Institution:	University of Northumbria at Newcastle
Unit of Assessment:	15 - General Engineering

a. Context

The Unit's main non-academic user groups are governments, industry and consumers. The main impacts associated with this Unit are on manufacturing, for both industry and consumers, and government policy. The Unit has achieved a variety of research impacts through knowledge exchange and public engagement

b. Approach to Impact

Throughout and before the REF period individual groups and individual academics developed and matured relationships with external stakeholders, research users and beneficiaries built upon research and supported by the Unit and the University processes. The key approaches to research impact that have been adopted are:

1. Academic-led collaborative research, through funded grant proposals to Research Councils, the EU and other funders;
2. User-led collaborative or contract research arising from industrial needs brought into the University by academics or our externally-facing Research Development Managers and supported by the University's Higher Education Innovation Funding (HEIF) or Technology Strategy Board (TSB) programmes, e.g. Knowledge Transfer Partnerships (KTPs);
3. Consultancy, industry training programmes and access to equipment for research;
4. Public engagement events in the region, nationally and internationally, explaining the Unit's research and which are now supported by a Public Engagement Manager;
5. Professional body meetings and seminars, and industrial membership of a Faculty Industry Advisory Liaison Board providing awareness of research expertise and industry needs.

1. Academic-led Collaborative Research

The Unit's history and culture has long been one of engaging industry during the preparation of research proposals and their subsequent delivery. In EU funding this has been essential, and more recently EPSRC has formalised this through Pathways to Impact. Recent examples include,

- EU grants ATHLET (2006-2009), PERFORMANCE (2006-2009), PEPPER (2010-2013), KESTCELLS (2012-2016) have included high profile European companies as project partners such as **Shell Solar GMBH**, **Bosch Solar** and **Linde Group** where the companies have access to state-of-the-art solar energy research findings.
- EPSRC SUPERGEN grants (2004-2008) and (2008-2011) have included key industry companies as project partners, such as **BP Solar Ltd**, **First Solar Inc**., **Pilkington Technology**, **Semimetrics Ltd**, **Sharp Manufacturing (UK)** where the companies provided research direction to the consortium and were able to exploit the research results.
- EPSRC STAPP grant (2011-2015) is an internationally collaborative project with partners such as **National Renewable Energy Centre (NAREC)**, **Reliance Solar Shurjo Energy**, **TATA BP Solar Ltd**, to strengthen solar energy research in UK and Indian companies.
- EPSRC power grid grant (EP/F06148X/1, 2008-2011) included **Scottish and Southern Energy plc** as partner, where the research findings feed into SSE wind power delivery.
- EPSRC energy systems grant (EP/F061811/1, 2009-2012) included **EM Renewables Ltd**, **GE Global Research**, **Mott Macdonald UK Ltd** and **NAREC** as partners. These partners have access to the latest renewable energy research findings.
- EPSRC award, (EP/K014803/1, 2013-2016) includes three project partners (**Dolomite Ltd**, **L-3 TRL Technology** and **Merck Speciality Chemicals Ltd**) with specific responsibility for commercialisation advice and benefiting from early insight into the research.

2. User-led Collaborative or Contract Research

The Unit has a history of using its research-derived expertise to respond to industrial needs *via* the University's HEIF funding, direct company funding, and TSB and Government funding schemes. Recent examples include:

- **Renown Engineering** (KTP 2010-2012) to improve engineering products and services for

the marine, petroleum, offshore, energy and defence markets. This project led to Renown having the capability for bespoke design, analysis and manufacturing which opened up new markets for the company and was highlighted by the TSB as: "*Outstanding*".

- **Ascendant Access Ltd** (KTP 2009-2011) to design new safety-critical high reach access platforms. This project led to a New Product Development process and enabled Ascendant to design the High lift product. TSB rated the KTP as: "*Very Good*".
- **Avid Technology Group Ltd** (KTP 2012-2014) to apply computational fluid dynamics/structural analysis to the design of key products for low/zero emissions vehicles.
- **Safinah Ltd** (KTP 2012-2015) which is developing new test methods and marine coatings.

3. Consultancy, Industry Training and Access to Equipment

The Unit provides more general open-door industry access through the University's Research and Business Services (RBS). The University has an "Open for Business" philosophy to enable companies to access expertise (http://www.northumbria.ac.uk/business/expertise/), funding, equipment and facilities. To facilitate companies' knowledge of, and access to, equipment the University maintains a **"Kit Catalogue"** via a weblink (http://kc-northumbria.lboro.ac.uk/).

- Examples of consultancy services to international companies, arising from the Unit's microwave research include **Doby Verrolec**, **Texecom Ltd** and **MM Microwave Ltd**. Activities include providing specialist knowledge into product design and testing.
- Examples of training staff from international companies include **Sirte Oil Company**, **Mellitah Oil and Gas** and **National Oil Company Libya**. These examples are based on research in telecommunications, instrumentation, electrical and mechanical systems.
- Examples of the use of our specialist research equipment include the NSI system for near-field antenna measurement (**MDS Space & Robotics Ltd** and **MM Microwave Ltd**) and the anechoic chamber for wireless system characterisation (**Texecom Ltd**).
- The Unit's Electron Microscopy facility, which routinely underpins our research, provides materials analyses and stress corrosion testing to companies (e.g**. ABB Ltd**, **BAE Systems**, **Black & Decker Ltd**, **Parker Hannifin Corp**, **Draeger Ltd**, **Nissan Cars Ltd** and **Siemens Energy Service Fossil plc**).

