish Ministry of Education to work in the area of elevator design. Dr A. Miszczyk of Department of Chemical Engineering, The Technical University of Gdansk, Poland, (2011, 2012, and 2013) visited the Unit to present seminars on his research in the area of electrochemical techniques for the examining of coatings. Prof. Y. Terumichi of Department of Mechanical

Engineering, Sophia University in Tokyo, Japan visited the DoET (2008, 2010) to carry out collaborative work in vibration problems in lift engineering.

**ii. Research students**

Over the census period the team has supported 16 PhD research students, and 8 research students have completed their PhDs since 2008. Investment in interdisciplinary research in a number of specialist areas, plus support from industrial partners, has resulted in an improved research environment for postgraduate research students. New software tools and hardware equipment to conduct research in Lift Technology and NDT have been obtained for PhD projects, including a non-contact laser system and new data acquisition modules for vibration measurement and analysis. Using the opportunities provided by the University's REF investment fund the Unit actively sought support for their activities producing research excellence with a powerful impact. Part of the investment has been dedicated to funding PhD studentships and over the census period the institution has been funding PhD studentships linked directly to the REF that have required matched funding from an industrial partner. Under this scheme the Unit secured support from industrial partners and has applied for and won £28,000 to support two PhD students.

All research students undertake a comprehensive training programme to assist them in the successful completion of their research and to prepare them for professional careers as engineers or academics. Generic research training is run by the Graduate School and covers induction to the institution's procedures and to the process of research; generic skills associated with research. Throughout the academic year the Graduate School also offers a programme of practical workshops organised by a full-time Research Training Coordinator and delivered by internal and external academics. At the discipline/project level training activities have been carried out and coordinated within the Unit. These include attending training workshops and sessions as well as participating in specialist seminars and conferences. The Unit has established a practice that more advanced PhD students present their research findings at international conferences. They are also encouraged to publish papers in peer-review high-impact journals.

Postgraduate students are expected, and are encouraged, to contribute to the research environment. The Unit's seminar programme involves invited visiting/ external speakers and PhD students have an opportunity to present their own research and to interacting with visitors. Specialist events that are run by the Unit include the annual *Symposium on Lift and Escalator Technologies*. Research students whose research projects are in the specialist area of Lift Technology actively contribute to the organization and to the programme of this successful series. The Unit also provides opportunities for PhD students to undertake undergraduate teaching duties such as running laboratory demonstrations and conducting practical tutorial sessions. In order to be able to carry out these activities they receive specific training from their supervisory team and/ or from experienced academic staff from the Department.

**d. Income, infrastructure and facilities**

A total of £908,759 of external income was generated by staff during the current REF census period, from funding sources such as the UK central government, national and international industry, commerce and public corporations. A substantial part of this came from Knowledge Transfer Partnership (KTP) projects that supported the UK businesses wanting to improve their competitiveness, productivity and performance: AMH Ltd, *Using Thermo imaging as Part of the Maintenance Routine* (Picton); Arnott Conveyors Ltd, *The Development of Low Noise Vibratory Conveyor* (Kaczmarczyk). A number of grants have been obtained in support of research activities carried out at the ICLT from the UL Leather Industry (Antunes, Covington, Garwood, Guthrie-Strachan) as well as from international commercial partners such as ThyssenKrupp Elevator AG (Kaczmarczyk, commercial research projects in the area of Lift Technology).

Since 2008 significant internal investment (over £500,000; from external income sources as well as from the University capital investment fund) has been made in research facilities to enhance its laboratory and testing facilities necessary for conducting leading research within the areas falling under the remit of UoA12 disciplines.

The Unit involves two research groups: Advanced Technologies Research Group (ATRG) and the ICLT group. The overall research strategy with targets for income and outputs is determined by the School's Research and Enterprise Committee. Within this framework the Unit develops its own annual research and enterprise plan with the main strategy to create and sustain an active

research environment so that all staff members are able to engage in research and knowledge transfer activities at the highest possible level. Each staff member receives support to develop own research and enterprise objectives aligned with the University's Raising the Bar strategy. Within this strategy the Research and Strategic Bidding Office (RSBO) offers a full pre-bidding service for members of staff looking for or applying for research / enterprise funding. The Performance and Development Review (PDR) process is then used to monitor and support staff in achieving their objectives in their respective areas of expertise.

