

Institution: The University of Edinburgh & Heriot-Watt University (the Alliance)

Unit of Assessment: 16 Architecture, Built Environment and Planning

a. Overview

The strategic alliance between the University of Edinburgh (UoE) and Heriot-Watt University (HWU), which is committed to aligning research and knowledge exchange effectively across a full range of relevant disciplines, is given tangible expression in this joint submission; it is between the Edinburgh School of Architecture and Landscape Architecture (ESALA) at UoE and the School of the Built Environment (SBE) at HWU, hereafter referred to as the **Alliance**. This Alliance offers an expertise base of over 60 researchers, covering virtually the entire spectrum of research domains listed in the UoA16 descriptor, with additional concentrations of expertise in building conservation, cultural studies, digital media, and health and quality of life.

The long history of collaboration between researchers in the Alliance dates back several decades, involving not just UoE and HWU but also the then independent Edinburgh College of Art (ECA). Since 1989, for example, the School of Planning and Housing has been associated with all three institutions. The Scottish Funding Council (SFC) allocated £550k (2005-9) to the East of Scotland Architectural Education Realignment Project to streamline architecture and built environment education across these institutions, and ECA merged with UoE in August 2011.

In parallel, broader initiatives to stimulate collaboration on architecture, built environment and planning research within the Alliance were promoted, including access for students across postgraduate specialisms. The results underpin this submission, which includes all research conducted in ESALA and in two of the three research Institutes in SBE*. The diversity of the Alliance is enriched by the location of these schools in major research universities. There is direct access to a unique breadth of skills and talents in UoE's reconfigured Edinburgh College of Art, ranging from painting, sculpture and design in their broadest dimensions to art history, cultural and film studies, music and musicology. Similarly, SBE offers opportunities for research links across a range of engineering disciplines in the Institute of Infrastructure and Environment. A growing body of interdisciplinary work is further strengthened by ongoing partnerships across both universities with colleagues in the humanities and social sciences, geography, engineering, medicine, health sciences and informatics, and by collaborations with national and international colleagues.

* These are the Institute for Building and Urban Design and the Institute for Housing, Urban and Real Estate Research. The third institute in SBE, the Institute for Infrastructure and Environment (IIE) is part of a joint submission between HWU and UoE to the General Engineering panel (UoA15) in REF2014. In what follows, where data on HWU's SBE are mentioned, these exclude data related to IIE and the General Engineering submission, unless otherwise indicated.

b. Research strategy

The Alliance occupies a unique and prominent position in Scotland, the UK and internationally, conducting multi-disciplinary research across a wide range of challenges in architecture, built environment and planning. Our vision is to be a vibrant locus of creativity and invention, setting research agendas, addressing Grand Challenges and providing new insights through work at scales from global to local and approaches from strategic to grassroots. Our strategy addresses: national and international priorities pertaining to climate change; healthy, inclusive and high quality environments; rapid urbanisation; urban change and resilient communities; digital technologies; creative industries; effective resource management; and innovations in construction and design.

Alliance highlights over the REF period include the following:

- **Research leadership:** our researchers have led on three major projects, each worth over £1M, and are collaborators on a further seven, with a combined full economic cost of over £26.3M
- **Awards:** our research has been recognised by 31 national and international awards, including best paper award, CIB World Building Congress, 2010; the Institution of Civil Engineers' 2011 Howard Medal; the Society of Architectural Historians' 2011 Founders' Award; the Royal Society of Edinburgh's 2013 Innovator's Prize; and the Royal Town Planning Institute's Education Award, 2013
- **Research degrees:** 85 doctoral degrees (an average of 17/yr) were awarded by the Alliance, compared with 72 (average 14.5/yr) in 2001-7, an 18% increase
- **Research infrastructure:** over £6M was invested in Alliance research infrastructure and

estate, with a further £110M invested at university level to provide facilities on which our researchers draw

- **Advancing global research:** we hosted 11 international conferences, including the CIB W070 International Conference in Facilities Management, 2008, with delegates from 24 countries and the European Real Estate Society 2012, with over 400 attendees.
- **Research Excellence:** The Alliance includes one of only four UK Royal Academy of Engineering Centres of Excellence in Sustainable Building Design, announced in 2013.

i. Support for strategy delivery

The Alliance aims to foster vibrant, successful and interactive research communities that achieve national and international impact. This is supported by sustained relationships with many partners and beneficiaries, detailed in REF 3a and 3b, which include: international government departments and NGOs; UK and devolved government departments, directorates and agencies; local government departments and directorates; housing bodies and providers; charities and not-for-profit organisations; museums, arts organisations and science festivals; industry professionals and institutions; industry partners and SMEs; and sound and digital media industry stakeholders.

