Institution: Edinburgh Napier University

Unit of Assessment: **13 - Electrical and Electronic Engineering, Metallurgy and Materials**

a. Overview

The members of staff included in the submission to UoA13 reside within the Faculty of Engineering Computing and Creative Industries (FECCI) and are associated with two distinct Research Institutes. The Forest Products Research Institute (FPRI) and Institute for Product Design and Manufacture (IPDM) include academic staff from the School of Engineering and the Built Environment and each has dedicated administration staff. Within each Institute there are a number of Centres and research groups that concentrate on specific specialist areas.

There are three centres within the Forest Products Research Institute included in this Unit of Assessment: namely Plant Science & Bio-polymers which develops methods to extract, separate, refine and process cell wall components into high value, bio-polymer based materials; the Wood Studio which focuses on the creative use of timber in the architecture, design and construction of buildings and structures; and Wood Science and Technology focusing on understanding the material properties of wood and how these affect its performance in different applications. Over the assessment period the Institute has had a turnover in excess of £5M due to its success in attracting funding for its novel research. Staff within the Institute have good opportunities to supervise research students, who in turn have opportunities to remain with the Institute for post-doctoral work and beyond.

The Institute for Product Design and Manufacture has a number of staff groupings including, Product Design & Development, Manufacturing, Energy Management, Electronics Manufacturing, Automation & Control, and Advanced Materials Centre. Its turnover over the assessment period of approximately £2M has been mainly in consultancy and expert services.

b. Research strategy

Post 2008

The Institutes covered by this submission had specific aims covered by the last research assessment exercise in 2008 and both wanted to become commercially relevant over the intervening period. FPRI with its centres has accomplished its targets for both external research income and highly rated research outputs. Research strategy within FPRI is closely aligned to Scottish and UK Government strategy, with public money boosted with funds from industry and has strong links with Forest Research. Edinburgh Napier University is specifically mentioned in the Forestry Commission's implementation plan for 2013-16
http://www.forestry.gov.uk/pdf/SFSImplementationPlan2013-2014final.pdf/$FILE/SFSImplementationPlan2013-2014final.pdf

IPDM has had success with commercial projects and has attracted UK and European funding to help knowledge transfer activities between the University and small to medium enterprises. Most outputs have been produced through long established industrial collaborations and partnerships.

Looking forward

Over the next assessment period to REF2020 Edinburgh Napier University will cultivate an approach to industrial interaction which will allow not only for knowledge transfer, but will also increase its outputs at international level.

The University's Strategic Plan and its Research Strategy can be described under five headings

- To grow research income.
  Future growth will come from successful bids for large projects which bring together sustainable staff groupings. FPRI and IPDM have been successful in income generation in the preceding period; however, both Institutes will seek to increase activity in the next assessment period up to REF2020.
- To grow both the number and the quality of research outputs.

Both IPDM and FPRI will target academics' time to produce increased numbers of high quality research outputs in terms of both publications and direct impact effects from the income generating projects.

- To be a preferred partner for research and consultancy.
  The reputation developed through professional publication and highly visible research contracts will generate interest from industry and government agencies, which will lead to the Institutes becoming recognised externally in their respective fields and hence to becoming expert services centres.
- To be regarded as significant international research partners.
  Continuation of current high level partnerships with European and UK Government departments and research agencies will be converted into more externally visible projects. The findings of the projects will be disseminated through public engagement activities to further enhance the reputation of the Institutes, School and University.
- To develop a sustainable critical mass of research students.
  Each research area will create scope for the engagement of research students which, when a critical mass is reached will enable particular projects to become self-sustaining in terms of outputs and new ideas and attracting project funding.