Both groups have at their disposal laboratory hardware and computational facilities necessary for conducting leading research in a number of key areas such as corrosion engineering, dynamics and vibration, lift technology, non-destructive testing and biomaterials. For example, the specialist hardware and software research tools include the B&K Pulse™ task oriented system for dynamic signal measurement, data acquisition and analysis with the latest technology transducers for force, acceleration, velocity, displacement, modal and acoustic analysis and measurements; LDS V406/PA500L and V721/PA1000L vibration test systems; TIRA TV51165-IN/BAA 1000 inertial shaker with $Laser_{USB}$ vibration control system; Polytec PDV-100 Portable Laser Vibrometer; the PMT EVA-625 and Henning LiftPC mobile diagnosis portable vibration analysers for lift ride quality measurement and analysis; ACM equipment: computer controlled electrochemical testing equipment provided for measurements of electrochemical Impedance spectroscopy(EIS), Electrochemical Noise (ENM) and polarisation resistance; potentiostat for controlling electrochemical experiments and DC electrometer for measuring the resistance of very high impedance coatings; High Performance Liquid Chromatography with quaternary pumps, autosampler, diode array detector; Gas Chromatography and inductively coupled plasma (ICP) with auto-samplers; a range of computer software including specialist tools such as ELEVATE™ elevator traffic simulation system; COMSOL Multiphysics FEM modelling and simulation software and ADAMS multibody dynamics modelling and simulation software. The resources of the National Lift Tower (NLT) are available to conduct full-scale experimental tests, research and development in the area of Lift Technology. The NLT is a unique facility, the only one of its kind in the U.K. and in Europe.

**e. Collaboration and contribution to the discipline or research base**

**National and international collaboration**s.

A substantial effort has been made to sustain, promote and develop national and international research collaboration with many staff being active members of research networks, involving academic and commercial partners as well as professional institutions.

Leather science and associated biomaterials. Dr Antunes has been involved in collaboration work with the Nanotechnology Centre for Innovation for Sensors at Rhodes University, South Africa; with the Department of Chemical Engineering, Faculty of Engineering and the Built Environment, University of Cape Town, South Africa; The Metropolitan Museum, New York, USA and Instituto Superior Técnico Torre Sul, Av. Rovisco Pais, Portugal. Prof. Covington has led ground breaking research into the mechanisms of crosslinking and tanning of collagen fibres and has been involved in research projects carried out in Brazil, USA, UAE and China. At the national staff in the ICLT have been involved both with academia and the UK industry in its widest aspects. For example offering advice on dish development to The Fat Duck of Bray (Covington), collaborative work with York University, Kingston University, Scottish Leather Group in Paisley, The British Museum London, ServiceMaster, Xeros Ltd. and the Leather Conservation Centre (Antunes).

Engineering systems and structures. Research activities have led to a number of collaborative links. Prof. Kaczmarczyk, through his involvement with the Institute of Physics Applied Mechanics Group Committee, created an international network in the area of mechanics of slender structures. The network has led to the development of a new conference series entitled Symposium on the *Mechanics of Slender Structures* (MoSS). This series has attracted regional, national and international recognition and collaboration between the parties involved. The event has been running under the auspices of the Institute of Physics and the American Society of Mechanical Engineers, supported by the Institution of Mechanical Engineers. During the census period four international MoSS events have been held: July 2008, Baltimore, USA; July 2010, San Sebastian, Spain; and January 2013, Harbin, China. Concurrently, extensive national and international collaborative links are being pursued in the area of passenger transport in buildings and lift engineering. This has resulted in national and international partnerships within the elevator and

escalator sector, with academic, professional and commercial partners involved. Prof. Kaczmarczyk and the Lift Engineering Research Group, collaborated with the Chartered Institution of Building Services Engineers (CIBSE) Lifts Group and developed another new conference series, the *Symposium on Lift and Escalator Technologies* (http://www.liftsymposium.org/), supported by the Institution of Engineering and Technology (IET) and the Lift and Escalator Industry Association (LEIA). The series brings together academic and industrial experts from within the field of vertical transportation engineering. During the census period two events were held at the University (the 1st Symposium, September 2011 and the 2nd Symposium, September 2012) with the third event (the 3nd Symposium) organized to take place in September 2013. Following these developments a number of important academic international links have been forged, including partners in Brazil (Prof. J. Balthazar, Universidade Estadual Paulista; UNESP), China (Prof. D. Cao, Harbin Institute of Technology), Germany (Prof. R. Iwankiewicz, Technical University of Hamburg), Japan (Prof. Y. Terumichi, Sophia University, Tokyo), Poland (Prof. W. Ostachowicz, Institute of Fluid-Flow Machinery in the Polish Academy of Sciences, Gdansk), Spain (Drs J. Abete/ X. Arrasate, University of Mondragon; Prof. I Herrera, University of Extremadura) and USA (Prof. W. Zhu, University of Maryland Baltimore County). Furthermore, research in the area of dynamics and vibration of elevator systems has resulted in the *Partnership for Research and Innovation* agreement with TKE AG, a leading international company in passenger transportation in buildings (2012). This agreement has facilitated collaborative research work in the area of lift technology and related scientific disciplines. It has spearheaded a broad range of forms of cooperation including sponsorship of postgraduate (Doctorate/ Masters) studentships, sponsorship of research chairs and honorary posts and secondments, contracted research and consultancy projects.

Engineering materials. Dr Mills has developed international collaboration links with the University of Delft (Prof. A. Mol) and with North Dakota State University in Fargo, North Dakota, USA (Profs S. Kroll and V. Gellings). A very strong link has been established is with the Technical University of Gdansk, Poland (Dr A. Miszczyk), with which the University has an Erasmus exchange agreement. Dr Bennecer has been involved in collaboration with Prof T-H Gan and A Chong from Brunel University. Dr Su has collaborated with City University, London, and Cranfield University.

