Institution: Coventry University

Unit of Assessment: 15

a. Overview

The Unit undertakes theoretical and experimental research which generates advanced engineering solutions to real-world problems. The Unit comprises three research groups and one lone researcher. These groups are:

1. Sensing, Safety and Control: Led by Professor **Gaura**. Members: **Blundell, Brusey**, **Burnham, Haas, Harris**, **Lin, Shelton-Rayner, Thake**. The group undertakes theoretical and applied research into control systems, real-world networked wireless sensors, simulation-based engineering design, and human factors research in automotive and aerospace safety. The group supervise 45 researchers and research students.

2. Manufacture, Materials, and Metrology: Led by Professor **Li**. Members: **Aleksandrova, Brusey, Cobley, Jamshidi**, **Overend.** The group researches materials science and metrology together with intelligent manufacturing, and integrated planning and scheduling for 3- to 5-axis manufacturing centres. The group supervises 13 researchers and research students.

3. Civil Engineering: Led by Professor **Gaterell**. Members: **Claisse, Ganjian**, **Karadelis**, **Liu, Montazami**. The group researches environmentally friendly, energy efficient construction materials and sustainable built environments. The group supervises 20 researchers and research students.

Dijkstra is a new addition to the Unit with a background in Genetic Engineering and Bio-sciences research. Dijkstra has advanced the understanding and measurement of the effects of microgravity.

b. Research strategy

i. Achievement of Strategic Aims since RAE 2008

We are returning 21 research-active staff including seven Professors. Their research maturity profile is: 29% Early Career Researchers, 47% mid-career researchers and 24% senior researchers. Eight of this Unit were submitted to other Units in RAE2008 (UoAs 23, 24, 28 and 29).

The Unit's combined research vision was to deliver advances and innovation at fundamental and application levels to enable real-world solutions to the following socio-technical challenges: i) the realisation of low carbon economies in automotive and civil engineering; ii) enhancing human safety in operational and harsh environments; iii) improving industrial competitiveness by advances in manufacturing practices, materials science, and metrology.

Since 2008, the Unit has seen £4.5M investment in research and support infrastructure, in addition to the £55M investment in a new 15,000m^2 new Engineering and Computing Building (see section d). It has won £9M in research income, including ca. £1M of donated assets from industry, from over 130 grants and contracts, and collaborated with more than 100 organisations. The Unit has grounded its research in industrial problems aligned with national and European priorities, in sectors including automotive, aerospace, manufacturing and construction, social housing and healthcare. It has had over 500 journal articles, conference papers and book chapters published, and delivered 84 keynote lectures and invited talks. 46 PhD students have successfully completed during the REF period.

Research achievements: The Unit has made a number of scientific breakthroughs. Examples include: **Blundell** (**MB3**) developed a new aircraft tyre model that can determine load paths through the landing gear of an aircraft and into its fuselage when it is taking off, landing and taxiing, in collaboration with Airbus. **Haas** (**OH2**) devised and implemented a new 'radiation free' method to evaluate radiotherapy equipment's motion tracking capability. This enabled the development of a tumour tracking solution. **Gaura** (**EGau2**) introduced and defined edge mining as a fundamental approach in the Internet of Things (IoT); **EGau2** showed a reduction in IoT node packet transmission and energy usage of two orders of magnitude beyond the state of the art. **Gaura** (**EGau3**) and **Brusey** contributed significantly to the safety of personnel required to wear heavy protective clothing in hot environments; their on-body, real-time, wearable sensors are exploited in current work by NP Aerospace on increasing de-mining safety. **Lin** (**ZL1**) devised a Short-Stroke Single-Phase Tubular Permanent-Magnet Motor for Refrigeration Applications, which achieves optimal efficiency and is being utilised in industry for energy efficiency improvements.

