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Institution: WestCHEM
Unit of Assessment: UoA 8 (Chemistry)

a. Context

WestCHEM is the joint research school of chemistry for the West of Scotland comprising researchers from the Universities of Strathclyde (SU) and Glasgow (GU). Impact has been generated from research published before and after the inception of WestCHEM in 2005. The non-academic user groups and beneficiaries in the REF period are industry, government, military and defence agencies, health agencies, and the public. WestCHEM has major research foci in Catalysis & Synthesis, Chemical Biology, Molecular Medicine & Synthetic Biology, Complex Chemical Systems, Dynamics & Structure, and Nanoscience & Materials Chemistry. The impact generated by WestCHEM research has manifested itself as: (1) commercialisation via licensing and spin-out companies; (2) production of new or substantially improved materials, devices, products, techniques, and processes; and (3) knowledge transfer (KT) to industry partners through our research expertise. WestCHEM has an ethos of collaborative working with commercial partners as demonstrated by the number of outputs bearing the name of a co-author from a user sector (30% of all papers in the review period), which shows the close interaction between academics and the potential users at the research stage. Significant impact has resulted directly from our research through the introduction of mechanisms to ensure exploitation and through established relationships with industry. Since 2008, we have been awarded £2.95M in industrial research contracts, spun out four companies, and have 25% of our research student projects collaborative with industry including 20 CASE awards.

b. Approach to impact***Mechanisms for engagement***

WestCHEM has made significant investments in infrastructure to enable it to create impact directly from its research. There are clear opportunities for staff to interact and engage with industry and to exploit IP, for example, through initiatives centred here:

- The **EPSRC Centre for Innovative Manufacturing in Continuous Manufacturing and Crystallisation (CMAC)** funded by EPSRC, Scottish Funding Council, and industry (including GSK, NiTech, Pfizer, Astra Zeneca, Fujifilm, and others). The Centre brings staff into direct contact with a user group of potential investors and industrialists allowing collaboration to flourish.
- The **Complex Chemical Systems lab**, which is extremely well equipped for research into several major applications ranging from the development of evolutionary chemical entities, inorganic cells for water treatment, materials for solar fuel devices to the production of potential drug and drug delivery candidates and houses over 40 researchers with close links to external partners such as Unilever, GSK, and ACAL Energy.
- **Centre for Process Analytics and Control Technology (CPACT)**, which has engagement with 24 end-user and vendor companies through research, KE, training and feasibility studies leading to KT. It is the longest established industry engagement Centre in WestCHEM, with a 50% increase in company membership over the REF period.

WestCHEM has clear routes to apply successful academic research to address major societal and economic challenges that lie in the domains of drug discovery, industrial manufacture, healthcare monitoring, education, and environmental protection. WestCHEM requires all researchers to exploit and develop the impact potential of their research. KT activity by individual members of staff is embedded in their job descriptions and the annual performance review. Academic and research staff are encouraged to participate in initiatives such as the GU Crucible Programme and the SU Programme in Research Leadership. The latter operates workshops and master classes on researcher skills, commercialisation strategies, academic-client communication and management, culminating in an output driven workshop, the 'KT Challenge'.

Institutional support for impact creation

Core to WestCHEM's research exploitation and KT are SU's Research & Knowledge Exchange Services (RKES) department and GU's Research, Strategy and Innovation Office (RSIO) which provide a range of services to exploit the commercial potential of the IP arising from research such as managing contractual agreements and developing engagement with businesses. These departments liaise and work closely together to ensure that there is a cohesive approach to

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exploitation. Joint ventures are commonplace where one of the partners usually leads and represents the interests of both partners.

Since 2010, GU has devolved *Business Development Managers* providing dedicated support to all staff, matching the needs of external funders to WestCHEM expertise, providing guidance through the plethora of schemes designed to achieve impact (e.g., those provided by the TSB), and facilitating opportunities for collaboration (e.g., the bi-annual Industry Open Day, >500 participants).

An important development that is re-shaping the way that we undertake research and engage with the public and private sectors is the creation of a Technology and Innovation Centre (TIC) at SU. An investment of £100M (£50M University, £25M industry partners, £25M Scottish government) has allowed planning of a new centre to house up to 1200 researchers based on multidisciplinary research themes rather than the traditional disciplines. WestCHEM is well represented through leadership of one of these themes (bio-nanotechnology), which will occupy space accommodating up to **130 researchers working on collaborative industry-driven research problems**. We see this as a future mechanism to increase impact from research across WestCHEM.

Sources of Funding for impact generation

In 2009, GU and SU were awarded EPSRC **Knowledge Transfer Accounts** (KTAs), which were designed to increase the volume of EPSRC-related research outputs delivering impact beyond academia and to foster a more entrepreneurial culture in the academic community. WestCHEM was well placed to benefit from both awards and twelve academics were funded to a total of £898k bringing in an additional £230k of industrial funding.