These activities will form a focus for not only the research, but will feed into the further development of research–teaching linkages and public engagement events.

c. People, including:

i. Staffing strategy and staff development

Staff are supported to develop their research in a number of ways: First, staff discuss their research aims in consultation with their research centre directors and their Institute directors to ensure alignment with University research strategy. Second, individual staff development is based on an alignment of staff research interests with strategic aims, and through twice yearly Professional Development Review. Third, once development aims have been identified these are taken forward by, for example, the allocation of protected time for research; enrolment on University-wide staff researcher development activities (which include workshops on grant applications, writing for publication and presenting at conferences); mentoring and coaching for specific aims, such as a paper for publication, drafting a grant application and undertaking a PhD by Published Works.

The following sections provide the University-wide context within which the local activities described above take place.

EC HR Excellence in Research Award

The European Commission HR Excellence in Research Award recognises a commitment to the principles of the Concordat to support the career development of researchers. Edinburgh Napier University received the award in December 2010. This was gained through a detailed gap analysis of our existing policies, followed by the development and implementation of a robust action plan. This took into account the views of researchers at all stages. In December 2012 the University successfully retained this award for a further two years due to its continued progress against the Concordat Action Plan. As part of its commitment to the Concordat the University created a Concordat Working Group that comprises researchers at a variety of career stages. This provides a further route for communication between researchers and the University, with the working group reporting directly to the University Research and Knowledge Exchange Committee.

Recruitment, Selection and Promotion

Capacity building for research sustainability is central to all aspects of work in the Unit of Assessment. The UoA adheres to HR good practice in staff recruitment and promotion in line with University policies, and uses a Personal Development Review (PDR) process to identify specific staff development needs. The approach adopted has three key elements: the recruitment of experienced researchers to enhance existing areas of excellence and provide research leadership; the recruitment and development of junior staff with a demonstrable research potential; and the

development of existing staff through active participation in events, mentoring and development programmes tailored to the specific needs of staff in the UoA, as well as in those offered at University level.

Staff development strategy

In 2011 a gap analysis on the University's training and development provision for researchers was conducted using the Research Development Framework (RDF) created by Vitae. All events in the University's Researcher Development Programme are mapped against RDF so that researchers can obtain comprehensive development to support their own career development and planning. An extensive programme of approximately 20 events per trimester has been developed. These are all tailored to our researchers and comprise relevant sessions for all stages of a research career. The programme has helped foster the research culture across the University by bringing researchers together to share best practice. All sessions are evaluated by the researchers, which allows the relevance of each session to the development needs of the researchers to be maintained. As part of the creation of the Researcher Development Programme the University has further increased its online provision of resources, covering topics such as induction to the University, and research ethics and integrity. Using the Research Development Framework graphic the University has created a dynamic portal for researchers to identify their own development needs and help with their career planning.

In December 2012 the University held a research development conference entitled *'Supporting Researchers at Edinburgh Napier University'* which was attended by over 45 researchers and was well received by researchers from all career stages. Through such events as these conferences we continue to build the research culture across the University. These achievements have been recognised nationally through a THE award in 2010 for Outstanding Support for Early Career Researchers (Edinburgh Napier chaired the award-winning team, the Universities Scotland Research Training Sub-Committee).

Mentoring, probation, appraisal and training

The introduction of an online system (HR Connect) allows development needs identified during a researcher's individual Professional Development Review to be captured. It records attendance at events, as well as other evidence of continuing professional development. Exemplar career paths have also been created that help illustrate the types of activities that researchers need to consider as they progress through different career stages and helps provide relevant career guidance. Participation in UK-wide surveys (e.g. PRES, CROS and PIRLS) allows the University to continue monitoring progress in supporting researchers and their development.

Equality and diversity

During 2010 the University's HR policies and procedures for Recruitment and Selection, Equality and Diversity and Interview Preparation were reviewed to ensure that they aligned with the Concordat principles for equal opportunities for researchers. The University is committed to the principles of Anthea Swan (which promotes gender equality for women in SET research) and is actively working towards gaining formal recognition. The University also hosts and provides funding for the Scottish Resource Centre for Women in SET.