Harris, for the first time gathered empirical evidence supporting Reason's model of human error

having its root causes in managerial failures (**DH1**). Further development of this work has been used by the Taiwanese Air Force and airlines as the basis for developing safety training. **Harris**' award-winning work on the validation of the Human Error Template for predicting pilot errors in civil aviation (**DH3**), and his first empirical demonstration of the detrimental effects on manual flying skills of frequent utilisation of high levels of aircraft flight path control automation (**DH4**), have both been adopted by industry. **Shelton-Rayner (GSR1)** published the first research to use leukocyte reactivity as an objective index of cognitive workload, which has potential for use in Human Factors. **Dijkstra** (**CD1**) demonstrated for the first time the effect of magnetic fields on the gene expression of bacterial cells.

Li (**WL1**) devised a Particle Swarm Optimisation-based method for integrating and optimising multi-axis machining processes, planning and scheduling. **Aleksandrova** (**SA2**) produced a fundamental study of the linear stability of magnetohydrodynamic duct flows present in tokamak blankets and semiconductor crystal growth. **Cobley** (**AC3**) was the first to identify frequency as a key parameter when ultrasound is used to modify the surface of materials, and has advanced understanding of this phenomenon. He (**AC1**) developed a novel technique with applicability to the targeted delivery of drugs. The technique uses ultrasound to disrupt microcapsules, and has the potential to be used with drug-containing metal-coated microcapsules which have been drawn to body tissues of interest by a magnetic field, thereby releasing the drug to the tissue and minimising side effects.

In Civil Engineering, **Claisse** (**PC4**) and **Ganjian** have developed an original method for modelling the industry standard "Rapid Chloride Permeability Test" which predicts concrete durability. **Liu** (**SL3**) carried out the first robust experimental examination of the effect of coating methods used in the construction of heat and mass exchangers, drawing valuable conclusions with regard to heat exchanger design.

Further Evidence of Achievement: The Unit's combined REF2008 Strategy and Plans included:

- **Coordinate and develop research in low carbon vehicle technology**: through leadership of key work packages (**Burnham, Blundell, Gaura, Brusey**) in the £29M (£1.9M to CU) Low Carbon Vehicle Technology Project (LCVTP).
- **Further strengthen its pool of collaborators as part of its strategy of "research co-design with industry"**: This has led to considerable industrial impact and fast uptake of research results (shown in the majority of outputs and the case studies, see REF3a and REF3b) and 15 KTPs (and equivalent regionally-funded projects).
- **Increase research depth and industry uptake in key competencies including multifunctional materials, pervasive sensing and non-linear control**: The Unit's success in driving forwards from innovation in basic research through to demonstration, scale up and knowledge transfer is demonstrated in its successful winning of cycles of *EPSRC-TSB-Industry* grants. For example **Gaura** and **Brusey**'s research on the use of wireless sensor networks in building monitoring began as basic research funded by an EPSRC Case studentship. Once the feasibility and applicability had been proven (**EGau2**), a KTP grant was awarded to support knowledge transfer and this was followed by direct funding from the KTP industry partner. Subsequently, TSB funding (£400k) was awarded to support large scale retrofit of the technology to housing stock. **Cobley**'s research in novel electroless plating was funded by EPSRC through the Innovative Electronics Manufacturing Research Centre (IeMRC). A subsequent award of a KTP enabled the uptake of the research by industry.
- **Diversify and increase its funding sources**: This includes growing research income from key funders including EPSRC, TSB and the EU: the Unit won over 40 grants from the EPSRC and EU.
- **Develop a new area of research**: For example, **Li** established intelligent manufacturing planning research at Coventry University in 2009 and now holds an EPSRC studentship and 4 FP7 grants.
- **Ensure research continuity and accelerated growth in several key areas**: For example, in Pervasive Sensing and Automotive, through a series of people development and researcher support actions (see Section c). The Unit has taken technical leadership of work packages in major collaborative projects, demonstrating its research maturity and the esteem in which it is held. Examples include the £29M LCVTP project, mentioned earlier, the €5M Sensors Towards

