Institution: Institution: Glasgow Caledonian University

Unit of Assessment: 11 Computing

a. Context

UoA11 aims to generate new and useful knowledge by undertaking work in the area of health and wellbeing and in the area of authentication. UoA11 work has endeavoured to be both societally driven (see our case study on Technology to Optimise Movement for Health and Wellbeing) and business orientated (case study on Secure User Authentication on Smartcards). The impact of our technology solutions has resulted in improved clinical outcomes for NHS patients and enhanced security of business processes for our industry collaborators. Beneficiaries of our work include practitioners, policy developers knee replacement, stroke and falls patients, physiotherapists, surgeons, nursing staff, charity and security software designers and users. We have also strengthened our public engagement work by presenting at a number of different science festivals e.g. Edinburgh International Science Festival, Big Bang Scotland.

b. Approach to impact

Post RAE2008 we undertook a review of how we organised our research, re-evaluated the types of beneficiary and how we engaged with both the academic and wider communities. In particular we took on our University's motto of the Common Weal to focus on research that can deliver practical benefits to society. This realignment has not just benefited us in terms of the portfolio of grants and the quality of our PhD students but has had wider benefits for our research active staff. We demonstrate our research in action through a wide range of outlets e.g. Knowledge Transfer Partnerships, pay-to-view journals (i.e. subscription based), open access journals, media events, seminars, social media, conferences and bespoke one-off events such as the Edinburgh Science Festival. In order to develop and promote the impact of the Unit's research in the area of health and wellbeing and in the area of authentication, approaches have been adopted that have increased and strengthened community engagement and strategic partnerships; brought the Unit's researchers closer to research users in clinical practice, communities and businesses.

i) Community Engagement: the unit has strengthened our public engagement work by presenting at a number of different scientific events e.g. Edinburgh International Science Festival, Big Bang Scotland and Active Ageing Congress. The unit has specifically supported and enabled staff to achieve impact from their research through support to: plan, organise and participate in public conferences/events; make themselves available as experts for media; used touring exhibitions as a device to communicate existing ideas and stimulate new ones.

ii) Direct involvement with health and well-being policy facilitators and businesses: The staff in the unit have developed relationships with key leaders in the assistive technology field e.g. George Crooks (Medical Director of NHS 24 Scotland and the Scottish Ambulance Service) and Sara Mitchell (National Programme Manager Delivery Framework for Adult Rehabilitation) in order to develop impact from our research through dissemination within their organisations (e.g. the NHS and Scottish Government). In the area of authentication we have established relationships with a number of companies including a successful KTP with ECEBs and a consultancy with Baillie Gifford Global Investments.

iii) Development of strategic partnerships: to maximise the impact of our work we have established partnerships with several NHS hospitals research co-ordinators and the Scotland wide community on Falls (see impact case study). Informatics Ventures and the Scottish Informatics and Computer Alliance (SICSA). As regards companies (out-with the ones mentioned in our impact case studies and in REF5) we have established partnerships through grants and consultancies with: Orange, Shearwater, Scottish Enterprise, The Lottery fund, Baillie Gifford Global Investments and Santander. These investments and collaboration have resulted in long term partnerships. Overall our income has increased by 51%, our outputs are up by 52% some of which are joint papers with these companies. This demonstrates robust engagement in these stringent times.

iv) Impact Articulation: Articulation and promotion of the Unit's research has been enhanced through close collaboration between investigators and experts in the institutes marketing and communication and digital outreach services with the appointment of a Research and Community Communications Officer. This includes creation of project-specific websites (https://www.envisagerehab.co.uk), targeted mass media through press and television (http://www.bbc.co.uk/news/uk-scotland-glasgow-west-11233452), and public events (including the introduction of public inaugural lectures and an institutional 'research celebration event' for the general public). The unit has organised and participated in large-scale international events that

deeply embed public awareness in the unit's research. This included, the 8th World Congress on Active Aging (Glasgow, 2012) and has facilitated participation in major public exhibitions and events at the Glasgow Science Centre such as BodyWorks (www.glasgowsciencecentre.org/bodyworks).

v) Impact and staffing: staff support for impact activity is integral to staffing procedures, for example, promotions criteria and biannual Performance, Development and Review (PDAR) processes. These both incentivise the concurrent delivery of research excellence in conjunction with research based community engagement and external partner work with key stake holders.

c. Strategy and plans

1) The over-arching strategy over the next five years will be to promote excellence and growth in the thematic areas of digital health and wellbeing and authentication by applying for high quality grants, investing in new academic staff; by promoting collaboration between our researchers and research partners nationally and internationally, and proactively engaging in dissemination and knowledge transfer through the new Institute for Sustainable Engineering and Technology Research (ISETR).

2) Developing research impact skills: UoA11 will continue to prioritise research impact skills training for all of our researchers. Working with our award winning Graduate School to extend training for early career researchers promoting 'engagement, influence and impact' from the Vitae, Researcher Development Framework. The Caledonian Research Excellence Development Opportunities (CREDO) forum will continue to develop research impact training for researchers and research leaders. UoA11s Peer Review College will develop new processes to help researchers develop comprehensive plans to support the pathway to impact strategy made at the application stage of external grants and commercialisation activities.

