

Institution:	THE UNIVERSITY OF MANCHESTER
Unit of Assessment:	UoA12a Chemical Engineering
a. Context	

The principal **beneficiaries and audiences** for the UoA are industry, *schools and the general public* through public engagement activity, *government and charitable bodies*. This UoA is industry-facing in its history and contemporary culture. We expect researchers to address industrial need whilst striving to advance the discipline. We impact upon process industries ranging from small start-up companies to large multi-nationals. We are at the forefront of Chemical Engineering's drive to make process industries sustainable. The UoA principal types of impact are economic and environmental.

Research is organised around a matrix of 5 informal groupings of cross-cutting themes: 1) Sustainable Industrial Engineering, 2) Multi-scale Modelling, 3) Process Development and Integration, 4) Instrumentation and Analytical Science, 5) Molecular Systems and Biomaterials. Across all of these groupings there is the potential for significant impact. Our track record embraces examples from a wide range of impact domains, including: economic impacts; impacts on the environment; health impacts; and impacts on public policy.

Recent research in the area of life cycle analysis is creating impact across all of the above domains by enabling organisations to improve their ability to increase efficiencies and reduce their carbon footprints. Research in other areas, which takes advantage of our pilot-scale facilities, leads to significant industrial impact, both economic and environmental. Specifically, the new James Chadwick building (superseding the Morton Laboratory) provides an incubator facility for the development of ideas from underpinning engineering science to fully developed process technology. Research based on modelling and simulation in the area of process integration, for example, creates significant impact across the more traditional chemical industries such as oil and gas and has global reach. Whilst the impacts there are primarily economic they also include environmental aspects through the reduction of emissions and pollution abatement.

b. Approach to impact

The Unit's approach to interaction with its user community and other beneficiaries and audiences is enabled by teams at Unit, Faculty and University levels. In the Unit we have a Director of External Affairs with an Industrial Advisory Board and a Schools Liaison & Public Engagement Officer. These academic roles are supported by a Research Support Manager engaging at Faculty level with the Business Engagement Office, as well as the University's exploitation company UMI³. UMI³ has received over £200m third party investment funding to support spin-out activities and, in March 2008, Europe's largest seed fund dedicated to one University, at £32m, was set-up within UMI³ as the 'UMIP Premier Fund'. Added incentivisation is through 85% of net income from commercialisation going to the investigator.

The above structure facilitates a responsive and agile approach enabling us to evaluate and act on opportunities as they arise internally or externally. Impact is explicitly included in promotion criteria with 5 academics having been promoted as a direct result. Additionally, workload is managed for staff engaged in impact activities. Impact is realised through three core unit activities: 1) engaging with industry; 2) new business creation and licencing; and 3) engagement with the user and wider community. The following tables present examples of these approaches:

1) Engaging with Industry:

Approaches to engaging with industry	Examples
Initiate and exploit University-wide strategic partnerships.	Astra Zeneca, BP, Shell, Unilever, Siemens, Rolls Royce, National Grid have all sponsored multiple research projects under umbrella agreements that facilitate agile responses to new opportunities.
Collaborate around focused centres within the unit, based on established	The Centre for Process Integration (CPI) incorporates the activities of 5 researchers. A consortium of 16

Impact template (REF3a)

industrial consortia.	Member Companies has priority access to results (see case study in REF-3b).
Create consortia to facilitate innovative discussion and exclusive uptake of outputs.	BRITEST (see case study in REF-3b) consortium of 21 members established as not-for-profit company in 2001 which has delivered over \$US 1 billion of benefits to members.
Gather project-specific industrial collaborators to inform and develop outputs.	The CCaLC project (see case study in REF-3b) included initial industrial partners from PVC, biochemical, pharmaceutical and fine chemical industries. Resultant case studies contributed to achieving 4000+ users.
Knowledge Transfer with proactive involvement of the Faculty Business Engagement Unit.	9 Knowledge Transfer Account awards (KTA), 2 Knowledge Transfer Challenge awards 1 Knowledge Transfer Fellow and 1 Impact Acceleration Award projects. Totalling £743k EPSRC and £237k industry funding. Follow on in-kind support totals £1,379k including the donation of a £895k pilot plant by Cameron. The latter involves Cameron staff being seconded into the pilot facility hence benefitting from immediate impact arising from experiments.
Facilitate collaborative scale-up of novel processes using the Morton/Chadwick pilot plant.	Unilever through Centre for Advances in Structured Liquid Engineering (direct, EPSRC, KTA & TSB funding). Cameron through KTA funding 10 year collaboration agreement signed in 2011. 90 attendees from global oil and gas companies attended launch.
Collaborate with industry through EPSRC CASE PhD studentships and Engineering Doctorate studentships	11 Industrial CASE studentships with SMEs and multi-nationals initiated during the REF period. For example, Arvia Technology Ltd., GSK, Tata Steel and The Welding Institute.

