Institution: The University of Huddersfield
Unit of Assessment: 11 Computer Science and Informatics
a. Context

The **types of beneficiaries** of the Unit's research are spread globally, and are in a range of user groups including the general public, companies and consultants. Our impact encompasses local companies (e.g KTP partners Polyseam, Perrigo, The Leadership Factor, Innovation Voucher partners such as LLB Partners), groups of learners in practice-based training (e.g. users of Prof Lu's Student Response System), individual software users (e.g. the users of the NTFS Permissions Explorer software, details below) and in more enjoyable forms of entertainment (staff in our Canalside studios http://canalsidestudios.com/about.html are very active in the Computer Game's business, for example through the Games Republic http://gamerepublic.net/).

The **types of impact** includes improved business processes, improved training practices, improved understanding, better educational devices, better security and know-how.

As a specific example of impact to the local community, members of our **Visualisation, Interaction and Vision** group recently conducted a KTP project (2009-11) using their developed technologies in data/image visualisation. The technical benefactor - The Leadership Factor - is a Market Research Agency specialising in customer and employee satisfaction research. As experienced statisticians they knew how to present data in a meaningful way, but needed our research and development experience in visualisation to present it online. This resulted in a new web reporting tool (cf "reporting your results": https://www.leadershipfactor.com/research-services) which includes indepth data mining and analysis. The Company claim categorically that this has impacted on them in that they have won new business because of the work, and as further testament have employed two Huddersfield graduates to support the area.

As a specific example of impact **globally**, a project involving members of our **PARK** group resulted in the design and development of software that allows NTFS permissions to be explored in an efficient, informative and intuitive way. Controlling file access permissions is an important aspect of data security and having a secure and flexible way of viewing and managing access control should be a standard requirement. However, administrating and monitoring NTFS permissions can be a cumbersome and convoluted task. Consideration has been taken from design to implementation to make the examination of special permissions, permission accumulation and inheritance easier for the user without any loss of clarity. In its first year of publication, the software has seen 2141 downloads from CNet.com:
http://download.cnet.com/NTFS-Permissions-Explorer-SnapIn/3000-2094_4-75325639.html?tag=mncol;9)
and thousands of downloads from our eprints repository (see http://eprints.hud.ac.uk/9743/ for full download statistics) from **60 different countries worldwide**.

As an example of an initially local impact that is now global, the rapid Spatio-Temporal Volume (STV) based video identification technique developed by the **Visualisation, Interaction and Vision** Group has been applied by a local Surveillance Firm (Vetatech Ltd.) to assist with the detection of vandalising behaviours and newly made graffiti in public places. This has been reported by the online magazine Global Forensic Science Today (http://eprints.hud.ac.uk/17765/) and the New Scientist Magazine (http://www.newscientist.com/article/mg21228386.300-graffiti-artists-caught-out-by-their-handiwork.html). In April 2012, Xu was invited by the Shaanxi Court Science and Informatics Centre (SCSIC) in the People's Republic of China and delivered a public lecture about his research into using computer vision techniques for crime detection. There were over 120 people attended the event including many from the provincial police department and local universities (http://news.xiyou.edu.cn/xinwenwang/2012/0331/2369.html). The speech had drawn great interest and been followed by an invitation from the ShaanXi Provincial Police department to assist the definition of the standards and specifications of their second generation highway monitoring and accident recording system. Xu's work has also facilitated the forming of a European Police Training Network across 6 countries with one of the recent meetings hosted in Huddersfield

(http://www.hud.ac.uk/research/crimetime/), also attracting regional police forces from West Yorkshire and Durham.

As an example of an initially local impact which is potentially global, staff members of the **PARK** research group have been collaborating with members of the School's Centre for Precision Technologies on the application of automated planning research (http://eprints.hud.ac.uk/13501/) to the calibration of machine tools. Given a description of a machine, and its various axes, the AI Planner produces a calibration plan that minimises the time taken to measure all of the errors of a machine. After initial in house trials, using the CPT's contacts, the technique has been applied to calibration of machine tools at a local company, Machine Tool Technologies Ltd, Nelson, Lancashire. The produced plans were identified to be suitable in that they either provided an optimal calibration plan (reducing downtime), or supplied proof that a calibration suitable to the client's requirements could not be performed.

b. Approach to impact

The unit uses a range of approaches to interact with beneficiaries:

- Connected via Business Staff: The *School* employs two Business Development professionals whose role is to connect up researchers with potential users of their impact. For example, their expertise in joining business with academic research recently led to the project "Energy-Efficient Computing" (2013 – 2014, TSB supported with a value of £130k). Led by the Department's Dr. Christopher Newman, this project exploits our research in mobile devices, with impact via the collaborator Tectra. The *University's* central Business Development unit feeds targeted contacts to researchers, for example matching up ***Innovation Vouchers*** with teams that can do the work. As an example, members of the **Information and Systems Engineering** research group were contacted via our Business Manager on account of Prof Lu's EU funded research in mobile devices, to develop a user interface controller for M L Shaw Fabrications Ltd. in Manchester, UK. The newly developed interface significantly reduced the company's existing cost of one mobile device set from £600 to £110. (http://xdir.hud.ac.uk/mobile-old/XDIR_Kirklees_Final.pdf). Over the REF period, academic staff in the unit have received and utilised c.10 such Innovation Vouchers.