The Alliance’s collaborative potential has been reinforced in the REF period by targeted initiatives: a joint Alliance Research Committee to foster excellence in research across both institutions and support a range of techniques and approaches to enquiry; strategy-formulating away-days; focused meetings for early exchange of information on particular research themes between schools (annually since 2010); joint seminar series for staff and PGR students; increasing cross-institutional supervision of postgraduate research students; and recent development of joint teaching & learning programmes (e.g. a joint Masters in Urban Strategies and Design from 2013). The work of the Edinburgh Knowledge Exchange Partnership (EKEP) - created as the vehicle for outreach from the Alliance to bodies beyond the academy - has been funded internally. EKEP has held four major outreach events since 2011 with industry partners, e.g. Skanska and Arup, and policy stakeholders, e.g. Scottish Government, Historic Scotland, City of Edinburgh.

Alliance ‘kick-start’ funding (part of the £180k available each year to support our researchers) has been dedicated since 2011 to stimulate new collaborative work, broaden mentoring opportunities and develop young researchers’ skills via a competitive process; each proposal is required to include staff from both Universities and to involve early career researchers (ECRs). An example of the five projects funded in 2011/12, demonstrating the synergies that arise by bringing architects and engineers together early in their research careers, includes work by Moffitt (ECR) with Wang, on visualising thermodynamics to develop design processes. This resulted in a competition entry, *An Exothermic Landscape*, for a site on the world’s largest landfill (Fresh Kills on Staten Island, NY), and a publication on computational fluid dynamics steady state modelling and thermal comfort calculations, as well as on methods to convey this graphically.

To encourage interdisciplinarity (50% of our research outputs are interdisciplinary), the Alliance pursues funding from a broad range of sources, many of which are committed to impact. As an example, the RCUK cross-council-funded *Mobility Mood & Place* project involves researchers from across our two universities, in landscape architecture and environmental design, health and human geography, architectural design and computing, psychology, geriatric medicine, neuroscience and social anthropology, with expert advisors in Canada (WHO and Simon Fraser University), Australia (Emotiv Lifesciences – a bio-informatics company) and the USA (Harvard University).

ii. Research themes and groups

Within this culture of interdisciplinarity, which recognises the value of both individual scholarship and collaborative working, research is grouped around the following ten cognate themes, some supported by formal research centres (characterised by external advisors and annual University reviews). All are led by professors who provide scholarly leadership, mentoring and expertise in securing research funding and most have benefited from targeted recruitment of ECRs and established researchers. These themes and groupings reflect the major aims identified in the Alliance’s three RAE2008 submissions, the achievements of the last REF cycle, and future ambitions. Selected examples of achievements are listed below under each theme, illustrating how the goals and aspirations in these areas (and of the Alliance as a collaboration) have been met or surpassed in the REF period, establishing a confident base for achievement of future strategy.

Creative Industries and Innovative Design - developing new modes of production and construction

Environment template (REF5)

(led by McLachlan, Pedreschi)

Development of innovative techniques in working with concrete (*Fabric Formwork*, Pedreschi, McLachlan) led to the RIBA President's commendation for research in 2008 and Most Creative Urban Garden design award at the Royal Horticultural Show Chelsea, 2009. Our researchers won Scottish Home Awards for 'House' or 'Designer House' of the Year in 2011, 2012 and 2013 (Brennan; Wiszniewski). Examples of award-winning, research-led designs include *The Wholelife House* (Brennan), a Scotland's Housing Expo exemplar; *Speirs Lock masterplan*, winner of 2009 British Urban Regeneration Association (BURA) award and Scottish Award for Planning 2009 (Rankin) and a villa by Zone Architects, winner of a Royal Incorporation of Architects in Scotland Award in 2012 (Ewing). ECR Moffit supports expertise in sustainability.