One outstanding success of this KTA funding has been the spin-out of Biogelx Ltd. (founded December 2012), which produces biomolecular gels inspired by biological systems. The crucial IP arose from EPSRC-funded research; KTA funding from both GU and SU was used to advance the impact potential to the stage of spin-out formation. The spin-out benefited from £40k of investment by Glasgow-based angel syndicate Gabriel and the Scottish Investment Bank (SIB), coinciding with £100k Smart R&D award from Scottish Enterprise. The company has generated sales since early months of operation and has signed license and collaboration agreements with two leading stem cell companies and is set to achieve income of around £200k in its first year of trading. Biogelx was recognised by an RSC Emerging Technologies Award in 2013.

Another successful example is a KTA project in hydrogen storage, which led to €2.2M EU funding through the JTI project HYPER and €1.7M industrial matching funding from EADS (Germany), hydrogen storage system manufacturers McPhy (France), fuel cell manufacturers Paxitech (France), the IEn in Poland, and the EU JRC (Netherlands). The aim of the project is to construct H₂ power systems to be used in UAV (drone) and portable battery recharger demonstrators.

A further £113k of KTA funds, leveraged against '**Bridging the Gap**' funds and £20k of industrial funding, brought together five departments (including WestCHEM) to organise workshops with GSK and Pfizer on continuous manufacturing and crystallisation. This funding led to seven PhD positions jointly-funded by GSK, Pfizer, AstraZeneca, and FujiFilm. This multi-partner collaboration led ultimately to the establishment of a £6M EPSRC-funded consortium on Innovative Manufacturing (CMAC), led by WestCHEM and involving 7 university and 10 industry partners.

WestCHEM members have also benefited from support from **Scottish Enterprise** through their **Proof of Concept** and **High Growth Team** programmes, which are designed to advance research into commercialisation and sustained growth. A recent example is Scottish Enterprise's support (£414k) that resulted in the formation of the spin-out company Novas Technologies (2012), which merged with InsigniaPack in a strategic alliance to form Insignia Technologies. Insignia Technologies now employs 10 people and has just launched the world's first chemically intelligent embedded 'consume before' label for cooked meats through a commercial retailer. This is early stage impact but is expected to be the subject of an impact case study in the next review period.

Another excellent example of multi-agency involvement in the funding of impact generation by WestCHEM is that of the Glasgow-based pre-clinical drug discovery company MGB Biopharma. The company has licensed WestCHEM technology and — in conjunction with WestCHEM — is developing powerful new antibiotic treatments for drug-resistant infections including those caused by MRSA and *C. difficile*. The US market alone for a new treatment is valued at \$200-300M. The development of the technology was funded first through the **Synergy Fund** (owned by

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WestCHEM) and then through **Scottish Enterprise's Proof of Concept Programme** and from royalties from Isovorin® (worldwide sales of \$50M in 2009, developed at WestCHEM in the 1980s). The investment (2010) for further development and commercialisation was led by Scotland's largest angel group, **Archangel Informal Investments Ltd**. Archangel led an angel syndicate to provide start-up funding with **TRI Cap Ltd**, **Barwell plc** and the **Scottish Co-investment Fund**. At £2.2M, this represents the largest investment made by this syndicate in a life sciences technology.

Other mechanisms such as the £1.9M **Encompass programme** led by GU in collaboration with SU, the **First Step Award Programme** (3 awards), and SFC's **Innovation Vouchers** (3 awards), have been used to support emergent SMEs. Larger, more established, companies have also been supported, for example, a KTA funded process audit for Philips Lighting identified routes to process efficiencies at their major UK manufacturing site. **Knowledge Transfer Partnerships** help businesses improve their competitiveness and productivity through access to the UK academic knowledge base. Over the review period, WestCHEM academics have been involved with 4 KTP programmes. One of the impact case studies submitted is based on a KTP with Carron Phoenix.

Strategic Partnerships

The recent selection of SU as the sole European partner for the **Korean Institute for the Advancement of Technology** (KIAT) has given WestCHEM the opportunity to increase impact further. The objective of this agreement is to transfer academic research into Korean technology companies. KIAT have committed ~£8M to this project with annual calls for research partners from SU. The programme began with the selection of up to 10 feasibility projects for 6 months, which were then distilled to 3 full development projects with Korean companies for 3 years duration. WestCHEM provided the research for the 3 full projects valued at over £1M in total. Another highlight and breakthrough in strategy for KT has been WestCHEM's collaboration with **GSK** through the WestCHEM graduate school. The construction of a bespoke framework has led to the establishment and growth of the collaborative **GSK Postgraduate Doctoral Training Centre**, which enables GSK employees and other hosted researchers based in drug discovery and chemical development, to work towards a higher (MPhil/PhD) research degree through their work-based projects. Direct investment from GSK has totalled more than £2M to date and has resulted in 56 students being registered for higher degrees at SU. Within this framework, SU academics collaborate directly on GSK-based drug discovery programmes, whilst providing continuous professional development and specific further scientific training to GSK graduate chemists. This has led to a series of distinct changes in GSK operational practice through the adoption of new and innovative approaches to personnel training, growth, and development, whilst complementing the available skills and expertise at GSK through continuous KT.