Mechanisms to maintain research quality and integrity

The University Code of Practice on Research Integrity provides a quality standard for assessing the day-to-day ethical issues that our researchers may encounter, including issues such as authoring guidelines and informed consent. During 2012 a cross-University working group – Phronesis – was established by the Research Integrity Committee to consider engagement of research with ethics. The outcomes have led to alternative approaches to communication of ethics matters and to staff development in ethical practice being established.

ii. Research students

During the period of assessment there have been 26 PhD completions, including both self-funded and those receiving full studentships.

Where appropriate, students are encouraged to take part in teaching activities such as tutorials and assessment. Research students play key roles in organising the annual Faculty Research Students' Conference and a number of other less formal fora at which they disseminate their research. Students have the opportunity to work closely with staff and to develop their own publications through joint authorship and single-authored work.

Doctoral Training
Training and skills development for research students is delivered through several mechanisms:

- A centrally-delivered Researcher Development Programme
- School-based training events for research students
- Faculty-based training programmes for research students.

This model allows provision of generic and subject-specific skills to be delivered across the University in a tailored manner.

Integration into the wider research culture
The University's Researcher Development Programme is open to all researchers regardless of career stage. Through a co-ordinated cross-University approach to education, training and professional development the University ensures that research students are integrated into the research community. Specific induction sessions are also provided for research students, allowing them to plan their own professional development and to network within their own cohort of students.

Monitoring and support mechanisms
In addition to regular supervisory meetings, all research students have their progress monitored formally twice a year, with formal documentation presented to the Faculty Research Degrees Management Group. Support is offered at School and Faculty levels with the University's Research Degrees Assessment Board playing a role in ensuring quality mechanisms are in place at local level and are implemented in accordance with the University's Code of Practice for the Supervision of Research Students.

Supervisory training and development
The University runs several events for research supervisors, from those getting started through to in-depth sessions for experienced supervisors. The University's three-day 'Supervising Research Degrees' course has been formally recognised by the Staff and Educational Development Association (SEDA), allowing participants to gain an externally accredited award upon completion of the course. New research supervisors also receive informal mentoring through participation in supervisory teams, allowing them to be supported as they develop their supervisory practice.

d. Income, infrastructure and facilities
During the period of assessment the projects run under UoA13 have a combined research income in excess of £6.8M. More than half of this has come from EU industries, Commerce and Corporations. The Institutes forming part of the UoA develop consultancies and supply professional services to clients through their outward facing centres that supply research, knowledge transfer and expert networking to small to medium size enterprises and large corporate clients. From 2008 to 2013, the Institutes have been the University interface with relevant industries and have developed over 300 main collaborations.

Research funding has been from many sources including:

- European Regional Development Fund
- Scottish Enterprise
- Forestry Commission (GB and Scotland)
- Scottish Forestry Trust
- Historic Scotland
- Industry (CONFOR, Adam Wilson & Sons Ltd, BSW Timber Ltd, Euroforest Ltd, Howie Forest Products Ltd, James Callander & Son Ltd, James Jones and Sons Ltd, John Gordon

& Son Ltd, Scottish Woodlands Ltd, UPM-Tilhill) [Howies was acquired by BSW Timber so is now one company]
- Building Research Establishment Ltd.
- Royal Society of Edinburgh and STSM funding from COST Actions and consultancy with John Brash and Company Ltd, Accsys Technologies PLC, MiCROTEC.
- During the last five years there have been three Knowledge Transfer Partnerships (Technical Fibre Products, Axon and SFX) and two Proof of Concept projects, as well as many short-term R&D projects for local companies and organisations.