Advanced Monitoring and Control of Gas Turbine Engines (STARGATE) project (EU FP7), the £3.5M Fundamental Understanding of Technologies for Ultra Low Carbon Electric (FUTURE) Vehicles project (EPSRC), the €3.5M Collaborative and Adaptive Process Planning for Sustainable Manufacturing Environments (EU FP7) and the €8.8M Retrofitting Solutions and Services for the enhancement of Energy Efficiency in Public Edification RESEEPE project (EU FP7).

ii. Future Strategic Goals and Aims

Over the next five years the Unit will:

- Continue to undertake excellent research to drive theoretical innovation and experimental breakthroughs within its existing areas of strength.
- Develop novel solutions to real problems across a range of industrial sectors by furthering its engagement in collaborative projects with academic and industrial partners. To this end, knowledge transfer will remain a key component of the strategy.

Areas of priority will include enabling low carbon transportation and buildings, and leading the development of highly efficient industrial and manufacturing processes, as well as enhanced operational safety. The programmes of research will incorporate the human operators, builders, trainers and maintainers to support a systemic, robust, through-life approach to engineering design. **Li, Gaterell, and Gaura**'s groups are already working more closely together to enhance critical mass and interdisciplinary working. This will be further enhanced through the bringing together of three Faculty Research Centres:

- **Advanced Engineering**, which will concentrate on the integration of core engineering activities including modelling, simulation, dynamics and structural optimisation, with human factors, control and wireless sensing,
- **Manufacturing, Materials and Metrology** which is closely linked to the recently-announced £26M Unipart Manufacturing Academy (see section dii), and
- **Built Environment**, which is bringing together the Civil Engineering group with research in sustainable and low impact buildings.

To deliver this strategy, key aims for the next period include:

- Increasing the number and strength of collaboration with academic partners:
  - In the UK (who currently include Oxford, Cambridge, Imperial, Cranfield and others) through jointly funded research projects (such as the previously mentioned LCVTP, FUTURE and STARGATE projects)
  - Internationally (currently including Macquarie, Australia and Purdue, MIT in the USA) through joint projects, and staff and PhD student visits, using internal funding and the FP7 International Research Staff Exchange Scheme;
- Building on strong industrial links to become the research partner of choice in key areas of expertise.
- Strengthening research and knowledge transfer in manufacturing and transport, including passenger safety and comfort.
- Investing in people, facilities and PhD programmes (see section c below) across the Unit. An International Advisory Board is now being established to further shape the research priorities.

In summary, the submission shows a significant growth in the scope, visibility, vibrancy, volume and quality of research activity since 2008. This, coupled with targeted investment in people (Section c) and facilities (Section d), shows that the Unit is well positioned to deliver its strategy to 2020 and beyond.

c. People, including Staff and Research Students

i. Staffing Strategy and Staff Development

During the review period the University has invested ca. £4.5M in this Unit's staff, facilities and equipment, with strategic new appointments and internal staff development to support the three main socio-technical challenges outlined for the Unit's research strategy (low carbon economies, human safety and industrial competitiveness). In particular: i) hiring of **Harris** from Cranfield to support Human Factors, **Gaterell** form Birmingham to develop Low Impact Buildings research and

Jamshidi to develop Metrology, and ii) promotions to to Professor for **Blundell**, **Gaura** and **Li**,, Reader for **Brusey**, **Cobley** and **Liu**, and Research Fellow for **Montazami**,.

Concordat: The University is using the nineteen agreed measures of progress drawn from Careers in Research Online Survey (CROS) and Principal Investigators and Research Leads Survey (PIRLS), to implement the principles of the Concordat to Support the Career Development of Researchers. The University was awarded the European Commission HR Excellence in Research Award in 2013. Current priorities include developing a new web-based researcher career development portal and the extension of our researcher progression ladder.