Spin-out companies

One mechanism for creating impact used by WestCHEM is that of spin-out company formation based on IP created by members. Since 2000, 8 spin-out companies have been formed, 4 of these from 2008. In total, these companies now employ 55 people. The earliest spin-out company, Xstalbio is featured as an impact case study and continues to generate impact. A second company, D3 Technologies became Renishaw Diagnostics Ltd, and has raised >£12M of funding to date. The others (Biogelx Ltd. and Insignia Technologies) remain early stage but are likely to feature in future assessments. WestCHEM has an investor partnership with the IPGroup who are currently in the process of investing £1.2M in new spinouts and our academics are engaged with US VCs, e.g., Archventure and Polaris.

Public Engagement

WestCHEM is strongly committed to inspiring the public, especially young people, and has a wide-reaching and well-established network of outreach activities. Academic and technical staff, PGRs, and undergraduates are all actively involved in a wide variety of events, from STEM Ambassador engagement and British Science Association events to Salters Festival, Glasgow Science Festival, Edinburgh Fringe, Bright Club, and RSC Chemistry at Work events. We are involved in sci-art exhibits, RSC Edinburgh Christmas Lectures, other public lectures and school events, publications in the popular press such as New Scientist, the Observer, and interviews on BBC radio and TV. Notably, one of our PGR students—Jamie Gallagher—presents at several public science festivals each year and amongst a host of other accolades, was a winner of Fame Lab Scotland and runner up in the UK final. Most recently, we were represented at what is believed to be the first ever

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Science Slam event in the UK and at Café Scientifique. Other highlights are two talks given at TEDGlobal in 2011 and 2012. Together these videos have been viewed over one million times since posting on the web in 2011/12.

Recognising that future researchers are influenced heavily by their teachers, WestCHEM has a longstanding schools liaison via SU's West of Scotland Teachers Meeting, now in its 13th year, during which more than 100 teachers attend a day focussed on updating their professional skills and inspiring their teaching. WestCHEM researchers showcase the latest developments in their field, alongside talks given by WestCHEM alumni on industrial chemistry and by education experts on the latest initiatives affecting schools. This is in addition to pupil-oriented activities such as work placements, project work, talks, and lectures during which SU alone engages with approximately 2300 pupils per annum (2011-12 figures).

c. Strategy and plans

WestCHEM has an ambitious strategy to embed impact generation across all its research themes and has appointed KT Champions to implement this strategy. They provide support and guidance through the plethora of schemes designed to achieve impact and facilitate opportunities for collaborations (e.g., industry open days, company visits, and creativity workshops). At both partner institutions, structured training in KT processes, business skills, and entrepreneurship is available to PGRs, ECRs, and undergraduate students. Clinics and placements are organised to reduce/remove barriers and encourage broader academic participation in SME-led programmes. Over the past two years, we have pioneered a new way of sharing intellectual property with industry: Easy Access IP provides royalty-free licenses to WestCHEM technologies, significantly lowering the barriers associated with accessing IP and accelerating KT. Finally, we will exploit industry-academic collaboration centres such as CMAC and TIC to enhance our impact activities.

WestCHEM has targeted an increase in the amount and quality of its impact using the institutionally supported and researcher-driven mechanisms to deliver the following:

1. An increase in knowledge transfer activity by supporting staff to undertake KT and impact training offered both internally and externally, e.g., Royal Society industry fellowships.
2. A doubling of the number of KTPs by providing expert advice and consultancy based on WestCHEM research, e.g., CFACT and CMAC are well-positioned to deliver on this target.
3. Further successful spin-out of companies by learning from colleagues who have successfully achieved this through mentoring and dedicated workshops. Based on current activity, we are predicting 2 spin-outs in the next assessment period
4. An increase in the number of collaborative industry-funded projects thereby increasing opportunities for secondments to industry. We already have 25% of our PGRs co-funded.
5. The identification of opportunities for IP creation and exploitation through business development reviews.
6. An expansion of the GSK graduate school model to other industries and sectors such as chemical and life science companies.
7. The embedding of impact at all levels from under- to post-graduate programmes through the use of impact awareness, specific credit-bearing training, and vertically integrated projects.

d. Relationship to case studies

We provide eight impact case studies that cover the three categories of impact exploited by WestCHEM: (1) commercialisation via licensing and spin-out companies; (2) production of new or substantially improved materials, devices, products, techniques, and processes; and (3) knowledge transfer (KT) to industry partners through our research expertise. Many other examples exist as mentioned in the text and the 8 selected cases are our most well advanced in terms of reach and significance of their impact. In terms of the spin-out formation, we present our lead example focussed on *therapeutic protein and vaccine stabilisation technology with global reach across the pharmaceutical industry*. The second category of impact covers the majority of our impact cases and includes *creating new business through nanocomposite technology, improved drug discovery and development through use of novel iridium catalysts, illicit drug analysis as a tool to combat global organised crime, and cleaner, greener, cheaper: a catalyst for success*. The final category impact is KT, which is demonstrated by *development of PolySNAP computer software and improving the productivity of the timber supply chain in the UK*. Overall, these cases demonstrate the breadth and diversity of impact activities across WestCHEM and indicate the successes arising from a large proportion of our research portfolio over the years.