Institution: Glasgow Caledonian University

Unit of Assessment: 15 General Engineering

a. Context

The aim of the Unit is to generate impact through the managed exploitation of focused applied research output in collaboration with key industrial and civic partners. The Unit has submitted three case studies that reflect impact beyond academia. The range of underpinning research which has led directly to the impact as described in section b covers the work done by three of the four research themes of the Unit, namely; Diagnostic Systems and Sensors, Energy and Power Systems, and Engineering Processes and Manufacturing. The published output in these areas cover; methods, tools and products for condition and environmental monitoring, reliability and availability techniques and systems, and multi-phase flow modelling and measurements. The industry sectors which have the longest standing collaborations with the Unit staff are energy generation, supply and relevant support industries, [e.g. EDF and Doble], the principal benefit to these companies is financial with secondary environmental benefit through increased reliability and availability or waste reduction. A large investment has recently been made in the Environmental Technology and Management (ETM) area applied to water quality measurement with expected outcomes which will influence water management policy and regulation throughout Europe. There is also significant research activity in the transport, manufacturing and process industries though, for example, company funded research studentships and knowledge exchange. The overarching theme of the Unit is the development or use of sensors and instrumentation and the diagnostics of the data obtained from measurement. For example, the development of two products which are used for condition monitoring in HV plant, the development of a novel method of particulate solids mass flow measurement, and analytical measurement of water pollutants.

b. Approach to impact

The Unit makes interaction with industry a strategic priority and is pro-active in developing and sustaining these relationships. The current impact that these activities bring has been principally through the development of products or process improvements which results in benefits to company turnover, environment, sustainability and staff recruitment. We are directly involved with both multi-national companies and organisations who have inherent reach in disseminating and benefiting from our research, and with SME's who typically provide goods or services to a wide market. Alongside formal partnerships with Doble Ltd and FMC Technologies Ltd, knowledge exchange activity is seen as being of major importance in delivering impact to the community beyond academia. GCU and in particular staff in this Unit have been highly successful in engagement in KTP's with for example, Mahle Engine Ltd (El-Sharif, 2010), VAG Valves Ltd (McGlinchey, 2010), FirstScot Rail (Alikalli, 2013).

The Unit is actively involved with non-academic users through industrial collaboration, knowledge exchange and consultancy. The unit has long standing relationships with power generation companies (e.g. EDF) which has provided the inspiration and support for £270k of EPSRC funding and resulted in direct funding of £1.34M. The unit's research work in sensors and instrumentation has been supported by the establishment of a partnership with Doble Ltd to a value of £1.6M and the establishment of the FMC laboratory at GCU which has also secured 3 PhD studentships and 2 Knowledge Transfer Partnerships. Other consultancy and KTP's range in industries from; instrumentation, nutrition, light manufacture and rail transport.

The achievement of staff in impact producing activity is recognised through the University's formal performance review process, and in staff promotion criteria, and rewards and incentives scheme. Achievements are also celebrated in University newsletters, and website. Each member of UoA15 staff and each research theme develop an impact plan which is complementary to the School and University targets. The progress of each operational plan being discussed as part of the individual staff member's annual performance review. The Unit is well aware of the need to respond quickly to the rapidly changing demands of industry partners and the commercial environment and to act quickly in response to opportunities as they arise. For example, from a single root source in electrical condition monitoring, two highly successful projects with dedicated staff and resourced facilities were developed in response to both research direction and area of application as detailed

in impact case studies 1 and 2.

c. Strategy and plans

The strategy of the Unit is active engagement with major industrial or civic partnerships in applied research to solve real world problems. This involves providing the appropriate resources for industrially relevant research activity to be undertaken, the output of that research to be effectively disseminated both within and outwith academia, continuous linking with industrial partners to produce mutually beneficial and on-going outcomes and developing procedures to quantify the impact of those outcomes. Along with continuation of successful areas in electrical condition monitoring, two research areas identified to have potential for significant impact over the next period are multi-phase flow and water quality, both have approved significant future investment in facilities and staff. The water quality research has recently succeeded in gaining £1.8M in EU funding. The unit has two broad strategic strands to impact generation and measurement leading from the research activity of staff:

The strategy adopted post RAE 2008 has led UoA15 to a position where we: have increased the number of staff being submitted by 110%, with the concomitant rise in outputs to 74; increased our PhD completions by 30% and secured £3.68M of research related income and have direct support from major multi-national companies. [EDF Ltd, Doble Ltd, FMC Technologies Ltd].