Equality and Diversity: This is monitored through regular Equal Pay Audits. At our most recent, 2010 Audit, the Gender Pay Gap for Academic Staff at Coventry was 2.81% compared with 13.5% for the Higher Education Sector (Source ECU 2010). Coventry is a member of the Athena Swan Charter and has been awarded the Bronze Award at University level, and is a Diversity Champion within Stonewall.

Development of Early Career Researchers (ECRs): As evidenced by the staff submitted, the Unit has invested in the development of ECRs. ECRs are strongly encouraged to join research groups with critical mass and are assigned mentors who support their development, e.g. **Jamshidi** is mentored by **Li**. Research staff development is supported by a CPD programme which offers workshops and training to develop career and research specific skills, including research management, leadership and media skills. Staff (and PhD students) can access the Epigeum on-line training research modules. ECRs receive funding from the RAE QR budget for conference attendance and travel, and are given protected research time (see below). ECRs are encouraged to join PhD supervisory teams and learn from more experienced colleagues, before becoming a student's Director of Studies.

Career Development: All staff undergo an annual appraisal which sets targets, provides feedback and identifies career development and tailored workload planning. Staff plan and agree with line managers the specific research and scholarship activities associated with research supervision, publications and generating research income. There is an open promotion scheme to which any member of academic or research staff can apply for promotion from Lecturer grade through to Professor, or from Research Assistant through to Senior Research Fellow. The Unit's success in this is evidenced at the start of this section (promotion for **Brusey**, **Blundell**, **Cobley**, **Gaura**, **Li**, **Liu** and **Montazami**).

Protected Scholarship Time: All lecturing staff are allocated five weeks per year of protected scholarship time within their contract of employment. In addition, all research active staff are allocated additional research time within the annual workload planning model and are released as appropriate to deliver their externally funded projects. They can apply for up to £10k per year to pay for teaching relief and undertake additional research. The University funds research sabbaticals of up to 12 weeks per year (e.g. **Liu, Karadelis**) and provides up to £10k per year per applicant for Applied Research Fellowship Grants (ARFs) to support collaborative work with research partners (**Cobley**, **Haas**, **Li**, **Thake, Liu**).

International Staff Appointments: The Unit has a wealth of outgoing and incoming international activity. Unit members holding Visiting Professorships include **Li** (Huazhong University of Science and Technology and Nanjing University of Aeronautics and Astronautics), **Gaura** (Macquarie University), **Harris** (Shanghai Jiao Tong University) and **Burnham** (Wroclaw University of Technology). The University provides funding to support in-coming International Visiting Professors: recipients have included Dutkiewicz (Macquarie University) to **Gaura** and **Brusey**, and Murphy (Virginia Commonwealth University) to **Haas**.

In addition, the Unit has an active research seminar programme, which attracts international and national speakers from academia and industry.

ii. Research students

Recruitment: The Unit's strategy has been to support a significant growth in research student numbers. There are 91 doctoral students currently enrolled, over half of whom receive financial support from the Faculty of Engineering and Computing. In addition, industry (e.g. Diabetes Care, MIRA Ltd, and JLR) directly funds a number of studentships. This emphasis on research students will lead to a significant growth in completions over the next period.

Training and support mechanisms: Facilities to support students include the Statistics Advisory

Service provided by Sigma (the award-winning Mathematics Support Centre), the Centre for Academic Writing (for constructing discipline-specific arguments and writing styles), Skills Development Programme (developing research-specific, professional and career skills); Careers, Employability and Enterprise Programme, and Global Leaders Programme (help in developing a global mind-set). The GLP comprises i) lectures from leaders in multi-national organisations and ii) workshops, seminars and the opportunity to spend up to two weeks on a cultural exchange trip.

