Institution: Manchester Metropolitan University

Unit of Assessment: B11 Computer Science and Informatics

a. Context

Our main non-academic beneficiaries are (1) business and industry, (2) healthcare bodies and charities, and (3) community organizations (and their associated audiences). The first group includes technology companies such as Vicon Ltd (motion capture), Optos PLC (retinal imaging), and Tyrell Systems (building control and management), consultants such as Consard Ltd (eHealth), training companies such as Paul Ekman (facial expression recognition), and media companies such as the BBC and Reading Room (web design). The second category includes the Wellcome Trust (charitable foundation), the National Health Service (Lothian), and Family Health International (public health and development non-profit organization). The third group includes LAStheatre (production company), the Manchester Science Festival, and the Manchester Digital Laboratory (MadLab, community education space).

The main types of impact generated include: *Health impacts*: We are helping to improve the rehabilitation of patients with long-term health issues, through the development and delivery of novel technological interventions; *Economic impacts*: The operation of a technology SME (Tyrrell Systems) has been improved by collaboration with MMU researchers; the revenues of a community organization (MadLab) have significantly increased due to public engagement collaboration; *Impacts on public policy*: Policy debate has been informed by our work (for example, we have been consulted by the US Federal Bureau of Investigation (FBI); *Impacts on society, culture and creativity*: We have helped to inform the development of public engagement in Manchester and beyond, and to show how it might be embedded within the ethos of an organization; we have stimulated interest in and engagement with science and engineering, through a range of activities.

b. Approach to impact

Our main routes to impact are: (1) applied research and knowledge exchange, and (2) public engagement with science and engineering. These two routes are by no means exclusive, and our research both informs and is *informed by* our public engagement activities. Much of our research occurs at the intersection of computer science and other disciplines, which offers significant opportunities for high-impact work. Specific *current* research projects with significant external user involvement are (1) real-time muscle activity interpretation using ultra-sound, in collaboration with Vicon Ltd, (2) interpretation of facial images, in collaboration with Paul Ekman International, (3) tele-rehabilitation, with NHS Lothian and Consard Ltd., (4) automatic detection of glaucoma, with Optos PLC, (5) informed consent processes during drug trials in Tanzania, with Family Health International.

Applied research: An exemplar of how the unit manages and encourages impact is the tele-rehabilitation project mentioned above. Academics in the unit have specialist expertise and a long-standing track record in world-class research into vision-based human motion analysis, motion tracking and pattern recognition. In the NHS Lothian region alone, there are around 140,000 people with at least one long-term health condition. Working with healthcare professionals and Consard, this project investigates scientific approaches and novel technologies for developing low-cost automated assessment systems for patients who need to undertake therapeutic physical exercise and/or cognitive training. This work originated from initial contact from Dr Li with the Technology Strategy Board DALLAS (Delivering Assisted Living Lifestyles At Scale) programme. Once a viable project plan was established, it was supported by an MMU-funded Ph.D. studentship (via the University Knowledge Exchange and Innovation (KEIF) fund), with in-kind matched funding from NHS Lothian and Consard. KEIF supports the development of promising new initiatives that engage with business, public and third sector organisations. The fund aims to nurture academic entrepreneurship and innovation in order to strengthen external relationships and the impact of our expertise. Applications are assessed on the degree of innovation and creative use of funds, the quality of the business/project plan, exploitation of expertise developed at MMU, the quality of any existing or anticipated partnerships or customer base, plans for assessment of, investigation or

demonstration of market potential and projected income, existence of a novel combination of interdisciplinary expertise, and social impacts (economic, health, well-being, public good, etc).

Knowledge exchange: Computing and Informatics Research (CIR@MMU) academics also participate in Knowledge Transfer Partnerships (KTPs); these are supported by the University Research and Knowledge Exchange office, which has specialist Science and Engineering staff dedicated to helping to develop such relationships. Staff are given an allowance of 0.5 days per week (supported by the Faculty) to work on the project. A recent notable example involved our staff working with Tyrrell Systems on "remote control" of buildings, via an iPhone app. This project (which ran 2008-2011) originally stemmed from teaching and development work in mobile applications, and received £90K of funding (60% Technology Strategy Board, 40% from Tyrrell). Ged Tyrrell, CEO and founder of the company, stated, "working with MMU has been extremely beneficial and has ensured we have been able to stay on the front edge of the development curve". The project led to two MMU graduates being employed by Tyrrell.

Public engagement: Researchers within the unit have been heavily involved with helping to develop the University's approach to community/public engagement. Amos recently collaborated with external partners (MadLab) on the DIYbio Manchester project (see the impact case study for further details), and was awarded £30K by the Wellcome Trust to develop citizen science. CIR@MMU staff and Ph.D. students participate in the annual Manchester Science Festival, and our "Monsters, Maths and Microbiology" group (Amos and Ph.D. students Crossley & Carolan, plus partners from Healthcare Sciences) has been particularly active; we recently contributed to the extremely successful *Deadinburgh* experiential theatre event, which won several prizes at the 2013 Scottish Event Awards. The BBSRC has subsequently developed teaching materials based on the event (see http://bit.ly/1ag2Ouj); importantly, our involvement originated in Crossley's undergraduate project work (SimZombie, using simulated "zombies" as a way to illustrate patterns of disease), which was then further developed during the course of his Ph.D. programme in parallel with his main research. This would not have been possible without significant support from his supervisor (Amos), the Faculty and the University (who provided support for various activities to help develop the original activities). Beyond MMU, we have provided central contributions to the HEFCE/RCUK/Wellcome Trust-funded Manchester Beacon for Public Engagement; the DIYbio project was given a Manchester Beacon Recognition Award to acknowledge its contribution to developing community-university partnerships. His work on public engagement has led to Amos advising other academic institutions on their own public engagement strategy; for example, on March 2 2012 he gave an invited seminar on outreach to the University of Sheffield Crucible project for early career researchers and academics. Amos is also a participant in the Speakers for Schools initiative, and O'Shea has actively participated in public engagement (e.g., by serving on the local organizing committee of the 2012 Turing Centenary celebrations, and organizing various Turing-related events for the Manchester Science Festival).