Hybrid Design Processes and Digital Media - seeking productive research synergies, such as exploiting links with Informatics (led by Coyne, Kaka, Lee, Speed)

Links with UoE's world-class School of Informatics (85% 4*/3* and the largest submission in its unit in RAE2008) have been consolidated with the appointment of Speed as Professor of Design Informatics (2013). *Branded Meeting Places* (AHRC £328k, Coyne, Lee, Travlou), identified the spatial, social and philosophical implications of digital media and *ToTem/Tales of Things*, (£1.2M EPSRC, Speed), investigated archiving of memories via the "internet of things". Work to document the progress of construction (EPSRC £106k, Kaka, Motawa) using innovative Building Information Modelling techniques led to 2D/3D imaging and 3D/4D building models to monitor progress and quality (enhanced by the appointment of ECR Bosché), and IT-based collaborative environments (enhanced by the appointment of ECR Erdogan). ECR Bastian's appointment contributes new understandings in feminism, time and community.

Health and Environment, including *OPENspace* and *VISION* research centres - investigating links between the built and natural environment and human wellbeing (led by Aspinall, Ward Thompson)

Research collaboration here included engaging ECR Roe in groundbreaking work (featured in the *New York Times*, 2013) linking neural imaging to experience of the environment (Roe, Aspinall, Coyne) leading to an EPSRC/ cross-council grant (£1.27M 2013-16, Ward Thompson, Coyne) on ageing, mobility and the built environment. Leading research on salutogenic environments included support for older people's quality of life (*IDGO TOO* consortium, EPSRC, £679k of £1.5M, 2007-11, Ward Thompson). *GreenHealth* (Scottish Government, £175k of £1M, 2008-12) developed new techniques to investigate links between green space and health for deprived urban populations (Ward Thompson, Aspinall, Roe). Two ESRC-funded collaborative PhD studentships cover health, transport and environment (Brown, Roe, 2009-13).

Global Cities and European Spatial Planning, including the *Centre for Environment & Human Settlements* - challenging normative conceptions of the urban in a global context and addressing problems for city regions and rural-urban interfaces (led by P. Jenkins, Hull)

Work on the multicultural city of the 21st century (P. Jenkins, Uduku, Smith) included studies in South America and Sub-Saharan Africa and engagement of the Alliance with UoE's Global Development Academy and Centre for African Studies (e.g. *Home Space in the African City*, Danish Research Institute for Innovation, DK 400k, 2009-12, P. Jenkins); the *EdQual project* (DFID, £30k, 2007-10, Uduku). *PLUREL (Peri-urban Land Use Relationships)*, an EU 6th Framework project (2007-11, €250k out of €8M), studied the dynamics of rural-urban regions (Bell was social science coordinator) and *MP4*, an EU INTERREG Project (€190k out of €2.9M) focused on public place-keeping through transnational action-learning (Smith, Hull). Both developed appropriate planning guides (e.g. Neuman & Hull, Routledge, 2011).

History, Identity and Heritage, including the *Scottish Centre for Conservation Studies* and the *Visual Arts Research Institute Edinburgh* (with national galleries and museums) - exploring the use of visual research methods and the nature of place (led by Campbell, Dorrian, Glendinning, Whyte)

In this group, strongly represented in international publications, e.g. on Berlin (Whyte) and post-1945 global modernism (Glendinning), studies of the European city addressed urban theory and semiology, place memory, the aerial view, and visual culture, (e.g. in partnership with the Imperial War Museum), and was enhanced considerably by recruitment of Chmielewska and Kaminer, joining Wiszniewski and Ewing. The recent appointment of Dorrian to the reinstated Forbes Chair in Architecture adds significant international expertise. ECR appointees Anderson and Fair bring additional scholarship in modernist architectural history in eastern Europe and in British public and institutional buildings. Architectural history includes internationally leading work on Pirro Ligorio's Oxford Codex (Campbell) and on imperial and colonial/post-colonial

architecture throughout the former British Empire (AHRC, British Academy, and Graham Foundation, Bremner, Uduku). Whyte co-edited a book on the sublime in art and science with Nobel-laureate chemist Roald Hoffmann (“of profound importance”, *Wall Street Journal*, 2011).

