

**Institution: Edinburgh Napier University**

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

**a. Context**

This Unit of Assessment (UoA) covers staff from two distinct Research Institutes aligned with the School of Engineering and the Built Environment, within the Faculty of Engineering, Computing and Creative Industries. The Institute for Product Design and Manufacture (IPDM) encompasses electrical and electronic engineering and inorganic materials research and applications, while the Forest Products Research Institute (FPRI) concerns itself mainly with timber research and applications.

IPDM oversees research, knowledge transfer and expert networking with small to medium size enterprises organised through a number of more specialist “centres” that deal directly with Electrical, Mechanical and Energy (including Oil & Gas) industries. The main beneficiaries from the work of IPDM are SMEs in the Engineering sector that have involvement with communication equipment, process control and material manufacturers. Additionally there are overseas links with Canada and the Baltic states. The type of impact is, locally, wealth generation through product development and production.

FPRI interfaces with a wide range of industrial sectors (from pulp & paper, biopolymer based materials and textiles, right through to packaging, engineering and construction) through its associated centres and brings together forestry and timber materials research to improve silviculture, wood processing and timber utilisation to support the wood chain industries, particularly those in the UK. This includes improvement of the timber resource and reduction of wastage as well as European Standards development. The main impacts are on land owners, growers, forest managers, primary and secondary wood processors and timber frame construction companies, with future impact through regulatory bodies.

The technical impact of the work of IPDM ranges from improving component designs by refining fundamental understanding and underlying physics, and in some cases chemistry, as well as informing the manufacturing processes for specific artefacts. These are feeding directly into the commercial growth of Engineering SMEs. Some of the work on cellulose materials, and novel coatings, although not yet fully commercialised, has an influence in informing regulatory bodies. Other material project outputs have found direct application in industrial products, with two recent Knowledge Transfer Partnerships (KTPs) having immediate impact on the costs of design and production in their relevant industries.

**b. Approach to impact**

The majority of impact from the UoA’s technological research takes place within the context of the involvement of external companies and the main focus of the impact is on wealth creation. Some of the research has led to the establishment of spin out companies to exploit the research findings (e.g. Cardiodigital – the subject of one of the Impact Case Studies).

The contact with external users and audiences for the work of both Research Institutes happens on various levels. Approaches are made from industry to the centres if specific problems occur within a company. Often these are resolved through short, medium, or long term consultancies.

Depending on the nature of the work these may lead to commercially confidential company reports which themselves have an effect on company procedures and processes without being directly linked in the public perception.

The institutes also offer access to initial developmental opportunities for companies who after taking up local government innovation funding may jointly apply for further funding streams. Such projects have encouraged small companies to assess the impact of novel technologies and techniques in their fields. Each of the projects has formed the basis for further funding after an initial examination of ideas. The impact on the companies is in their exposure to new ideas and techniques, the subsequent impacts will be in production costs, profits and benefits to customers and hence company profitability.

Occasionally speculative contact is made to highlight joint funding opportunities available to partnerships. This is again usually biased towards wealth creating impact, although for some

products, that might also have a social or welfare impact. Through the period from 2008 to 2013, the Institutes met with over 1000 companies and facilitated the technology research and development of over 300 products and processes.

Since 2008 a number of Knowledge Transfer Programmes (KTPs) have been successfully initiated. These have occurred between the staff in the School of Engineering and the Built Environment and a number of companies including Axon Cable Ltd., whose initial contact with Edinburgh Napier had been as far back as 1990. The Axon Cable project developed a cable flex-life determination tool which is now available to all their design engineers worldwide and allows flex-life/material/cost options to be tested rather than to rely solely on engineers' experience and feel for structures. This reduces costs and time to quote, as well as giving confidence to the customer in the design processes.

Other KTPs include Technical Fibre Products (TFP) Kendal: who manufacture high performance non-woven materials for various industrial and high technology applications. The development of composite materials for EMC applications led to the KTP developing new lightweight novel materials and manufacturing processes and the company moving on from being a traditional paper products producer to a company with many other outlets including aerospace and military. A measure of the success of these types of programme is their continued implementation in the company processes and often worldwide handover after the completion of the locally undertaken project and the completion of higher degrees by the associates.

Some of the research provides deeper understanding of devices and systems and is undertaken in collaboration with engineers in companies worldwide; as is the case in the ferrite circulator work, which finds use in MESL Microwave, the former Filtronic Comtek and Apollo Microwave Canada. Again this directly influences the design processes within companies, which has consequent benefits to those they supply.

There is long term infrared (IR) sensor work sponsored by Pyreos Ltd, who also have access to some of the specialist equipment built up by the School's Signals and Systems group over a number of years. Here again the immediate impact is at the design and prototype stage.