Research forming part of the submission to UoA13 is linked to the needs of industry. A variety of mechanisms are used to establish and capitalise upon links with industry, including:

- EDTC Technology Gateway: EU and Scottish Government funded programme to enhance technology innovation in SMEs and develop company/higher education R&D partnerships.
- Product Realisation Centre: EU and Scottish Government funded programme to provide prototype manufacture services to SMEs through use of workshops and laboratories in further and higher education.
- Advanced Materials Centre: University specialist facility working with the Oil and Gas industry sector through the Industry Technology Facilitator (ITF) and strategic relationship with Tullow Oil. This Centre shares the specialist laboratories run by the School of Engineering and the Built Environment and has recently acquired additional fume cupboards to allow oil related electroless co-deposition projects to proceed simultaneously. The Centre also provides facilities and expertise to support the Scottish manufacturing sector and in particular the plastics Industry, in terms of materials development, processing, product design, property testing, characterisation and failure analysis.
- Electronic Manufacturing Services: this delivers specialist high technology electronics manufacturing services to approximately 20 companies (large corporates and small to medium size enterprises).
- Signals and Systems: this Centre delivers R&D in high frequency signals, data communications, sensor systems and automation and control in complex operational environments. The Centre has been successful in developing strategic innovation projects in the defence and manufacturing sectors. This Centre shares the specialist laboratories run by the School of Engineering and the Built Environment.
- 2KT: EU funded programme to facilitate R&D with industry across HE and FE. Edinburgh Napier University leads this programme with St Andrews University, Queen Margaret University, Edinburgh and Fife Colleges included.
- Plant Science & Bio-polymers: this Centre investigates new insights into the nano-scale structure of the plant cell wall and what drives it, and focusses on 3 areas: development of methods to extract, separate, refine and process cell wall components into new high value, bio-polymer based materials; fundamental and strategic research to develop new understanding of the key factors/drivers impacting on the structure and bio-polymer composition of plants/trees at all scales and characterisation of different cell wall components and how they interact.
- The Wood Studio: relates the use of timber in the area of architecture and design in internal and external cladding. The centre acts as a gateway for SMEs to develop their skills in the use of timber for these purposes.
- Wood Science and Technology: key aspects developed by this Centre are the growth and management of forests and how that affects the properties of the timber produced from them and the use of non-destructive techniques for assessing the properties of wood at different points in the supply chain.

The Institutes have access to and use more general shared facilities within the School of Engineering and the Built Environment but have some specialist laboratories. The specialist heavy structures laboratory undertakes many of the tensile and compressive test procedures, while the shared materials laboratory houses smaller scale tensile testing hardware which is used for consultancy and KTP work on smaller projects. Significant investment has been made in University facilities since 1 January 2008 with a new Scanning Electron Microscope laboratory being

commissioned to be used in the cell structure work of the Institute. Additional investment in the research infrastructure and facilities was made in 2010 with the purchase of a Spinning Rig installation.

There is a dedicated research laboratory for timber testing with climate control in which standard testing is undertaken for structural properties (which is mostly bending as this is the key property for construction) – from small clear samples to structural size battens. There is also a torsion testing rig for measuring shear properties. There are facilities to measure wood moisture relations, shrinkage and swelling, drying distortion, sorption and desorption (notably Dynamic Vapour Sorption apparatus), plus equipment for non-destructive measurement of trees in the forest and timber in-situ in buildings).

The Institute for Sustainable Construction, with whom FPRI collaborates within Edinburgh Napier University, recently acquired timber conditioning and testing apparatus from BPAC that includes a beam testing rig that extends our timber testing capability to the size of agricultural purlins. There are shared facilities with Forest Research for sample preparation that includes a drying kiln. Collaboration with sawmills has given access to x-ray scanners, and laser shape scanners.

The Research Institutes forming part of the UoA each have an advisory board that seeks to assist the University in ensuring that its research is industry-focussed. Advisory board members include senior management from industry, Scottish Enterprise and Scottish Engineering. These members also provide access to a network of contacts for contract research and consultancy.

e. Collaboration and contribution to the discipline or research base

Much of the work of each of the disciplines covered by UOA13 is collaborative in nature. Most of the outputs contain co-authors from industrial or other academic institutions, both national and international. Included in these are: Heriot Watt University, University of Cantabria, Spain, MESL Microwave Ltd, Apollo Microwave Ltd, Canada, Technical Fibre Products Limited (Kendal) and SFX Technologies Limited, the Petru Poni Institute of Macromolecular Chemistry in Romania, Glasgow University Chemistry Department and Forest Research, and more recently includes Forestry at Aberdeen University and Engineering at Glasgow University.