Sustainability of Urban Form, Construction and Environmental Management - including retrofit solutions for existing buildings and environmental impact assessment (led by Banfill, Hull, Roaf)

This research has won over £3.8M of funding, including *CALEBRE* (RCUK, £220k out of £2.05M, 2008-13, Banfill) on retrofit solutions for solid wall dwellings. *ARIES* (EPSRC, £1.16M, 2011-14), on the resilience of energy supply systems in the future climate, benefitted from ECR appointments D. Jenkins, Gul and Patidar in support of Banfill, as did *Decision Support for Building Adaptation in a Low Carbon Climate Change Future* (EPSRC, £693k, 2008-12, Banfill, D. Jenkins, Menzies, Patidar), and *Concrete2Cookers* (EPSRC, £101k, 2008-9, Carter, D.Jenkins, Banfill) on public engagement through school children. Menzies developed an integrative, whole-life selection tool for materials and components (Royal Academy of Engineering, £55k, 2011-13). Roaf contributes to the *climateXchange* centre of expertise connecting climate change research and policy on the adaptive capacity of rural Scotland (Scottish Government, £157k out of £3.6M, 2011-16).

Social Inclusion and Urban Governance - addressing inequalities and promoting citizens' inclusion (led by Bramley, Fitzpatrick, Ward Thompson)

Nationally important measurement and analysis in the UK *Poverty & Social Exclusion Survey* (ESRC Major Grant Partnership, £200k out of £4M, 2010-14, Bramley), and *Use of social sanctions across the housing and welfare fields* (ESRC Major Grant collaboration, 2012-17, £520k out of £2M, Fitzpatrick, Johnsen) is setting the policy agenda for the coming decade. It builds on earlier studies in homelessness prevention, e.g. *Multiple Exclusion Homelessness* (ESRC/JRF, £303k, 2008-11, Fitzpatrick, Johnsen), profiling of disadvantage (Fitzpatrick, Bramley) and disadvantaged communities' access to green space (*Urban Green Nation and Community Green*, Commission for Architecture & Built Environment, £80k, 2009-10, Bramley, Brown, Aspinall, Roe, Ward Thompson) to achieve substantial policy and practice impact.

Recruitment of Fitzpatrick and Johnsen reinforced this theme's expertise in social inclusion.

Housing and Property: planning, design and market operation - delivery of affordable housing, adaptability and sustainability, and the dynamics and regulation of property markets (led by Bramley, Jones, Leishman, Stephens)

This develops unique tools and models to assess local housing affordability and the impacts of planning reforms in England, including sub-regional housing market geographies (Jones, Bramley, Dunse), providing applications for local authorities across UK (Bristol-West of England, Gloucestershire, Highland), and new national/regional models of housing need, demand and supply for England (DCLG, £164k, 2008-10) and New Zealand (Housing New Zealand, £125k, 2011-13). Jones led a task force on *Housing Market Volatility* (DBIS/DCLG, £18k, 2007-08) and a study on options for property tax reform, enhanced by new expertise from Leishman in international housing policy and Stephens in real estate economics (Joseph Rowntree Foundation, £48k, 2013). The *SNACC* project on neighbourhood and housing within the *Adaptation and Resilience to Climate Change (ARCC)* initiative (EPSRC, £64k, 2009-12, Dunse, Bramley), focused on domestic energy demand. The appointment of ECR Matthews brings further expertise in urban planning to address deprivation.

Project Management - improving quality of life in efficient facilities, procured optimally and delivered by profitable construction organisations (led by Kaka, Ogunlana, Sun)

Bayesian Belief Networks and System Dynamics modelling were used to model risk in construction projects (Ogunlana). New appointee Chen developed multi-criteria assessment approaches for facilities management, real estate development and sustainable construction. The benefits of innovation in procurement were quantified as part of the *Health and Care Infrastructure Research and Innovation Centre* with Imperial College (EPSRC, £240k out of £7.2M, 2006-11, Kaka). Recruitment of Sun added expertise in research contributing to an improved construction supply chain (SWRDA, £1.1M, 2005-12); construction project management and control (KTP, £101k, 2006-8); and design support tools for sustainable homes (TSB/EPSRC, £258k, 2010-12). This theme has been strengthened by 5 ECR appointments.

