Institution: University of Nottingham

Unit of Assessment: 16

a. Context

The Unit vision is to improve society's environmental, social, cultural and economic sustainability through fundamental and applied research across both architecture and the built environment; reinforced through our integration with the Faculty of Engineering (2009). The impacts of this interdisciplinary research unit are economic, public engagement, environmental and practitioner. Beneficiaries include large multinationals (e.g. BASF, St Gobain), nationals (e.g. SiG plc, Zedfactory Ltd) and SMEs (e.g. European Thermodynamics Ltd, Nottingham City Homes) as well as professional bodies (e.g. RIBA), research laboratories (e.g. BRE) and the public. We also continue to work with trade and industry organisations (e.g. TensiNet). Our research structure reflects our multidisciplinary approach to impact, in which subject-specific research groups are brought together into our themed research divisions of Energy and Sustainability and Infrastructure, Geomatics and Architecture.

Exemplars of our approach include:

- Enhancement of public understanding and perception of new technologies, achieved through public engagement events, especially those conducted at the six Creative Energy Homes (CEH - our showcases for low energy housing). A further example is our work with artists exhibiting in open-air city-environments to engage with new audiences (Arts Council-funded 'Moving City' project and the EPSRC-funded Towards Pervasive Media project EP/H024867/1).
- Industrial, environmental and economic impacts as a result of development of new technologies and products for industry (Case Studies ABE02 and ABE03). Activities include quantification of cost, benefits and time for return on investment. We also engage in proof of concept projects, often building demonstrators to evidence deployment potential and to further develop the technology, ready for market.

The reach of our impact is extended by our close links with researchers on our China campus who, together with the University's Asia Business Centre, enable us to develop partnerships in this region; an example is the Memorandum of Understanding between Chinese automotive company FAW and the Unit's HVACR + Heat Transfer Group to establish a joint laboratory on low carbon vehicle thermal management and heat transfer.

b. Approach to impact

During the period, our approach has been predominantly 'bottom-up', supporting our staff to identify the potential for the achievement of impact arising from their research activities and subsequently achieving and capitalising on this.

Supporting staff in the development and delivery of relationships with key users.

The Unit forms part of the University of Nottingham's Faculty of Engineering (the remainder of which is submitted to UoA15), and benefits from the Faculty's support structure. Support to achieve impact from research is provided primarily through the Faculty-funded Research and Business Development Team (9.2 FTE), who provide direct advice and support to the full range of research and commercialisation activities, including a post to focus specifically on identification and quantification of potential impact and the facilitation of commercial exploitation of new inventions and IP. Other Faculty Support includes Project Costing Officers, Marketing services (for assistance with writing and designing marketing material for externally focussed facilities and events, design and construction of web pages to support the above and other marketing activities) and an Event Organiser supporting events such as conferences (e.g. *Designing Place*) and exhibitions (e.g. *Prototyping Architecture*); many targeted at industry directly. These services underpin our strategy to both technology pull (e.g. through formation of strategic partnerships), and 'technology push' (e.g. through collaborative research partnerships and PhD's). This enables us to be agile in our approach, ensuring that the most appropriate mechanism is employed to derive research impact.

Additionally, direct funding is available to Research Groups and their parent Divisions to facilitate their own efforts to form research partnerships – including travel for the preparation of international projects and to support proposal development.

Exemplars of relationships

The success of our approach is exemplified through our awards from industry: total new awards secured directly from industry for research during the assessment period are £1.7M across 35 projects. We also receive funding from industry through EU, EPSRC and other collaborative projects. The total value of our new awards for the assessment period is £9.7M (114 projects).

SME Ashwell Biomass Ltd (formerly Ashwell Engineering Services Ltd) has partnered with the Unit since 2008, when Ashwell was a collaborator in the EPSRC-funded project 'Small Scale Biomass-Fired CHP System' (EP/E0020062/1 £134,976). Subsequent collaborations between the Unit and Ashwell include the TSB-funded 'Integrated Biomass-Fuelled CHP/Cooling System' (Ref 200077, £560,658, Unit: £170,704) and a Carbon Trust-funded project to develop a low emission biomass boiler for Ashwell's small scale/domestic applications ('Small-scale wood and non-woody biomass pellet boiler with low NOx and particulate emissions', Ref 089-0514, £441,694, Unit: £115,000). These 3 projects have all delivered improvements in the combustion and emission performance of Ashwell's product ranges. Ashwell and the Unit have continued to partner in other funded projects.

Our partnership with Roger Bullivant Ltd developed new energy-saving technologies and allowed the company to develop a new consultancy service for other housing developers. Monodraught Ltd has also collaborated with the Unit since 2008, including through a Knowledge Transfer Partnership (KTP) project. Technology based on this collaboration and a subsequent licensing agreement has enabled Monodraught to successfully expand their product range (Case Studies ABE02 and ABE03).

A KTP project with the Mark Group has enabled the Group to offer a wider product range to its customers, and engagement with a broader customer base. Beyond this, the Mark Group has continued to work with the Unit and has funded a new 'home' (one of our CEH development), in which new insulation materials are evaluated.