In addition, knowledge transfer activities including consultancy have also included:
Verdex Ltd, Microspheres Technology Ltd, Axon Cable UK, Carclo Technical Plastics, Hexagol Limited, CONFOR, Adam Wilson & Sons Ltd, BSW Timber Ltd, Euroforest Ltd, Howie Forest Products Ltd, James Callander & Son Ltd, James Jones and Sons Ltd, John Gordon & Son Ltd, Scottish Woodlands Ltd, UPM-Tilhill and a large number of small and medium sized enterprises in Scotland funded by the Scottish Government, Scottish Enterprise and the European Regional Development Fund.

The outputs from all these collaborations have added to the research and knowledge base of the relevant disciplines through publication of journal articles and company reports to government and EU regulatory and standards committee memberships. For instance Dan Ridley-Ellis sits on the UK Timber Grading Committee and is one of the UK's nominated experts for timber grading standards, the only one from academia, and two of the KTP programmes have been listed for awards.

A number of staff (e.g. Sharp, Sambell, Gupta, Ridley-Ellis, and Turner) sit on editorial panels or boards of journals, for example, IET Proceedings on Microwave Antennas and Propagation and Electronic Letters; International Journal of RF and Microwave Computer Aided Engineering; IEEE Proceedings on Microwave Theory and Techniques ; Microwave and Wireless Component Letters and IEEE Transactions on Antennas and Propagation; Sensors and Transducers Journal; Proceedings on Urban Design and Planning (Published by the Institution of Civil Engineers); Ultrasonics (Elsevier Publication); International Wood Products Journal; Maderas-Cienc Tecnol Journal; Engineering Structures; European Journal of Wood and Wood Products; Baltic Forestry and New Zealand Journal of Forestry Science and several more, covering many aspects of UoA13. Likewise some of the more experienced members hold positions on professional institutional boards and subcommittees. Professor Turner and Dr Ridley-Ellis are chairman and board

members respectively on COST Action (Forestry) committees which network across approximately 28 countries and 70 institutions.

A number of UoA13 researchers are involved in public engagement activities either through STEM ambassador or Faraday Engineer commitments or through being invited to help with television shows, such as '*Bang Goes The Theory Live'*, or science festivals around UK. Typical of these activities is the Beltane Public Engagement Network. Edinburgh Napier is a founding member of the Beltane Public Engagement Network which initially started as a Public Engagement Beacon. We have continued our support of this organisation as its Beacon funding came to an end in 2012. Three of the UoAs research staff have obtained Beltane Public Engagement Fellowships allowing them time and support to develop their public engagement and impact from their research. We have also benefited from researchers gaining access to Beltane training on public engagement, including evaluation of public engagement events. Our support of Beltane has also included the establishment of an Edinburgh-based 'Bright Club' in which several of our researchers have used stand-up comedy as a route to engaging alternative public audiences with their research. Dr Ridley-Ellis is the main organiser of this activity and has taken part in approximately 50 stand-up comedy nights for researchers to engage with the public through comedy. He has also been an Edinburgh Beltane Public Engagement Fellow.

The University is a member of the research pooling group the Edinburgh Research Partnership for Engineering and Mathematics (ERPem) and the Institute for Product Design and Manufacture is particularly active in the Energy and Signals and Systems groups. In addition, the IPDM Director represents Edinburgh Napier University on the ERPem Board. The regeneration of ERPem through 2013-14 will further enable the formation of a manufacturing specialist group, which will involve Edinburgh Napier University academic researchers.