- Connected Via Placements Visits and Consultancy: Our academic staff have a range of opportunities to form personal relationships with potential research beneficiaries, from Placement Visits to Consultancy. We *place* over 100 sandwich students a year in commercial settings, and staff carry out visits twice a year. This gives staff the opportunity to form relationships which may lead to impact-bearing activities, such as KTPs, drawing on the Department's base of research and expertise. As an example of consultancy, our **Visualisation, Interaction and Vision Group's** research in performance technology was contracted over a period of 3 months to produce a range of promotional videos and animations for the Huddersfield Contemporary Music Festival. These were used throughout the festival in 2012, and as part of the report documentation for the Arts Council. The festival attracted 4,000 visitors over a 10 day period.

- Connected Via Collaborative Research Grant: Staff involved in funded research projects with external collaborators leads to an impact of a more subtle but more long term nature. For example, Lee McCluskey's ARTS Network (COST TUD1102) is spawning collaborations throughout Europe. As one example, Prof Margaret Bell (City Environment Professor at Newcastle University) is using funding from ARTS to collaborate with representatives of the cities of Newcastle and Santander in Spain to investigate the benefit of self-managing control systems on traffic pollution.

To support these approaches, staff in the unit have benefitted from a range of financial incentives to connect with industry in order to achieve impact (examples were given in the Environment, part c). In particular staff have access to a "Collaborative Ventures Fund", of up to £3000 per collaboration, to initiate work with a commercial partner with the potential of leading to research

impact. For example, a CVF and IV combination was used over a period of 6 months in 2012 for a local micro-company (LLB Partners), to re-design a natural language web interface to do more efficient web searches for identifying articles about individuals. Utilising Dr Di Cai's research in information retrieval, in particular, the company are currently implementing a new version of the software utilizing our research.

c. Strategy and plans

The Unit's strategy for delivering impact, within the first part of the REF period, has been sharply focussed at staff developing relationships with largely ***local*** collaborators, with small numbers of pinnacles of excellence delivering impact nationally and internationally. This was seen as being consistent with the view of Huddersfield as a regional University, and the need to develop a reputation which would attract students and local partnerships. This strategy was supported by the use of KTPs (3 run in the REF period, referred to above), of Innovation Vouchers and of Collaborative Venture Funding. With the development of the University Campus's 3M Buckley Innovation Centre (http://www.3mbic.com/), there will be a focus for more University research into impact with local companies.

With the significant increase in the Unit's number of staff engaged in fundamental and basic research, the consequential increase of research projects in the Unit in the last 3 years, the aspiration of the University to be known internationally, and the increase in the Unit's international research profile, the Unit is now changing the emphasis of the strategy to encompass both local **and** global markets for impact. Our research aims as outlined in the REF5 document are to "double our impact … evidenced by at least a doubling of excellent impact case studies in the next five years." To supplement this we have composed a complete research strategy which has been reviewed and evaluated by our International Panel of Experts (cf REF 5). This specifically details a clear path and support mechanisms for developing, recording and sustaining impact in the next 7 years, in order to deliver the impact profile of a research-intensive University by 2020.

d. Relationship to case studies

The two Case Studies given deliver different types of impact and to different groups of beneficiaries. The Student Response System is a clear use of research carried out in software and web architectures surrounding mobile, wireless, and XML technologies to the implementation of innovative training and learning techniques – an example of an interdisciplinary research team delivering an impact via ubiquitous devices in disparate areas of education ranging from Schools to the Shop Floor. The Autonomous Systems Case Study is a much more fundamental impact but where the beneficiary groups are less clearly defined: in this the research pushes the development of a whole field (knowledge engineering for planning, domain modelling) which has impact in industrial and road traffic autonomous systems, through stakeholder engagement, changes in the understanding of the potential of autonomy, and know-how.

Neither of the Case Studies are typical of the wide range of impacts in the local community that have been developed through department staff in the REF period, but can be seen as examples of impact that our new impact strategy referred to in part c. will deliver.