Progress Monitoring: There is a robust and effective doctoral training programme. All research students have a formal review every 12 months; progression depends on what has been achieved in the preceding stage. Milestones and 'deliverables' include mandatory induction and research methods training, a selection of subject-related courses in the early stages, the production of draft thesis material and, in latter stages, conference papers. Reviews involve a chair and subject expert – both independent of the supervisory team – and take the form of a mini viva. Outcomes are logged in the student records system. Supervision is by experienced teams (usually of three staff who must have a record of successful completions), and meetings with students occur regularly. Staff are required to attend introductory and follow-on training. Students are encouraged to take additional, voluntary modules where appropriate; many students undertake undergraduate teaching, within prescribed limits, and are then required to take the 'Introduction to Teaching in HE' module.

Independent Advocacy and Advice: Research students receive advice and support from the Faculty Postgraduate Research Tutor who is independent of the supervisory team. Additionally, there is a Faculty Research Degrees Lead (Associate Dean Research) who further oversees the PhD student pathway, meets regularly with student representatives and ensures that student concerns are resolved effectively.

Careers, Employability and Enterprise Programme: The careers, employability and enterprise programme helps postgraduate research students to enter the jobs market with dedicated training and support from the Careers Support Team on graduate careers and job seeking or business start-up.

Seminar Series: The Unit's students are strongly encouraged to participate in the annual University-wide Research Student Symposium. This enables students to bring their work to an audience of internal staff and external visitors, through posters and presentations. Over 50 students from this Unit present every year. Furthermore, there are group specific seminars for students, including: for **Sensing**, the Annual Research Students' Seminar between Coventry and Southampton (since 2006, and in 2011 extended to include Cambridge), with 20 staff attending and 15 students presenting each year; for **Control**, the annual Polish-British Workshop, with students from the USA, Russia, Spain and New Zealand (2008 onwards), co-sponsored by the Institution of Engineering and Technology (IET) Control and Automation Network and the Institute of Measurement and Control (InstMC) Systems and Control Technology Panel.

Industrial Support: Most PhD students follow a programme of work associated with a collaborating industrial partner or are involved in funded projects, for example: for **Gaura and Brusey,** all students are linked to industry- sponsors include Jaguar Land Rover, and Orbit Housing Association and there are 3 EPSRC CASE/DTA projects with Orbit, Meggitt and NP Aerospace; **Burnham**'s students include a PhD fully funded by Abbott Diabetes Care, one by MIRA and one by Jaguar Land Rover. The PhD students' industry experience is further enhanced by contributions made by external experts from industry and collaborating institutions as research advisors.

International Experiences: Examples of PhD students having an international experience include sponsored internships abroad, for example **Gaura**'s students to Harvard (3 months, 2010), MIT-Singapore Alliance (2 months 2009), UCLA (1 year, 2008/2009) leading to 5 journal publications co-authored with hosts. **Gaura** and **Brusey** also hosted 2 EU PhD students for one year in 2011 with further joint publications. This helps students secure appointments in world class institutions. For example, the appointment on graduation of a PhD student from the Pervasive Sensing Group to a post as a Research Fellow at MIT working on wireless sensing.

d. Income, infrastructure and facilities

i. Provision and investment in specialist infrastructure and facilities

The Unit operates from dedicated facilities in the new £55M Engineering and Computing building,

and on the University's Technology Park. The co-location of this Unit's researchers with those of UoA10 and UoA11 supports a vibrant research infrastructure and cross-disciplinary working.