Low Carbon Architectural Engineering and Construction Technology - delivering low carbon, high quality-of-life communities (led by Banfill, Pedreschi, Roaf)

IITSAFE (Integrating Technical and Sociological Aspects of Fire Safety Engineering) (Arup

Environment template (REF5)

Foundation, Royal Academy of Engineering, £250k, Pedreschi), studies the interface between regulation, design and user behaviour. Galbrun used Statistical Energy Analysis to study noise transmission and aural wellbeing, focusing on lightweight building structures. Roaf embedded solar and passive technologies in accessible design guidance, Forster developed predictive models for deterioration of lime-bound masonry (EPSRC, £130k, 2009-13).

iii. Five year objectives

The Alliance will continue to invest in the research themes identified above to enhance existing groups and centres of research excellence, and to place them at the forefront of new initiatives to address global issues and Grand Challenges, using its expertise to research:

- Health, demographic change and wellbeing, as influenced by the built environment;
- Climate action, environment, resource efficiency and sustainability, including better performing materials and buildings;
- Inclusive societies, inclusive access to housing, services, built environment and public space;
- Innovative societies, taking advantage of new materials, media and the digital age;
- Responsible societies, with a heightened awareness of our existing building stock and cultural heritage.

At the same time we seek to challenge knowledge boundaries and shape the research agenda of the future. To assist in achieving these aims, Alliance researchers will:

- Actively engage in the Horizon 2020 research programme, building on our wide network of international and external collaborators (e.g. 30 EU project collaborators from 15 countries in our EU FP6 *PLUREL* project) and extending our reach to new partners outside academia;
- Engage with UoE's four Global Academies focused on Development, Environment & Society, Health, and Justice, contributing via collaborative research proposals and KE to a step change in the way the Alliance is able to build interdisciplinary responses to global challenges;
- Exploit opportunities presented by HWU's Dubai campus, its new (2013) Malaysian campus, and UoE's offices in China, India, Brazil (the São Paulo Office of the Americas opened in 2013), as well as that planned for New York, USA, to extend the global reach of our research;
- Exploit continuing opportunities in a devolved Scotland and debates on constitutional reform to explore different policy approaches via a comparative perspective across UK, EU and globally;
- Extend the influence in policy and practice of EKEP as a national and international centre for architecture, built environment and planning research, focused on external and community engagement, the city and wider society and assisted by a *Projects* office;
- Deploy conventional, new and emerging media, especially social media and new paradigms of knowledge generation and sharing (e.g. the internet of things, twitter, crowdsourcing), to develop opportunities within a larger constituency of partners, consumers and audiences;
- Maximise interaction with the cultural community in Edinburgh by expanding our links with designers, performers, film makers, and with the international arts and science festivals;
- Build on participation in the Scottish Graduate School for Social Sciences (ESRC DTC) and other doctoral training initiatives (e.g. AHRC, EPSRC) to develop the next generation of researchers in areas of critical importance, to extend and challenge existing practices and knowledge generation, e.g. in salutogenic environments and practice-led design research;
- Develop innovative forms of critique, invention and analysis of historical and contemporary architecture and urbanism, which combine textual, graphic and spatial methodologies.

c. People:

As a major research concentration, the Alliance creates advantages in terms of scale, joint teaching, capacity to provide sabbatical cover, and responsiveness to external opportunities and context. These enable a core of experienced researchers to work internationally at high levels of excellence, while also creating numerous opportunities for early career staff to develop their skills. We have implemented aligned research development strategies since 2009 to support and enhance staff as academic leaders and innovators, as described below.

i. Staffing strategy and staff development

Staff succession policies, including recruitment, research leave and mentoring programmes

The Alliance has 24% Professors, 26% Readers, Senior Research Fellows and Senior Lecturers, and 50% Lecturers and Early Career Fellows. Succession planning aims to maintain a

balanced staff profile, attracting new, early career academics as well as more senior appointments and providing opportunities for internal promotion. Our policy of investing in early career researchers (22% of our returned staff are ECRs) as well as creating attractive opportunities for excellent academics (including research staff) at any stage in their career ensures all academic appointments are soundly based on research record and the potential to develop further.

