Institution: Brunel University

Unit of Assessment: 15 General Engineering

a. Context

The ethos and expectation of impact was built into the Royal Charter at Brunel University's inception in 1966 – stating that the institution would undertake ***"research and enterprise for the benefit of individuals and society at large."*** This initial commitment to "impact" created an institution with an applied research focus and an educational programme in which nearly all students studied on sandwich programmes. Our multidisciplinary research themes are serving non-academic beneficiaries across different sectors in the private and public domains, but can be broadly characterised in the following manner:

Sensors and Systems: national infrastructure providers, energy companies (oil, gas and nuclear), defence contractors, health service providers (public and private), and the transportation sector (aerospace, rail, and marine). The companies and organisations we engage with range from SMEs to nationwide organisations, and globally distributed companies. Although large-scale, mostly these are niche applications to solve a specific problem. But for the provision of diagnostics to the health sector, we have achieved impact in the end-to-end provision of a service.

Communications and Signal Processing: mobile telecom services providers, data network owners, and media broadcast organisations. Most of the organisations with which we engage – by necessity – have global reach. They are mostly offering services, either directly to the public or business-to-business, rather than being manufacturers. Our impact here is generally achieved with algorithms and methodologies which allow effective and efficient ways to transmit ever increasing amounts of data.

Manufacturing Systems and Design: our ultraprecision technologies are highly versatile and widely applicable across the manufacturing sector. From providing specialised niche applications to being embedded in mass-manufacturing processes, the impact of our research is directly visible in some globally famous and ubiquitous products. The impact has been delivered along the whole manufacturing process – in sub-systems manufacture and finished products. The environmentally sensitive design activities are in demand from the electro-electronic industries, particularly SMEs. The impact is achieved through whole value-chain analysis for sustainable consumption and has proved attractive to large and small companies.

Biomedical Engineering: medical device manufacturers, practicing clinicians and surgeons, and the pharmaceutical manufacturing industry. The medical device manufacturers tend to be SMEs, whilst the pharmaceutical manufacturers are global entities. Our engagement with those in clinical settings are all in the public sector. Our impact is generated through the invention and testing of implantable medical devices and the creation of novel bio-processing methods.

b. Approach to Impact

Our approach to impact in Engineering exemplifies the ethos of the University and is keyed into the University Strategy for Achieving Impact. The Research Support and Development Office (RSDO) provides the central support for each School's and the University's impact strategy and activities.

Whilst the nature of research (even applied research) suggests that not all projects will achieve significant impact, we can influence the likelihood of success. We achieve this by embedding beneficiaries throughout the project development and execution stages to understand how programmes can be shaped or primed to be able to pull through the elements suitable for exploitation. This approach has benefits in both directions.

Impact has been incorporated into the academic promotion process for MCRs and SRs. For ECRs, the start-up funds require the recipient to engage with the University's programmes on achieving impact, with the expectation that they will gain confidence in creating opportunities to interact with non-academic beneficiaries.

To facilitate this process and create opportunities for impact to develop, we operate mechanisms with specific purposes or aimed at different groups of staff or beneficiaries. Whilst the activities are common to other UoAs, the exemplars are from this UoA.

Strategic Partnerships:

Brunel has entered into strategic agreements with TWI, Jaguar-LandRover, Renishaw, and ESAB. RSDO provides personnel and expertise to support the development of strategic relationships with

industry and other beneficiaries. Long-term relationships with companies, by definition, have impact whether the benefits are financial, reputational, or serve as part of that company's long-term strategic objectives for product or process development. An example of how we have achieved impact through our strategic partnerships is that of ESAB (Welding and Cutting). ESAB asked the Manufacturing Systems Group to create a programme for their management on how to maintain their technological competitive advantage. This resulted in ESAB moving from their product-centric approach to being customer-focused. This is unusual in that a university was asked to develop a solution to create a business-critical shift.

Knowledge Transfer Secondment Scheme:
The University introduced a Knowledge Transfer Secondment Scheme to support industrialists to spend time (1-12 months, full- or part-time) at Brunel working with either an individual researcher or research group. Three examples from this UOA are: John Scott (KEMA) to work with **Irving**, Alan McMorran (Open Grid Systems) to work with **Taylor**, and Michael Kemmler (BioFocus DPI), to work with **Sutherland** and the Bio-processing Group. In Biomedical Engineering, the approach is to engage a cohort of medical practitioners as part-time Visiting Professors. They contribute as researchers and are able to put into effect the new techniques and devices. The Consultant Surgeons engaged are: C. Coulson, R. Irving, D. Proops (all QEH, Birmingham), M. Griffiths (St Michaels, Bristol), R. Hinchliffe (St George's, London), and A. Reid (Selly Oak, Birmingham).

