Institution: Manchester Metropolitan University

Unit of Assessment: B15 General Engineering

a. Context

The applied nature of most of our research in UoA15 means that the main non-academic users are industrial companies of all scales and types. This includes multi-national manufacturing companies, such as NSG (formerly Pilkingtons), Innovia Films Ltd., Rolls Royce, Selex, Unipart Rail, Alstom, Bobst, Cristal Global and Miba; utility companies, such as United Utilities; and numerous NW SME's. In the latter case, our interaction has often been through KTP programmes. In addition, we work closely with the Home Office, the Metropolitan Police, the Centre for the Protection of National Infrastructure (CPNI) in the area of security and threat detection and with national organisations such as Railtrack and the Manchester Airport Group (MAG). Other non-academic user groups are international research institutes, such as VTT in Finland and the Fraunhofer Institutes in Germany.

The main types of impact are the development of entirely new products, materials, processes or techniques (often patented) through applied collaborative research projects, consultancies or KTPs. These collaborations have had impact across a portfolio of products and processes, leading to improved performance, greater understanding and economic benefits to the companies. We provide 'test-bed' lab-scale facilities and expert characterisation not available to companies to support their own R&D activities. In addition, we supply a steady stream of trained research scientists and engineers to our partners and into the wider sector.

Our ability to work alongside industry led to staff being approached to undertake research into rail transport-related issues, which are described in one of our impact case studies. Looking forward, our close involvement and contribution to the establishment of the Greater Manchester Hydrogen Partnership will open to the door to new research activities which will generate wide ranging impact and societal benefits through the development of clean energy programmes for waste management and transport.

b. Approach to impact

Research active staff are instrumental in developing strong long-term relationships with our key users. Contact with new companies also comes through our Business Development Managers. Staff regularly visit companies to promote our capabilities and engage them in supporting collaborative projects. This can be direct support, or support in kind for research council proposals, joint applications to internal studentship competitions, directly funded industrial or government research projects or other knowledge exchange activities. In certain cases, e.g. Prof Ben Beake of Micro Materials, relationships have developed to the point where external collaborators have been appointed as Visiting Chairs. All these approaches allow detailed understandings of the requirements of the company to be appreciated by our staff, which in turn, ensures that the resulting research activities generate the desired impact.

The majority of external research funding in this UoA comes from collaborative projects with government or industrial partners. Our strong relationships across these sectors help underpin our successful record of achieving RCUK awards. For example EP/D079195/1 (PI – Bowring) was part funded by the Home Office and the Metropolitan Police Service, EP/F003951/1 (PI – Kelly) was supported by DuPont Teijin films, Toppan Printing Co and Gencoa; EP/E003133/1 (PI - Kelly) was supported by Teer Coatings Ltd.; EP/K017306/1 (PI – Kelly) is supported by Innovia Films Ltd and Kentech Instruments. Other studentships have been part funded or fully funded by industrial collaborators including Bobst Manchester Ltd., Innovia Films Ltd., Miba Coating Group, NSG, etc and by Government Departments (for example by the Department for Transport, CPNI, the MPS and other bodies). These companies have provided support in kind, such as access to their facilities, specific materials or training for students. In addition, the Sensing and Imaging Group has longstanding collaborations, which includes substantial and on-going funding, with a number of Government Departments or Authorities to develop a range of threat detection capabilities and/or

to advise and make measurements that impact on (for example) airport or mass transport security screening technologies (see impact case study).

Where the relationship is with SME's we often provide the company's only access to research facilities. For example, an internal MMU Knowledge Exchange award is currently being used to support the development of novel anti-mist coatings for ophthalmic lenses with Brinell Vision - a micro-SME. The successful outcome of this research will open up new markets for the company, through which MMU will benefit via IP agreements.

A substantial number of successful, and in some cases award winning, KTP programmes have been conducted with, or are in progress with a number of companies, including Cartwright and Sons Ltd, Lubrizol Ltd., Heat Trace Ltd., Ferguson Polycom, Lynton Lasers, TVR, Tyrrell Systems, Laser Rail Ltd. Bobst Manchester Ltd., Rotomotive, and John Hogg Technical Solutions Ltd. The project with Cartwright, which was rated as 'outstanding' by the KTP, involved the design of aerodynamic lorry trailers and has given the firm a predicted turnover of £18M. The project with Heat Trace was also highly rated and lead to the development of a new range of heating cables incorporating composite elements with negative temperature coefficients of resistance. The Company Chairman has stated: "*In terms of these deliverables the project has exceeded expectations; the launch of a new product in such a short time is testament to the excellent innovative acumen and dedication of those involved, and to their commercially-targeted, innovation-focused rapport."* The project with Lubrizol led to the development of a filler based compatibilising system for recycling polyolefins now being commercialised under the trade name ImerPlast.