31 new appointments during the REF period reflect targeted recruitment at all levels from Professor (5) to ECR (19). Examples include the appointment of 4 professors/senior research fellows and 4 lecturers under HWU's Global Platform for Research Leaders, and 2 prestigious UoE Chancellor's Fellows (5-year, tenure-track positions incorporating significant periods of research leave - full research leave in the first year and on a sliding scale thereafter), reflecting major investment in outstanding academics with clear potential as international leaders in their discipline. Recruitment has been truly international, attracting staff from Canada, USA, Netherlands, Portugal, Spain, Sri Lanka and Switzerland. Illustrating opportunities to maximise sharing of expertise across the Alliance, P. Jenkins retains a 50:50 post between HWU and UoE and Roe and Carter moved between Universities to take up lectureships.

Examples of successful support for career development in the Alliance include: Cairns moving to the Singapore-ETH Centre (SEC) Future Cities Laboratory in Singapore; Dorrian (subsequently returning to take up the UoE Forbes Chair in Architecture) and Finch moving from mid-career posts to Chairs at Newcastle and Salford Universities, respectively; ECR Wendel taking up a teaching fellowship and PhD studentship at Harvard; and ECR Roe a part-time Senior Researcher post at the Stockholm Environment Institute, York. Succession has been maintained through internal promotions - 4 to chairs, 7 to senior lectureships and 3 to readerships - as well as new appointments - 5 at professorial level, 4 at reader/senior research fellow level and 22 at lecturer/ECR level, including 4 internal research associates appointed to lectureships (for discussion on gender balance, see 'promoting equality and diversity', below).

All staff have annual appraisal and performance reviews with opportunities to discuss career trajectories and development support needs. As excellence in research and/or scholarly work is expected of all staff, each ECR is mentored by a more experienced researcher and given initial workload relief to allow time for research development. The wide pool of expertise across the Alliance has proved very useful for matching researchers and mentors, while encouraging wider synergies and new, often interdisciplinary, opportunities. Staff are entitled to apply for sabbatical leave (normally one semester of leave for each four-year period of service), subject to the availability of appropriate cover. Satisfactory achievement of planned research outcomes is a requirement for approval of any further academic leave. Over the REF2014 period, 22 staff have taken sabbatical leave.

Offering pump-priming support for new research and knowledge exchange ideas, including links into teaching & learning

Early Career Researchers (ECRs) receive additional support to help them develop into confident and independent researchers operating at an international level. They are given extra training, priority access to funding for pilot projects and networking activity on which to build major grant applications and larger research projects, study days and career development courses, tuition fee scholarships for appropriately-qualified postgraduate research student applicants in their area of expertise, and financial support for travel and other activities that will enhance their research career. Internal funding of c. £180k a year is available for all staff to help develop quality research outputs, attend conferences, test methodologies, develop new collaborative ideas, etc.

Examples of such funding that "prioritises investment in people and activities" (RAE2008) demonstrate promotion of research at several levels. Complementing the work of EKEP, a Projects office was launched in 2009 and enhanced by a further grant in 2012 to support design-led research and innovation from both staff and students, and to engage the public in debate about contemporary design and sustainability issues. Current Projects include: Colour Capture Workshops in Zurich and Edinburgh (McLachlan); Spaces and Practices of Welcome (Ewing) and work with the charity Learning Planet on mobile school design in Africa (Uduku). A separate award in 2012 brought staff and students together from three diverse disciplines - architecture, textiles and glass - to study ecclesiastical buildings, most notably St Peter's Seminary, Cardross, and a series of practical workshops to develop new and experimental pieces that exploit leading-edge technologies in fabric-formed concrete and glass.

Maintaining and enhancing standards of research quality and integrity

To support the vital base of talented and committed researchers, we have increasingly worked together across the Alliance on common systems and processes to manage and promote research. We operate a single "Research and Commercialisation" office model through which the Alliance is supported by 10 staff expert in promoting all modes and phases of research, from the first stirrings of an idea, through the funding application process, to realisation, IPR agreements, publication, wider dissemination and maximising impact. Close vertical and horizontal liaison in these processes is achieved through effective protocols governing which University leads on negotiations and contract or licensing development for joint projects. This system includes rigorous review and ethical approval processes, with all external grant applications since 2011 undergoing internal peer review as well as scrutiny by specialist administrative staff experienced in a high volume of applications. This not only acts as a quality assurance mechanism for the University and the Research Councils, but also provides mentoring for the next generation of PIs.