Entrepreneur in Residence:
In late 2009, Brunel appointed David Riley to implement a programme of engagement with staff to foster entrepreneurial culture and encourage commercial engagement. The activities concentrated on SMEs and were to introduce staff to SME networks, facilitate introductions with specific companies, to teach staff about the drivers, barriers, and risks to SMEs taking part in R&D, and to help staff understand the culture within an SME and thus how to make the case to an SME to take up an invention or new process. Measures of success include the increased level of SME participation in our EU projects and the subsequent exploitation of the outcomes and deliverables.

Advisory:
We encourage senior researchers (SRs) to seek out and take up roles in appropriate companies. We see our external Advisors as part of a reciprocal partnership as this allows industrialists and other beneficiaries to present their technological and business challenges and our staff to discuss potential programmes that might address them. For example, **Cosmas** is an Advisor to the BBC, and **Mousavi** to the World Health Organisation.

IP Management:
We are able to better target support to achieve impact with our patenting activity because the University strategy is to only file an application if there is a business case for the invention. We do not file patents speculatively for all inventions that our staff bring forward. For the protection and commercialisation of IP that originates from inside Brunel, RSDO arranges seed funding, sector-relevant management support, and patent filing. Staff in this submission hold over 70 patents. Due to the University's patent strategy, we have achieved significant take-up of our patents through product development or licensing arrangements. For example, IP within the 'Ultramill' (**Cheng**) is protected by two international patents and a licence for its production has been granted.

Consultancy:
We encourage staff to take-up consultancy opportunities, especially where novel techniques or solutions can be deployed. The University has a 'Consultancy Lifecycle' process which follows up contracts in part to check how effective that piece of work was for the client and to see how it could be extended. Further work has included extended consultancy, joint projects, and patents. Each year, staff in this submission will visit over 150 students placed in industry. This allows them to remain in contact with the needs of our industrial partners, and helps identify opportunities for consultancy, short courses, contract or collaborative research, as well as opportunities for staff exchange between industry and academia.

Training for Staff:
We consider confidence building as an important step in the effective learning of the impact agenda. We do not take the view that academic staff will 'just know' or 'pick up' how to achieve impact. We offer a dedicated programme for ECRs as part of their probation. All grades of staff are

offered training in the various aspects of 'Research Impact' – how to recognise and capitalise on opportunities, demonstrating the wide variety of ways in which impact can be achieved, the barriers to engaging with non-academic beneficiaries and strategies to overcome them, and business and legal aspects. Exemplars:

- RSDO helps staff draw up 'Personal Impact Plans' as part of the promotion process.
- In 2013 we piloted the 'Brunel Impact Academy' to target ECRs and MCRs who want to improve their understanding of how best to work with companies.
- The in-house *Impact Toolkit* which is designed to be a 'self-help' package.
- Training in public engagement of the benefit of research is provided for PGRs, postdoctoral fellows and staff of all levels.

c. Strategy and Plans

With the requirement for impact embedded in our Royal Charter, Brunel will remain dedicated to creating and improving the socio-economic impact of its research. By maintaining a strong culture of business engagement, Brunel has the ideal base from which to build further capacity to collaborate effectively with beneficiaries and to respond to changing business landscapes in the global context. Our strategy aims to build upon existing strengths in terms of research excellence, strong collaborative projects with major industrial players in the sector, and a record of achieving impact in a number of sectors. We will seek to institutionalise relationships to create strategic alliances. Working at a corporate level will require a change in the way in which our academics and their industrial counterparts work to both accelerate impact, and increase its value to the nation.

Building on our current strategic partnerships, by 2020 we will be working with a small number of major strategic partners who come to Brunel for all their research services, and whose research needs Brunel commits to fulfilling. This approach changes both the nature of the active relationships from academic-industrialist to university-industry and the way in which academics are involved in the commissioning and planning of research.

Our impact strategy is linked into that of the University and will include using the resources and services provided by RSDO. To ensure and accelerate the exploitation of our research we will:

- build the culture of user engagement in our ECRs by ensuring that user-engagement is part of the mentoring process,
- appoint Theme 'Impact Champions'. They will be trained and supported to promote impact, mentor project proposals and help identify 'success stories' and case studies.
- involve beneficiaries and end users of research at all stages of research,
- use the opportunities opened up by the Brunel EPSRC Impact Acceleration Account,
- put together networks of our beneficiaries to create critical mass for business pull-through,
- address the particular challenges in achieving impact with interdisciplinary research,
- continue to work in partnership with other groups, organisations, and funding agencies to maximise the value of intellectual and financial resources.