High Performance Engineering Centre (HPEC): The Faculty of Engineering and Computing has developed an entire floor (2050m^2) of the new £55M Engineering and Computing Building at a cost of £4.5M to provide a laboratory-based High Performance Engineering Centre (HPEC) to support academic research, industrial research and teaching. Facilities include: a scale model, £1M Wind Tunnel built and delivered by Mercedes Petronas with a 1m^2 cross-section that can accommodate models up to 25% scale for a typical car; a MTS four-poster shaker rig that can take vehicles up to C-Class size and is used to support research into vehicle ride and durability**;** a £0.5M 250kW transient engine dynamometer from AVL; a £0.5M**,** 8 Tesla cryogen-free magnet which will support collaborative research between the Unit, and magnetohydrodynamics and fluid dynamics researchers in UoA10 Applied Mathematics; a Metrology Laboratory; three Flight simulators; an Environmental Test Chamber part funded by the European Regional Development Fund to help manufacturers, installers and building operators understand the thermal properties of their products; Rapid Prototyping facilities; six Hass CNC machine tools (£0.5M); electrical and electronic laboratories and Fatigue and Tensile Testing facilities.

High Performance Computer (HPC): During the census period the University has invested a total of £1.8M in hardware for the HPC facility (568 cores, 3.0GHz, 4GB RAM per core) which has been used by **Blundell's** group for automotive crash work and computational fluid dynamics (CFD) work on exhaust after treatment. **Alexandova** has used it for her fluid mechanics and magnetohydrodynamics work.

Cross-HEI Shared or Collaborative use of Research Infrastructure: The Unit's researchers have access to specialist facilities at collaborating universities, including those at Oxford, Imperial Loughborough and Cranfield, through the Unit's leading role in major, multi-partner projects such as the EPSRC-funded FUTURE project.

ii Current and Planned Investments in Infrastructure and Facilities

Unipart Manufacturing Academy: Coventry University has been awarded a £7.9M HEFCE Catalyst Fund grant and will establish a joint £26M Manufacturing Institute with £18M input from the Unipart Manufacturing Group. The project includes a new dedicated academy building in Coventry. This will house specialist equipment to support manufacturing and metrology research in a high-value manufacturing environment. The Institute will deliver up to £4M/year in research contracts by 2016.

iii Research Funding Portfolio and Future Plans

Funding Support Resources: The total number of research grants and contracts during the reporting periods was **130** and the Unit income was **£9M**. EPSRC and UK government/EU funding represents over 50% of the total grants won. Applications for funding are supported by the University's Business Development Support Office (BDSO). BDSO provides research funding identification, bid writing, bid appraisal, training and project management support to the Unit.

Future Funding Plans: The aim is to grow the annual external funding for this Unit to £4M per year by 2020 by:

- Increasing the diversity and quality of funding sources including a greater focus on EPSRC, Horizon 2020 and international sources through collaboration with world-leading institutions and companies such as Airbus, JLR and TNO.
- Increasing the number of large grants focused on the global challenges of Manufacturing, Low Carbon Vehicles, Integrated Transport and Logistics, and Low Impact Buildings while collaborating with leading universities both in the UK and internationally.
- Increasing the number of medium sized interdisciplinary grants, for areas such as Integrated Road and Rail Transport, including Specialist Vehicles and Enhanced Energy Efficiency.
- Exploiting synergies between the groups to provide specialist consultancy in order to cross-fund and develop research activities and linking over the next five years with large initiatives such as the Unipart Manufacturing Institute.

iv Consultancies and Professional Services

Examples include vehicle dynamics work supervised by **Blundell** for JLR on tyre modelling (£70k),

projects for Protean on the modelling of torque vectoring on electric vehicles (£60k) and a range of specialised short one and two day courses on Vehicle Dynamics and Tyre Modelling (£20k); Staff working with **Jamshidi** in Metrology have delivered consulting and other projects to clients including Rolls Royce, Airbus, Boeing and Unipart. The income from these activities is £500k; **Gaura** and **Brusey** have provided consultancy services in the area of Building Performance and Evaluation to Housing Associations and building contractors in UK and Europe. **Liu** has been working with the industry partner Triton Showers on novel heating methods. Three patents have been delivered through this project: GB1305613.0, GB1305617.1 and GB1314203.9.