University support: KEIF support is available either as £5K awards, or as grants in the range £10-50K. CIR@MMU researchers currently hold 5 KEIF grants, which accounts for **8.5%** of the total number of KEIF grants across the entire University (the full list is available at http://www.mmu.ac.uk/staff/fundingopportunities/). As the School as a whole has 59 full-time academic staff (**4%** of the total University roster of around 1,500), this demonstrates that CIR@MMU is a leading unit in terms of translating its research into potentially high-impact projects. The University also offers Research Accelerator Grants (up to £5K) to Early Career Researchers. These require (a) that ECRs be mentored by a more experienced member of staff, and (b) that a full external funding proposal should result from the grant. CIR@MMU academics have, so far, been awarded two such grants; importantly, though, the idea of using £5K awards to kick-start research activity was first trialled within the University as part of the NanoInfoBio project (coordinated by Amos) cited in one of our impact case studies. That is, a project led by CIR@MMU established the local conditions for these awards to be instigated. In terms of School-specific facilities, the University has recently invested £150,000 in the creation of a state-of-the-art usability laboratory, which provides equipment for analysing human-computer interaction. This is used by both researchers and undergraduate students, and is available to external partners. Recent commercial clients include the BBC and local web design agency Reading Room.

c. Strategy and plans

CIR@MMU impact strategy is aligned with the Faculty strategic plan (2013-2017), which aims to (1) increase enterprise income by 50%, (2) increase the number of patents granted or applied for by 75%, and (3) increase the number of knowledge transfer partnerships by 50%. Additionally, the University Research and Knowledge Exchange (RKE) strategy underpins this by setting out a roadmap towards strengthening the RKE culture and enhancing related career opportunities for staff. Central to this is support for inter-disciplinary research. Also at the level of the institution, the University is in the process of setting up a Technology Transfer Office, which will help to fully exploit our intellectual property, and provide staff and students with advice and support on all aspects of innovation. Fundamentally, we seek, within CIR@MMU to (1) strengthen the "impact culture", (2) encourage the application of our research to significant problems, (3) develop our engagement activities to extend the reach of computer science into the non-academic community. We now describe how the specific impact types described in (a) will be further developed and encouraged in the future, through the application of these three basic principles.

In terms of health impacts, the Faculty plan includes specific provision for the promotion of cross-disciplinary research collaborations along key translational themes. These include biomechanics, bioinformatics and healthcare; two of our research groupings (Sensory and Biological Computation, and Networks and Distributed Systems) already undertake significant amounts of research in all three areas, and the Computational Intelligence and Reasoning group is actively growing its activities in healthcare. We will increase the number of applications we submit for University Ph.D. studentships by specifically targeting significant problems in these key themes.

Manchester is currently the second largest "digital cluster" in Europe after London, and the city has the ambition to be a leading global digital city. Digital Innovation is a cross-Faculty organization that combines education, research and enterprise activities that fall within the "digital agenda". This is well aligned with future national and EU funding priorities and the aim is to further strengthen MMU's position as a beacon for innovation in this field, and encourage further impacts on the economy and society, culture and creativity. In 2014, Digital Innovation will move to a newly refurbished physical space, which will combine research laboratories with teaching space and the University's enterprise incubator. CIR@MMU researchers are highly active in the Digital Innovation network; Amos serves on the steering group, and we will increase our level of engagement with Digital Innovation by proactively highlighting the set of skills, expertise and facilities available within CIR@MMU. Digital Innovation will provide the framework for "match-making" between our academics and colleagues in other Faculties, to ensure increased levels of inter-disciplinary collaboration on significant problems. This will manifest itself in a significant increase in the number of cross-disciplinary proposals, and in the amount of public engagement and enterprise activity. In terms of impacts on society, culture and creativity that might accrue through public engagement, as a School we now include outreach activities as a factor when considering individual staff workloads and promotion cases. That is, there is a clear benefit to undertaking these activities, whereas before they very much relied on the goodwill of staff to organize them in their spare time.

d. Relationship to case studies

Both case studies (healthcare IT assessment and DIY biology) are inherently inter-disciplinary, and are closely related to our impact strategy. One of them is based primarily on traditional research results, and the other describes a funded collaborative public engagement project between MMU and a community organization. As such, these case studies illustrate the *breadth* of our impact. Additionally, the DIY biology case study illustrates the benefits that accrue from supporting public engagement work. By embedding community outreach into an EPSRC-funded proposal, and then delivering a high-profile public event, we directly kick-started discussions that eventually led to a highly successful project supported by the Wellcome Trust.

Links to all impact-related activities are at http://www.scmdt.mmu.ac.uk/cir/REF/