The University will:

- measure our success in accelerating impact through defined performance metrics that embrace both take-up by beneficiaries and longer-term cultural change within Brunel,
- introduce 'Knowledge Transfer Leave' to support members of academic staff in spending dedicated periods of time engaging in knowledge exchange projects outside the institution,
- provide additional investment in media relations.

Exemplars from each theme's aims are:

Sensors and Systems: the power systems group have joined forces with National Grid and will give expert input to the planning of the European 'Super Grid' which is a collaboration of all the national transmission system operators. The aim is to apply Brunel-developed algorithms as part of the modelling process of the pan-European electricity transmission network. A key task for the Impact Champion will be to work with their counterpart in **Biomedical Engineering** to achieve better traction with medical device manufacturers – this will exemplify the difficulties of multidisciplinary working and garnering impact across boundaries. The opportunities for creating impact in data analytics are considerable as the techniques are at an early stage. But the challenge will be to convince traditionally conservative engineering industries of the added value for business advantage. Creating a critical mass of exemplars and success cases will be important.

Communications and Signal Processing: as the communications industry is dominated by a relatively small number of very large conglomerates, the Wireless Communications group will seek to capitalise on current relationships for Brunel to forge a strategic alliance with one or more of the majors. The Impact Champion will concentrate on the opportunities emerging from the fusion of media communications and content providers – there are many SMEs and the sector is well versed in adopting technologies fresh from the research environment.

Manufacturing Systems and Design: is already forming a network of key beneficiaries in micro- and nano-scale metrology centred on the National Physical Laboratory, TWI, and ESAB. The Impact Champion will be focussing on 'circular economy', drawing on expertise from across Brunel.

Biomedical Engineering: the programme of using a cohort of Visiting Professorships will be maintained – it is successful. The closer co-operation with **Electronic Systems** researchers will need careful management to maximise impact – taking up Knowledge Transfer Leave is a good option for a researcher to gain the experience required by trials to satisfy the Medicines and Healthcare products Regulatory Agency. It is especially important to engage beneficiaries and end users at the earliest stages of research. The Bio-processing group will seek a strategic alliance as process scale-up plant requires large significant investment.

We have two cross-theme plans:
EPSRC Impact Acceleration Account: is being used to set up a programme to provide opportunities to draw together researchers with expertise relevant to the automotive sector (particularly **Manufacturing** and **Electronic Systems**) but who are not yet working closely with the sector. This activity encompasses all stages of research, from conception through to eventual industrial realisation, and is leading to a new strategic level of co-operation and collaboration with the UK automotive value chain. Jaguar-LandRover, BP, Lotus, Ricardo, and Mahle Powertrain are all involved with this activity.

National Structural Integrity Research Centre (NSIRC): part of the rationale for the (Brunel-led) NSIRC is that a national facility has the critical mass, with careful planning and management, to generate globally significant impact. NSIRC has the potential to achieve unique levels of impact because of the founding principle of holistic product design for structural health and condition monitoring, prognostics, and structural health management. The sectors that we are targeting are: energy, transport, advanced manufacturing and infrastructure – which brings together our researchers from **Signal Processing** and **Sensors**.

d. Relationship to the Case Studies

The differing types of plans outlined above have been formulated from understanding how staff have achieved the impact described in the Case Studies. The detailed actions have been devised to overcome the barriers that staff encountered or to develop skills that they requested – the University's culture of conducting research relevant to non-academic beneficiaries is a necessary but not sufficient criterion to maximise impact.

The case studies '*Development of Generator Dispatch Algorithms for National Grid*' (Sensors and Systems) and '*Dynamic Extractions'* (Biomedical Engineering) demonstrate how the Knowledge Transfer Secondment Scheme can succeed and justify Brunel expanding this scheme.

The '*Ultramill*' case study (Manufacture Systems and Design) shows the power of creating a network of SMEs to leverage the collaboration required to devise and deploy such a complex instrument. The influence of Brunel and the UK SMEs combined, is now part of ubiquitous product.

The '*DTV4All*' and '*Delivering Real-Time Mobile TV Services*' (Communications and Signal Processing) case studies both exemplify the value of engaging beneficiaries right from the start of a research programme. Both cases involved multi-national multi-platform broadcasters and network service providers.

The non-destructive testing case study, '*Teletest Focus*' (Sensors and Systems), and the cross-theme '*NSIRC*' study are testament to the value of maintaining long-term relationships. Starting more than 10 years ago as a small-scale collaboration between a researcher and an industrial professional, the relationship has grown into a strategic partnership between Brunel and TWI.