The following examples further demonstrate how our research activities generate impact:

- The Surface Engineering Group work closely with Bobst Manchester Ltd. (BML). Their core business is to supply vacuum roll coating platforms to film producers for the commodity food packaging market. Their senior management team recognised the strategic need to develop new revenue streams from higher value new technology to maintain and potentially enhance its market penetration. The extensive expertise in coating deposition processes and surface characterisation techniques provided by MMU has enabled new expertise to be developed at BML that provides a platform for further technological innovation and new product development, both of which are key elements of their group corporate strategy.
- Collaborative research conducted between Cristal Global and MMU has helped them to understand some of the more fundamental aspects of photocatalysts and photocatalytic surfaces, effectively extending their own R&D group and giving them access to equipment and, most importantly, expertise that they do not have in-house.
- MMU have played an important role in the development of new technology strategies for NSG (formerly Pilkington's). It has enabled them to investigate areas of interest that could not be justified as having immediate business payback, and therefore would not be internally funded, but which could hold the key to very successful future ventures. Specifically the relationship between NSG and MMU has allowed NSG to investigate novel materials systems using specialist sputtering plants which may be the key to new product classes in coming years.

In terms of support to staff, time for research, enterprise and knowledge exchange activities is managed through a workload model and measured through the Personal Development Review process. All Heads of Department must support "community and public engagement" as well as knowledge exchange activities. Thus, active staff are encouraged to apply for time to undertake activities and the outputs from these activities are reviewed annually. Outstanding performance on commercial or community engagement work is rewarded and recognised through an annual call for Professors, Senior Research and Enterprise Fellows, and Readers and can be linked to contribution zones. Additional support is provided by the Faculty Business Development Managers and Innovation Managers, who are available to facilitate all activities, including drawing up IP agreements, advising on consultancy contracts, providing project costings, etc. Centrally, these activities are managed through the RKE team. The School of Research, Enterprise and Innovation provides cross-faculty support through new staff induction schemes, grant writing workshops, FP7 and Horizon 2020 workshops, etc. Staff are also encouraged to participate in learned societies and

policy making committees to ensure we are closely involved with and contribute to agenda-setting bodies.

Extensive use is made of institutional facilities across this unit. For example, much of the research in UoA15 takes place in recently refurbished labs in John Dalton Tower, or in a specifically designed Engineering block, and is supported by Technical staff. These areas include specialist labs for Surface Engineering, Sensing and Imaging and vehicle Dynamics. Again, the RKE team and Financial and Legal Services provide expert support for staff undertaking all research, enterprise and knowledge exchange activities. Successful outcomes are promoted through the Central Press Office on our web site and through regular releases such as 'Research Matters'.

c. Strategy and plans

This unit is guided by the MMU Corporate Strategy i.e. *To deliver research that has a real impact on current and future global challenges.* The objective of this strategy is that '*All new knowledge created at MMU will have a cultural, environmental, social or economic, and interdisciplinary impact embedded from the start of the research application process*.' To enable this to be achieved at unit level, we are moving away from conventional research groups towards innovative translational research themes, which reflect the broader challenges being encountered locally, nationally and internationally. Our involvement and partnership with, e.g. the Home Office and the Greater Manchester Hydrogen Partnership are examples of this approach under the themes of 'Security' and 'Sustainability'. Working with this UoA is a Research and Knowledge Exchange team including an Innovations Manager, a Business Development Manager and a Key Account Manager. Together, they provide a network of support to enable staff to develop and extend relationships with our non-academic collaborators. Within the Faculty, there are regular competitions for staff to bid for funding to support studentships or post doc projects. All of these require an external collaborator and a clear statement of the potential impact of the project as a pre-requisite for entering the competition. This approach ensures that all our projects are strongly focused on impact

d. Relationship to case studies

The case studies selected reflect our focus on applied research, our ability to work alongside our industrial partners and our success with "real world" translational themes. We have included the *impact of our research on vehicle track interaction* in the rail industry that demonstrates how industrial partners use our research to inform policy developments and technological innovation and ultimately improve the experiences and safety of passengers. As mentioned, the rail industry recognised our strengths in this area and approached MMU to service the research needs of their industry. We are also including a case study on *threat detection and security* and how our research in novel sensors has potentially life-saving applications. This example shows how we are trusted to work in partnership with the Home Office and the Centre for the Protection of National Infrastructure (CPNI) on topics of national importance. Our Legal Department have been closely involved in this area to establish patents and agreements, which allow us to exploit IP generated through this work. Finally, we have put forward a study that demonstrates the growth of our applied biomechanical and bioengineering work in the heathcare sector. The case study articulates *the impact on the elite performance of the British Paralympic swimming team*. This ground breaking research has not only boosted the performance of our athletes, but also helped set new guidelines on disability assessment.