Post REF2014 we intend to work with an expanding network of industrial partners to generate impact by working to:

- expand our research active staff base through a combination of staff recruitment and development as detailed in REF 5.
- develop and integrate research focusing on increased end user competitiveness, sustainability, technological advances and internationalisation. In particular, working collaboratively with EDF, FMC Ltd and Doble, and with European partners in the water quality area.
- consolidate and increase research effort on the development of novel sensors and instrumentation, process and reliability modelling, and manufacturing automation.
- Develop young and new areas of research; water treatment which has already attracted £1.8M in FP7 funding, and in multi-phase flow with a proposed collaboration with TUV-SUD-NEL.
- enhance engagement with organisations with established industry networks, for example, CEED, Scottish Enterprise, West of Scotland KTP Centre, GCU business development support network, GCU European Office, Innovation Centre in Sensor and Imaging Systems, etc.

Impact will be managed and enhanced by the following:

- A senior member of research staff will have a dedicated role to champion and manage the culture change required to embed the impact paradigm within the Unit.
- Research theme leaders will be given training in the definitions and quantification of impact relevant to the funding councils and REF2020 which they will cascade within their teams.
- Each research project team and / or PhD supervisory team will have (at least) one member identified as being responsible for impact.
- Criteria for support of research activity within the Unit will include a “pathway to impact”.
- The Unit’s research output will be disseminated through publication in high quality open access journals as identified by each Research Group and approved by the ISETR review panel.
- Subsequent impact will be disseminated to as wide an audience as possible, though media events, seminars, social media, conferences and bespoke outlets as appropriate determined in consultation with the University Communications staff. This publicity will attract future enquiries and opportunities.
- Impact will be recorded and monitored in PURE, with feedback to individuals and Research

theme leaders and the Unit leader.

- Input will be received on impact generation from the ISETR Industrial and Academic Advisory Board and used by the Unit to inform strategy and activity.
- The Director of the ISETR will host regular networking events for academic researchers and industrialists from key industries, both current partners and potential beneficiaries, who can help inform decisions on activity prioritisation to maximise impact.
- The Business Development team within the School following training in impact measurement will have an increased role in identifying new business / industrial partners and converting research activity to knowledge exchange and consultancy activity to maximise impact.
- A strategy within the unit is to target "blue chip" research funding. The application process to these funding bodies will be aided by review by the ISETR Impact Panel.

Data on impact has been gathered by a survey of industrial partners. These data are fed back and disseminated to academic staff through the research management structure and are recorded in PURE.

d. Relationship to case studies

The three case studies demonstrate our engagement with business and industry. This is achieved in a number of structured and informal ways. Two of the case studies [McMeekin and Zhou] describe the impact that arose from research that was undertaken with the involvement at the outset of industrial partners [Doble and EDF] who would go on to be the eventual beneficiaries of the work. The other case study [McGlinchey] resulted from a dissemination of the work of the Unit to Murphy Pipeline Ltd through a dedicated website.

The principal beneficiaries of the research produced by the unit described in the case studies are:

1. Doble Engineering, a multi-national with 110 offices around the world in the business of diagnostic instrumentation and services for energy generation, delivery and industrial users. Doble Engineering has developed a new diagnostic instrument product line and associated services based on research conducted by the unit. A new £1.2M Doble Centre for Innovation has been established at GCU to work to improve the measurement and assessment of the condition of high voltage systems, the identification of new opportunities to enhance the reliability and integrity of power stations and the development of new products and technologies.

2. EDF Energy, who are a wholly-owned subsidiary of the EDF Group, one of largest energy groups in Europe's. The electrical power research conducted by the unit to develop new algorithms and test apparatus enables EDF to improve reliability and availability of energy supply in the UK. Further developments within this area have been adopted by Wuhan Electric Power (China) demonstrating the international reach of this work.

3. Murphy Pipeline Ltd, part of the Murphy Group who are a major multinational company in the building and civil engineering sector. The research in the area of pneumatic conveying led to the modelling and testing of a novel method of tunnel backfilling, which is three times faster than traditional methods, resulting in £1.5M saving and an environmental award on a single project and is now considered best practice. A significant future investment in the multi-phase flow area has been approved.