e. Collaboration or Contribution to the Discipline or Research Base

i Examples of Research Collaborations: During the reporting period 130 projects were carried out of which the vast majority included collaboration with external academic or industrial partners. Industry partners include JLR, Airbus, Augusta Westland, MIRA, Ricardo, Unipart and Orbit Housing Association, Meggitt and Rolls-Royce. Projects with significant academic research collaborations include: the EPSRC funded FUTURE Vehicles in collaboration with Loughborough (lead), Cranfield, Imperial College, Oxford, Sheffield, as well as 12 automotive/supplier/consultancy companies **(Burnham)**. EPSRC TARF-LCV, working with partners including Brunel, Manchester, Imperial, Exeter and Nottingham **(Blundell).** EU FP7 CAPP-4-SMEs with Sandvik and 6 European manufacturing SMEs **(Li)**. EU FP7 STARGATE with Meggitt PLC (lead), Cambridge, Loughborough, Rolls-Royce and others (**Gaura, Brusey**). Further, collaborations with over 50 universities and institutes are supported by the Unit and resulted in joint publications (for example, **JB1,2**, **AC4**, **EsG2**, **KB4**), staff and PhD students' visits/internships and joint seminars and workshops exemplified throughout the document.

ii Examples of Interdisciplinary Research: The Unit's PIs engage successfully in both internal and external interdisciplinary work. Internally this is supported by researcher co-location (the Futures Institute Building for example hosts research in control, sensing, manufacturing, health sciences and operational research), joint PhD supervision and joint projects (e.g. **Gaura**'s sensing work with input from Health Sciences researchers on physiological and movement monitoring as well as evaluation of seats and cabin comfort within JLR contracted research). Furthermore, a major project involving key staff in this Unit carrying out interdisciplinary research was the LCVTP project collaborating with JLR, Ricardo, MIRA, Tata, Zyteck, Warwick Manufacturing Group and Cranfield. The staff and their disciplines included: **Blundell** in aerodynamics, structural optimisation and crash analysis; **Gaura** with wireless sensing for occupant comfort; **Burnham** with vehicle supervisory control. EPSRC research projects such as Urban Futures **(Gaterell)** and Intelligent Digital Household Networks **(Liu)** are also multidisciplinary and between them include engineers, economists, ecologists, social scientists and architects. Strong interdisciplinary collaborations is delivered through a clearly defined project management structure and shared working environments.

iii. Examples of how Research Collaborations have informed Research Activities and Strategy: This Unit's PIs engaged as the primary academic partner in several large projects which in turn led to the development of strategic research themes, with follow on cycles of investigative feasibility research and innovation through to knowledge transfer. For example, the work with Cenex in the Advantage West Midlands Niche Vehicle Project **(Blundell)** providing a base of low carbon vehicle collaborative work for the follow on activities in the LCVTP project. The EPSRC FUTURE programme **(Burnham)** and the EPSRC TARF-LCV programme **(Blundell).** The Utrasound work by **Cobley** was originally funded by IeMRC (EPSRC), further progressed through a TSB scale up feasibility grant, and is now the subject of an EU Eco-Innovation project, with a number of UK and European partners investigating the use of ultrasound to enable maskless patterning of materials and aiming to install prototype equipment into two industrial facilities. Further, a successful KTP has been investigating the development of novel composite coatings using ultrasound, with Daido Metals, and a second use of ultrasound in electroplating with Harwin PLC.

iv. Leadership in the Academic Community:

Examples of National and International Advisory Board Membership

Gaura: Chair of the Electronics, Sensors, Photonics KTN Wireless Intelligent Sensors Group since 2005. **Blundell:** Member of the Engineering Professors Council (EPC), and the IMechE

Automobile Division Events Committee. **Gaterell**: Director of the St Modwen Environmental Trust, Director of the Sustainable Housing Action Programme: Founding member of the Prince's Foundation Research Committee.