3) Developing and enhancing relationships with key partners, beneficiaries and end-users: Our progress since the RAE2008 submission shows a vibrant, forward-moving, research culture. We have had a significant growth in doctoral students (from 3 to 51) and funding secured (see REF5) within the unit for both industry specific issues and wider research, includes diverse sources such as Heritage Lottery Fund, Paths to Health Charity, Orange, NHS, UK Research Councils (e.g. MRC & EPSRC), Numiko, ECEBs, NES, EU, and the Calman Trust. We plan to maximise the potential impact from current and future research on Technology to Optimise Movement for Health and Wellbeing by continuing our relationships with our current partners but by also growing our collaboration, in the first instance at University level as we have a strong allied health research profile. , indeed we have received funding to set up two new networks one funded by the Carnegie Trust which will establish a Scottish Music and Health Network (SMHN) and the other, funded by SICSA which will see established a network for researchers in the area of Technology for Health and Well Being (THAW). One of the main aims of the second network is to closely work with the new Scottish Government innovation centres of Digital Health (DHI) and Sensors & Imaging (CENSIS). Our authentication strategy is to focus on mobile devices, and an EU funded project has already begun in this area (started September 2012). Through this joint project we will continue our authentication research in collaboration with Edinburgh University and work with organisations who deal with sensitive information, such as UK banks.

4) Plans for research impact: Post REF2014 we intend to work with an expanding network of partners to generate impact by working to:

- expand our research active staff base through a combination of staff recruitment and development as detailed in REF 5.
- develop and integrate research focusing on increased end user competitiveness, sustainability, technological advances and internationalisation. In particular, working collaboratively with the innovation centres, the NHS and with EU partners by taking part in Horizon 20/20 proposals.
- deliver impact from our research as regards the move from hospital based care to the home through our work with the newly created Digital Health and Sensors Innovation Centres.
- focus on the relationship between authentication, and the impacts on people. Strong scientific metrics are required in these areas to support the adequate protection of data.

The key drivers of our research over the next five years will operate in the context of (1) greater internationalisation of research activities (2) innovation in research methods (3) an increase in our use of a wide variety of funding models that can be addressed and utilised and, (4) changes to the way we disseminate and transfer our knowledge.

5) Methods to articulate, evidence and benchmark research impact: We will be supported in this

effort at school level by the newly created Institute (ISETR) whose role includes: identifying and disseminating national and international research priorities as identified by Technology Strategy Board, Research Councils and Horizon 2020; promoting cross-disciplinary research across the Institute areas and collaboration with industry. Funding is provided by the institute for up to 5 PhD studentships per year for projects that can demonstrate strategic academic and industrial links and promotion of research quality. Key Plans:

- Research Theme Leaders will be given training in the definitions and quantification of impact relevant to the funding councils and REF2020 which they will cascade within their themes.
- Each research project team will have one member identified as being responsible for impact.
- The unit's research output will be disseminated through publication in high quality open access journals as identified by each Research Theme and approved by the ISETR review panel.
- Subsequent impact will be disseminated to as wide an audience as possible, though media events, seminars, social media, conferences and bespoke outlets as appropriate.
- Impact will be recorded and monitored in PURE, with feedback to individuals and Research Theme Leaders.
- Input will be received on impact generation from the ISETR Industrial Advisory Board and used by the unit to inform strategy and activity.
- The Institute will host regular networking events for academic researchers and industrialists from key industries who can help inform decisions on activity prioritisation to maximise impact.
- The Business Development team within the School will have an increased role in identifying industrial partners and converting research activity to knowledge exchange and activity to maximise impact.

d. Relationship to case studies

UoA11 comprises two areas of research: Technology to Optimise Movement for Health and Wellbeing and User Authentication Methodologies for Secure and Competitive Business. This work is spread across two themes: Interactive and Trustworthy Technologies and Visual, Affective and Pervasive Systems. The unit is submitting the research work of 13 FTEs, an uplift of 63% on RAE2008. UoA11 work has endeavoured to be both societally driven (see our case study on Technology to Optimise Movement for Health and Wellbeing) and business orientated (case study on: A Secure User Authentication on Smartcards). The impact of our work in the first instance is on health and welfare and in particular with the improved outcomes for patients and related groups that our research delivered. Our technology was the first to demonstrate that recently discharged patients could monitor their own rehabilitation programme in their homes and that they benefited from improved clinical outcomes as a result e.g. improved range of movement, walking speed and balance, all of which are important for daily living activities. Alongside the independent clinical measures that showed improved outcomes from using our technology the patients also said that they had "an improved quality of life" according to EQ5D scoring (EQ5D is a standardised instrument for use as a measure of health outcome) which is another example of health impact. The work outlined this case study demonstrated impact on the following:

1. Public Policy and Services: by influencing the formation of government strategy for the future delivery of health services in the community at National and UK government level.
2. Health: by providing our technology for rehabilitation in the home to patients whose medical outcomes and quality of life were improved as a result of using it.
3. Commerce by working with a company (NUMIKO) to create and then sell their series of physical activity music games to the BBC for their CBeebies website.

Secondly as regards business we have also achieved impact through our work on Secure User Authentication on Smartcards as Ecebs continue to trade and are still pursuing identity authentication products and services based on using the 'Feedback in Biometrics' series of applications for identity authentication. Beyond the impact for Ecebs our work [1,2] is cited in two books that are widely used by both practitioners and educators as comprehensive reference sources within the field: The Handbook of Fingerprint Recognition (cited in Chapter entitled "Securing Fingerprint Systems" Springer, 2009) and Pattern Recognition, Machine Intelligence and Biometrics (cited in Chapter entitled "Fingerprint Identification – Ideas, Influences, and Trends of New Age", Springer, 2011). Our work has also been cited in the search report for the patent application entitled "Logo or Image Recognition" by Yahoo Inc. (2011).