Collaboration and engagement with industry users. The research activities have informed the interaction with the Unit's industrial partners through consulting activities and KTP projects. Dr Bennecer initiated a number of industrial links in his capacity as a consultant with Diana Quintero from Bourbon Automotive Plastics and Cummins UK. Prof. Covington acted as a consultant for the international leather industry with contracts in USA, Denmark, China, Pakistan, India and Russia; Prof. Kaczmarczyk has been involved in a number consulting contracts with TKE AG at their international project sites (Brazil, Canada, China, Germany, UAE, USA) and KTP as well as consulting projects with UK partners (Arnott Conveyor Ltd., ACE Lifts); Dr Mills has facilitated industrial cooperation with leading UK companies, including Midland Corrosion Services and Pronto Paints; Prof. Picton has worked on a number of collaborative projects with the UK industry (AMH Ltd, Knights of Old).

**Contribution to the discipline**. During the REF census period the Unit staff carried out activities that contributed to the wider discipline of UoA12. They have produced publications including books/ book chapters and journal articles and have given conference and seminar presentations. They have delivered invited lectures and have been invited to sit on the Organizing / Scientific / Technical Committees of a number of major international conferences and meetings.

Book Publications. In 2009 The Royal Society of Chemistry published Prof. Covington's book *Tanning Chemistry*. *The Science of Leather*: This is the first book in the subject for sixteen years, for which the author was given the Alsop Award, established in 1939, for 'outstanding scientific contribution to the leather industry' by the American Leather Chemists Association. In 2009, Prof. Covington was given the Merit Award for Excellence in the Leather Industry by the International Union of Leather Technologists and Chemists Societies (IULTCS), only the second time this 'leather Nobel prize' was given. In 2011, Prof. Kaczmarczyk's book *Systems Engineering of Elevators* was published by Elevator World, Mobile, USA. It is the first book ever published on the subject of systems engineering in the area of lift technology.

Membership of Organizing/ Scientific/ Technical Committees. The Unit Staff have been invited to chair technical sessions/ mini-symposia and to sit on the Organizing / Scientific / Technical Committees of a number of major international conferences and meetings including: Mini-

Symposium on Vibration Problems in Vertical Transportation Systems at 11th Biennial International Conference on Vibration Problems, Instituto Superior Técnico of the Technical University of Lisbon, Portugal (Kaczmarczyk, 2013), International Conference on Structural Nano Composites, Cranfield University, UK (Su, 2012) 9th International Conference on Damage Assessment of Structures, University of Oxford, UK (Kaczmarczyk, 2011); 18th International Congress on Sound and Vibration, Rio de Janeiro, Brazil (Kaczmarczyk, Picton, 2011); IULTCS Congress, Valencia, Spain (Covington, 2011); 7th BSSM International Conference on Advances in Experimental Mechanics, University of Liverpool, U.K. (Kaczmarczyk, 2010); 7th International Conference on Modern Practice in Stress and Vibration Analysis, University of Cambridge, UK (Kaczmarczyk, 2009); 8th International Conference on Damage Assessment of Structures, Beijing, China (Kaczmarczyk, 2009), IULTCS Congress, Beijing, PR China (Covington, 2009); EuroCorr Conference, Edinburgh, UK (Mills, 2008). Staff presented a number of invited/ keynote lectures at the UK and international venues: the Procter Memorial Lecture. Annual Conference of the Society of Leather Technologists and Chemists of the UK (Covington, 2011); the John Arthur Memorial Lecture, Annual Conference of the American Leather Chemists Society (Covington, 2012, the first person to do so for the second time in the 52 years history of their most prestigious keynote presentation); Institute of Sound & Vibration Research, University of Southampton, UK (Kaczmarczyk, 2009); Joint Institute, Shanghai Jiao Tong University, Shanghai, China (Kaczmarczyk, 2012); the Australian Institute for NDT 50th Anniversary Conference (Picton, 2013), Department of Materials Engineering, Electrochemistry and Corrosion of the Technical University of Gdansk, Poland (Mills, 2010, 2011, 2012).

Advisory/ editorial boards. The Unit staff members have been invited to a number of advisory/ editorial boards, exemplars include: EPSRC Peer College (Picton, 2008-13); The **Appointment and Promotion Committee, University of Jordan (Kaczmarczyk, 2012)**; *Corrosion Engineering Science and Technology Journal* editorial board (Mills, 2008-13). The Unit researchers have also held leading positions in professional/ learned societies / institutions such as: Kaczmarczyk (Member of the Applied Mechanics Group Committee of the Institute of Physics); Mills (Technical Secretary to the Institute of Corrosion). Contribution to the discipline through organizing conference/ symposia: *Mini-Symposium on Vibration Problems in Vertical Transportation Systems*, Instituto Superior Técnico of the Technical University of Lisbon, Portugal (Kaczmarczyk, 2013), *Symposium on the Mechanics of Slender Structures* (Kaczmarczyk; 2008, 2010, 2013), *Symposium on Lift and Escalator Technologies* (Kaczmarczyk; 2011, 2012, 2013).