Examples of Conference Organisation and Programme Chairs

Ganjian and **Claisse:** Founding members of the Organising Committee of the International Conference on 'Sustainable Construction Materials and Technologies'. **Harris:** Chair Engineering Psychology and Cognitive Ergonomics track, HCI International since 1996. **Gaura:** Chair of the SENSORCOM Applications Strand (2011 and 2012); Organiser and Chair of the Electronics and Microsystems Symposia Suite, NanoTechnology International Conference and Trade Show (2002-2010). **Burnham**: Founding Member and Co-organiser of the Annual Polish British International Workshop Series (2008 onwards), General Chair for the UKACC International Conference on CONTROL (2010). **Li**: Program Committee Chair, the 17th IEEE International Conference on Computer Supported Collaborative Work in Design (2013). **Gaterell:** Chair of the international INCLUSEV Conference funded by EPSRC in March 2011.

Examples of Invited Keynote Lectures (over 80 for the Unit)

Gaura: 14, including: IEEE Information Society, IEEE ICITIST conferences. **Harris:** 8, including: SafeSkies Conference; 25th National Congress of Italian Aerospace Medicine Society. **Blundell:** 3 including: the Institution of Mechanical Engineers (IMechE) Greater London Region.

Examples of Membership of Research Grants Panels or other External Bodies

Harris: National Air Traffic Services Safety Review Committee (SRC) as Special Advisor for Human Factors; **Gaura** (over 80 grants evaluated in period): Member of EPSRC College of Peers (2003-2009), reviewer for EU FP7, Leverhulme Trust, and 4 world wide National Research Councils; **Blundell:** EPSRC and EU FP7 proposal and project reviewer; **Cobley:** expert reviewer EU FP7; **Brusey**: expert reviewer NC3Rs (UK Government).

Examples of Journal Editorial Boards

Blundell: Journal Part K: Multibody Dynamics; Guest Editor (2012). **Gaura:** Associate Editor, IEEE Sensors; Guest Editors: **Gaura** and **Brusey**: Measurement Science and Technology, Institute of Physics Journal (2012); **Gaterell**: Engineering Sustainability Journal and Environmental Technology Journal; **Claisse:** Construction and Building Materials (2013); **Harris:** Cognition Technology and Work (2008); Ergonomics (2010); **Ganjian**: American Society of Civil Engineers Journal of Materials in Civil Engineering on Sustainable Construction Materials and Technologies (June 2010); **Jamshidi**: Proceedings of the International Journal of Computer Integrated Manufacturing (2009); **Li:** Journal of Network and Computer Applications (2013).

Examples of Election to Membership, Fellowship of Learned Societies or Awards and Prizes

Blundell: Fellow of the Institution of Mechanical Engineers (FIMechE). **Cobley**: Fellow and Vice Chairman of the Institute of Circuit Technology. **Harris**: Fellow of Institute of Ergonomics and Human Factors, Fellow of HEA. **Burnham**: Vice President (2011-2014), Board of Trustees Member, and Nationally Elected Member of Council of the Institute of Measurement and Control (InstMC); President of the European Institute for Applied Research (IAR). **Gaura**: Chair of the Wireless Intelligent Sensors Interest Group, Electronics, Sensors and Photonics KTN (2006-2011). **Harris:** Ergonomics Society President's Medal (2008), as part of the Human Factors Integration Defence Technology Centre, for 'significant contributions to original research, the development of methodology and the application of knowledge within the field of ergonomics'. **Gaterell**: EPSRC Urban Futures project involving Coventry, Birmingham, Lancaster, Exeter and Birmingham City Universities led to the Trevithick Prize, 2010, by the Institution of Civil Engineers for the best journal article in Engineering Sustainability in 2009; and the Bronze Medal, 2009.

Examples of External Research Examining

Blundell: Cranfield, Birmingham, Loughborough, and Surrey. **Gaura**: UCL, Southampton, Brunel and Sheffield. **Brusey**: Reading, Southampton. **Li**: Birmingham, Cranfield, Hong Kong University and National University of Singapore.