Industry is directly involved in the setting of the research agenda for the fundamental wood quality research (the Strategic Integrated Research in Timber network) through regular project management meetings, seminars, and discussion workshops. Other mechanisms include participation in British and European Standards committees and industry mirror committees such as UK Timber Grading Committee.

Those involved with the unit of assessment, having been grouped around centres within specific Institutes, can progress ideas to the next stage of commercialisation through the university central unit which helps with all aspects of commercialisation from IP protection to full development of spin-out companies. This has happened successfully with two recent companies; Funky Moves and CardioDigital; the latter having been bought out by an even larger company in the field of medical instrumentation.

Consultancy with companies ranges from basic testing for product development and standards compliance through to expert services. These include development of new settings for MiCROTEC grading machines that have increased yields for saw-millers while also allowing economic extraction of higher timber grades than was previously possible.

Examples of company involvement with the Institutes through KTPs and consultancies include: BSW timber, James Jones and Sons, Forest Research, Scottish Enterprise, Buccleuch woodlands, UK Forest Products Association, Raytheon, SELEX SAS, ECA Technology, Microspheres Technology Ltd, Verdex Ltd, and Tullow Oil, and SFX.

Staff involvement with industrial consultancy and research is encouraged within the School as a mechanism for continued professional development and practice, and also so that current industrial and research practises can feed into the teaching at undergraduate and postgraduate levels.

**c. Strategy and plans**

The on-going strategy of UoA13 is to grow the number and types of impact through applied and 'contract' research. Recognising that the Institutes have strong links with industry (mainly small to medium sized enterprises) the strategy is to increase these links and to extend them to include larger international companies and the wider community. The route to impact with industry can be

**Impact template (REF3a)**

quite short with applied research results leading to timely impact on production or profitability. Forest resources are utilised across a wide range of industrial sectors (from pulp & paper, biopolymer based materials and textiles, right through to packaging, engineering and construction) and are essential in supporting Europe's transition to a more environmentally sustainable economy, reducing wastage for current industry through earlier assessment of wood quality, improved forest management and application of better grading technology. The strategy for FPRI will be to engage more effectively with these sectors and to continue to inform Government on longer term strategic issues, such as forest planting in response to forest policy, climate change, pests and diseases. Working with Forestry Commission and Scottish Enterprise this is anticipated to produce long term environmental, social and economic impact. Additionally FPRI's influence will transform a range of forest resources across Europe into high value products through fundamental and applied research, knowledge exchange and education. The commercial impact will largely be seen through those to whom there has been a transfer of knowledge. Some of the more 'blue skies' research into cell structure and its modification will initially impact the scientific community, form the basis of patents and start to deliver commercial impact by the formation of spin outs or again through knowledge transfer to existing industry.

IPDM's impact strategy is to continue to organise and undertake knowledge transfer activities of all kinds with mainly engineering companies in the UK and Europe, in the areas of microwave engineering, sensor systems and process control which have significant local and global interest and hence produce short to medium term economic impacts. The impact of the work in engineering materials will continue to be felt by SMEs across the UK and Europe through knowledge transfer activities which contribute to economic and social impact.

In both institutes there is a longer term fundamental type of research which will have the capability to be commercialised through various spinout routes and otherwise deliver impact. Some of this has already started in regard to cellulose fibre technology and advanced material coatings of interest to the oil industry.

**d. Relationship to case studies**

Case studies presented as part of this submission are derived from activities within both Research Institutes:

1. Mechanical properties of UK grown timber – improving quality and reducing waste
2. Signal Analysis Solutions for the Medical Device Industry

The case study on the mechanical properties of UK timber has a different set of routes to impact. The fundamental research has influenced EU Standards for timber grading. This in turn has opened avenues for a wide range of beneficiaries, from growers (tree breeding for stiffness) and saw-mills to timber frame construction companies. The impact on these beneficiaries has been in improving their processes, which have fed into their profits and benefits to customers. Construction companies have benefitted from an increase in suppliers of quality construction timber.

The case study 'Signal Analysis Solutions for the Medical Device Industry' has helped form the routes to commercialisation within the university. The fundamental research work in the representation of fluid flow using wavelet transforms quickly showed promise in blood flow characterisation and also into the medical diagnostic field. This led to the establishment of a spin out company which developed the commercial application of the work and provided direct impact in aspects of health and welfare through subsequent treatment and monitoring of patients. The company also created financial impact for new employees and profitability for the initial and subsequent companies.

Both case studies show different routes to impact because of the nature of the underlying research. In one case it was fundamental in nature, applying a new mathematical technique to the understanding of blood flow in humans. In the other it was understanding the nature of siculture in UK and Europe leading to the development of new processes and procedures for the forest products sector. Both have provided financial impact directly to industry. Additionally the 'Signal Analysis Solutions' case study shows it has had and will continue to have a direct health impact in the community.