4. Public Engagement

The Unit's academic staff have a long standing commitment to communicating the excitement of their research through public engagement. Recent examples include:

- **Newcastle Science Festival** at the **Centre for Life** (March 2012) where "*Visible Light Communications*" and "*Using Solar Electricity*" exhibits, and a "*Sound and Vibration*" hands-on experience and lecture were provided, based on the direct research of the Unit.
- **British Science Festival** (September 2013) where the Unit organised an interactive session on "*History of lighting to the era of light-based communications*", a drop-in session on "*Stress monitoring by telemetry to increase safety in transport*" and a talk on "*A Brilliant Future: How sunlight will wave goodbye to our fossilised past*" based on the Unit's research.
- **Nature's Raincoats Exhibit**, a hands-on exhibition explaining new materials for super-water-repellency, was exhibited at **Techfest** (Mumbai, Feb '12; by invitation and sponsored), **Big Bang Fair** (London, March '13), **BBC Summer of Wildlife** (Cardiff, June '13; by invitation and sponsored) and the **British Science Festival** (Newcastle, Sept '13).
- **Nature's Raincoats Website** (www.naturesraincoats.org), a linked website which has ca.7,000 hits per month, provides a section "Work with Us" as a pathway for companies and educators to access water-repellent materials research. Two examples are i) images for a **Brazilian textbook** (Conexões com a Química, volume 2, obra coletiva, 1ª edição) and ii) an invited appearance and a film in the **Royal Institution** *"Cutting Edge 2012: Research Behind Sailing*" Grand Debate (part of the **RCUK** sponsored 2012 Olympics celebrations of the role of scientific research www.rcuk.ac.uk/media/Pages/CuttingEdge2012.aspx). Funding to further develop Nature's Raincoats is included in EPSRC grant EP/K014803/1.

5. Professional Bodies and Industry Membership of Advisory/Liaison Boards

- The Unit routinely hosts and provides facilities for professional body meetings and seminars

(e.g. **IET Northumbria Branch**, **IoP North East Branch** monthly meetings and **IEEE UK&RI Communications Chapter**) thereby facilitating academic/industrial contacts.

- The Unit showcases its research expertise and identifies industrial needs via the **Faculty Industrial Liaison Board** and as part of an annual awareness raising **Faculty Show** to which Industry Board members and Visiting Fellows and Professors (including industrialists) are invited. The Advisory Board includes key people from international companies such as **Parsons Brinckerhoff**, **GE Oil and Gas**, **Caterpillar** and **Alcan**.

c. Strategy and Plans

Since RAE2008 the Unit has been developing and embedding a more structural approach to impact. This involves i) improved understanding and training of academic staff, ii) coordination of activity through key staff designated as Business & Engagement Champions, iii) more systematic recording and tracking of contacts, and iv) support and resources to achieve impact. In brief:

1. **Understanding & Training of Staff** - All new staff are required to attend a mandatory "*Introduction to Impact*" workshop within 6 months of joining the University, which explains impact, its importance and how to achieve it. Training and support for staff in preparing applications for external funding of research includes a specific focus on the EPSRC concept of Pathways to Impact. Public engagement training has been improved through the appointment and activities of a University-funded Public Engagement Manager.
2. **Business & Engagement Champions** – One senior member of staff in each Department now formally carries a Business & Engagement responsibility. These staff act as coordination points between the University's Research & Business Services and Unit staff providing advice to both central support staff about the academic research and facilities, and to academic staff about central support (e.g. HEIF funding, KTP support, contract research, services, intellectual property protection, spin-out formation).These staff have knowledge of previously successful relationships with users and help academic staff make appropriate contact via advice and the CRM database.
3. **Recording & Tracking of Contacts** - A dedicated Client Relationship Management (CRM) database detailing external organisational contacts and previous interactions with the University is being developed. This will be made available to the Business & Engagement Champions as a resource to assist in coordinating and advising staff.
4. **Support & Resources** – The University has significantly restructured its approach to HEIF funding with the provision of innovation project awards (£6k +VAT) to companies to seed-fund research and consultancy projects, and innovation vouchers for access to University expertise. In 2013, the University restructured its support to provide a Faculty-based externally-facing Business Development Manager who liaises with companies to identify their needs and to match them to the Unit's expertise for KTP, TSB and EU schemes.

These developments complement and enhance, rather than replace, the Faculty's continued support and development of academic relationships and collaborations, consultancy, industry training and access to equipment, public engagement, professional body engagement and industry liaison boards and Faculty Shows, which have all proved successful in generating impact.

d. Relationship to Case Studies

Case Study 1: "Improving Performance of Metal Cutting Tools for SNA Europe"

This shows how successive collaborative research projects, starting in 1998, led to a preferred partner status with SNA Europe (a world-leading producer of metal cutting and hand tools for machine building, construction and agriculture industries) who directly funded research.

Case Study 2: "Development of Novel Low-ohmic Thin Film Resistors for TT Electronics plc."

This demonstrates how the Unit's materials research led to an invitation by TT Electronics plc (a global electronic company) for a joint Industrial Fellowship (The Royal Commission for the Exhibition of 1851) in a user-led research project to develop novel low-ohmic thin film resistors.

Case Study 3: "Guiding the Implementation of Photovoltaic Systems in the UK and Europe"

This shows how knowledge built in successive collaborative EPSRC and EU research projects, coupled with complementary DTI funding on field trials, led to key knowledge on photovoltaic system operating characteristics that informed UK and EU governmental policies.