Institutional Support

The Unit works collaboratively with other institutional resources outwith the Faculty including; the Partnerships Team who provide strategic support for key industrial partnerships; the Technology Transfer Office; a Contracts Officer to ensure appropriate legal agreements are in place and KTP Officers (reflecting the direct route to impact arising from KTPs) to support the formation of new KTP projects. The Unit recently established a Faculty-based Technology Demonstrator to showcase our technologies, in response to the success of our involvement with the University Technology Demonstrator which reaches around 200 companies per annum through visits and events.

New academics and early career researchers are also provided with mentoring at Faculty and Research Division/Group level, and specific RBDM support. Opportunities for involvement in collaborative projects to build experience and develop contacts are also actively provided.

To incentivise our staff we have a reward process in addition to the normal excellence based promotions routes. Where technology is successfully commercialised through a patent and subsequent license, staff are rewarded through a share of the license income generated (50% up to £25K and 40% above this). Staff are also allocated 50 days per year to deliver external consultancy and there are mechanisms for financial reward through payments from professional services projects. An exemplar is design work incorporating outputs from research for a sustainable office complex undertaken for the Ordos Dongsheng District Urban Planning Bureau in China (Heath). Most licence deals are also supported through extensive consultancy agreements with the academic inventors. The Unit has filed 16 patents and concluded 2 licensing agreements, leveraging income of £200k.

The achievement of impact in all its forms is also recognised through the annual personal development and performance review process.

c. Strategy and plans

As indicated above, our previous strategy was principally 'bottom-up' or investigator-led. Our future strategy will complement and reinforce this approach through a series of 'top-down' initiatives.

Within this framework, the Unit's vision is to deliver maximum, measurable impact from its research to a broad beneficiary group. Deriving stakeholder benefit from our research has been the goal of our impact strategy, and we are now further focussing our delivery; aligning and building on the

University's Knowledge Exchange Framework.

Based around current and new areas of research excellence, our 'top-down' strategy is to achieve impact through a series of Grand Challenges (a current example is Energy), delivered through high quality, collaborative partnerships. Each multidisciplinary Grand Challenge reflects an objective driven by (or with clear potential for) stakeholder engagement and will draw on discovery-led research through application-led development to implementation. Further emphasis during the translational stage will ensure additional success in bridging the traditional 'valley of death' at this stage of development. Our 2014 challenge mapping exercise, will inform the Unit's next generation Grand Challenges.

Our top-down strategy to ensure these Grand Challenges deliver impact will be underpinned by the following core pillars;

People – the Unit will continue its focus on the recruitment and support for exceptional people. Strategic investment in staff to support Grand Challenges will be made while opportunities for key staff to take each challenge from conception, through research to the achievement of impact will be reflected through systems such as extended leave schemes and workload modelling.

Leadership – recognising the different skills required of successful leaders in this extended developmental environment, the Unit's 'Future Leaders Programme' (already providing a framework of opportunities and skills to create the multi-skilled leaders required to steer its Grand Challenges) will be extended to a wider staff group.

Training – building on our existing provision, experience-led training for staff specifically focussed to support the research process from discovery to adoption will be provided.

Measurement - Success is monitored throughout the project life cycle through metrics and indicators, both direct (new/additional industrial income, increased engagement of staff throughout the research lifecycle, new company formation, licence income) and where possible, indirect (new jobs created, stakeholder profit arising from the Unit's research).

Mentorship – This will underpin our strategy, drawing support from a wide range of individuals across the Faculty and experienced in all aspects of the research-to-commercialisation process. Mentorship from experienced staff in UoA15 will be instrumental here.

Investment – The Unit will invest strategically in infrastructure to support Grand Challenges both in terms of pump priming early stage research but also to provide technology demonstrators to help bridge the "valley of death".

Processes and Systems – We will further develop our processes and systems, building on our experience from REF 2014 to ensure that these meet needs as an impact-driven Unit.

The cornerstones of our 'bottom-up' strategy will continue to revolve around strong RBDM and institutional support to individual academics and research groups, access to flexible funding to support impact-related activities, marketing and event organisation. It will also be crucial to access study-leave schemes to maximise engagement in impact-related activities, along with targeted secondments with stakeholders including industry (e.g. EPSRC Impact Acceleration Account funding and the Royal Academy of Engineering Industrial Secondment Scheme).

d. Relationship to case studies

Working with end users through our CEH development (Case Study ABE01) exemplifies the breadth of our approach to impact. Collaborative working through fundamental research (EPSRC funding) through to user-driven uptake of technology via KTP projects and uptake of new thinking in building design have all provided a means to deliver the impact outlined. Prototype development and testing, augmented by software developed through a KTP project with Monodraft to provide product visualisation and energy performance calculations underpins the new product launch described in Case Study ABE03. Intellectual property based on research conducted during the FP4 'TRIPLESAVE' project (1998 – 2000), and subsequently licensed to an industry partner, underpins the development of COOLPHASE®, resulting in the impact described in Case Study ABE02.