2) New business creation and licencing:

Approaches	Examples
Proactive liaison from UMI ³ to encourage protection and commercialisation of IP.	The Unit filed 21 patents during the REF period. Multisensor Systems Ltd is a spin-out company from the Unit and UMI ³ facilitated independent investment in 2010 (see case study in REF-3b).
Integrate new researchers to collaborate with previous spin-offs, creating synergies between new ideas and established technology.	Industrial Tomography Systems Plc (ITS) was spun-off in the 1990s. New academics, Rodgers and Martin (Peter), now collaborate with ITS which has grown from £478k to £1,447k in turnover and 12-15 employees.
Interaction with The UMIP Premier Fund to facilitate timely funding for commercialisation.	Water treatment spin-off Arvia Technology Ltd commercialised through UMIP Premier fund. Since 2008 raised >£3M of investment & has 18 employees.
Further develop for exploitation knowledge generated during PGR projects	3 PhD Plus Scheme and Doctoral Prize Fellowships awarded within the Unit. Knowledge Transfer Fellow transfers EPSRC funded PhD projects to industry.
Introduce PGR students and academic staff to impact opportunity events.	Promotion of impact and entrepreneurial creativity in postgraduate researchers by hosting 2 day impact competition organised by Knowledge Transfer Fellow.

3) Engagement with the user and wider community:

Impact template (REF3a)

Approaches	Examples
Initiating and hosting agenda-setting events.	2012 hosted IChemE launch of Chemical Engineering Matters to audience of 100+ stakeholders. Initiation of ChemEngDayUK held at Imperial in 2013 and Manchester 2014.
Promotion of STEMNET Ambassador roles to graduate and PDRA researchers.	Active encouragement of PGR students and PDRAs into Ambassador roles. Activity results in direct discourse about our funded research.
Incorporation of public engagement & discourse into EPSRC funded projects.	Martin (Peter) EPSRC Challenging Engineering Award incorporates collaboration with Science Made Simple to develop school shows based on project research.
Engagement with debate of topical issues in media based on research findings.	Azapagic : BBC Manchester radio interview on nuclear power (SPRING project), Dec 2011. Goddard : Stem Cell Technologies at Cheltenham Science Festival 2011. Scully ; interviews with Reuters, BBC and Sky TV on assistive technology (iMAgiMat).

c. Strategy and plans

The University of Manchester places impact at the heart of its strategy. Our Strategic Vision 2020, which drives planning and investment across the institution, identifies Social Responsibility as one of our three core goals. Alongside our aspirations to be one of the top 25 research universities in the world, we aim for our research to make a real difference and resonate throughout society. We aim to rank among the top three universities in the UK for application and exploitation of our research, with the most generous rewards to staff for income from intellectual property.

The approaches to impact described above contain elements of excellent practice, but these are not currently embedded systematically across the Unit. In the future, each member of staff and each research group will develop an impact plan, aligned to School, Faculty and UoM targets, as part of their PDR with a view to exploiting the same mechanisms more systematically.

There is considerable scope to advance the evaluation of impact across the unit. This will be incorporated into the individual and group impact plans and supplemented by making unit resources available to evaluate impact professionally and quantifiably and to provide feedback from non-academic users to researchers.

It is expected that relationships forged through industrial impact will lead to the creation of at least one funded industrial chair over next 5 years. Over the period 2012-2020, we aim to contribute to doubling the number of science- and engineering-based start-up companies in the North West, compared to 2004 – 2011. This will be supported by Faculty which will promote the use of sabbatical leave for staff to facilitate the societal and economic impact of their research.

Our impact is already strong in some areas and we are strengthening others in order to maximise impact potential. This will be through professional and learned societies, by influencing policy and setting agendas as well as through CPD, especially using our pilot plant facilities.

d. Relationship to case studies

Of the four impact case studies submitted under REF-3b, three are based on research started between 1993 and 2008. One, the Centre for Process Integration (CPI) case, demonstrates the success of industrial-consortium led research and has informed our strategy for impact, with respect to engagement with industry (see approaches listed in Table 1 above). A second case, BRITEST, has similarly provided the basis for our current strategy (see also Table 1). The value, and hence the impact, of such an approach was not at first realised and the case exemplifies the dynamic approach to opportunities necessary to maximise impact from research. A third case, Multisensors, is an example of proactive encouragement to protect and commercialise IP through, for example, appropriate workload management of academic researchers. The fourth case, CCaLC, is based on much more recent research undertaken with impact in mind, where impact was intentionally built into the project plan, initially through the incorporation of industry partners.