In addition to the Alliance-level support for staff and students, there is a comprehensive programme of University-level support for research leadership, management and staff development. UoE's Institute for Academic Development (IAD) and HWU's Centre for Academic Leadership and Development (CALD) organise briefing events and workshops, providing a range of online resources and support for PIs, ECRs and PhD supervisors. HWU invested 6 FTE posts in its 'Research Futures' programme to support research leadership, and led the Scottish Crucible, part of a programme that won the 2010 Times Higher Education award for ECR support, with HWU's own Crucible shortlisted for a 2011 Leadership Foundation for Higher Education award.

Prestigious Fellowships, reflecting international standards of research excellence, include:

- Ian Campbell, as Rudolf Wittkower Guest Professor, Bibliotheca Hertziana Max-Planck Institute for Art History, Rome (2010-12), offers scholarship in Medieval and Renaissance architecture;
- Remo Pedreschi was appointed Visiting Professor in Structures at the Royal Danish Academy of Fine Arts, School of Architecture (2013-15);
- Paul Jenkins, Visiting Professor at the Universities of São Paulo (2007-12), Witwatersrand, Johannesburg (2010-13) and Eduardo Mondlane University Mozambique (2010-13) has developed a research network with global expertise in rapid urbanisation;
- Mark Dorrian was appointed Visiting Professor at the University of Michigan (2010), Arkitektsskolen Aarhus, Denmark (2013-14) and Tianjin University, China (2011 – present);
- Gillian Menzies, given a Royal Academy of Engineering Industrial Secondment and subsequently a Research Fellowship (2011-13), has developed an integrative whole life selection tool for materials and components, contributing to sustainable environment expertise;
- ECR Richard Anderson was awarded a 2010 Mellon Foundation / American Council of Learned Societies Fellowship and Alex Bremner a Paul Mellon Centre Fellowship at the British School in Rome (2013-14), strengthening architectural history expertise.

Support for the career development of research staff

The Alliance employs 16 Research Associates (RAs) and Fellows (RFs), six of whom are on continuing contracts. In the REF period there have been six cases of internal progression, either to Research Fellow or to Lecturing posts. As part of the Alliance's commitment to research staff, RAs and RFs participate in annual staff reviews and Academic Staff Leadership programmes and are eligible to apply for 'kick start' awards and Career Development Fellowships (e.g. Fernandez Gonzalez, 2013). UoE and HWU were both awarded the HR Excellence in Research Award by the EC in 2010 (renewed in 2012/13) for their work in implementing the principles of the 'Concordat to Support the Career Development of Researchers' - among the first UK universities to receive this recognition. Both institutions provide support for all research staff, including induction and mentoring, career and professional development, supervision and teaching support specifically for research staff. PIs are trained in the Code of Practice on award of new grants to ensure they recognise responsibilities and provide effective support for RAs and RFs.

Through internal funds, grants are available to assist research staff develop further research outputs and impact at the end of a project, to bridge gaps in staff funding between awards and to identify new job opportunities. Examples include support for a contract extension for an RA in ESALA's OPENspace research centre in 2012, allowing the RA time to prepare more publications and progress to a new, externally funded research contract. During the REF period, 7 RA/RFs have moved on to continuing academic posts internationally (e.g. Brazil) and in the UK, one

researcher to an analytical unit in the Scottish Government and 4 to lectureships in SBE.

Promoting equality and diversity

Our expanding international profile is reflected in 31 new staff recruited from an international field in the REF 2014 period. Both UoE and HWU have Equality and Diversity (E&D) Coordinators at university level, and in UoE at School level, charged with supporting the mainstreaming and integration of equality and diversity awareness into the day-to-day activities of their staff. They gather and report on E&D information for staff and students, ensure staff are trained in understanding Equality, Diversity and Internationalisation, and set annual local diversity objectives.

The staff of the Alliance is 31% female, compared to 20% in 2008, reflecting a policy to promote equality of opportunity for all staff. Within the REF period, 53% of the promotions (Professor (1), Senior Lecturer (5) and Reader (2)) were awarded to women and 39% of new appointments have been women. There is encouragement for further career progression and both Alliance partners are committed to the Athena SWAN charter; Heriot-Watt received an Institutional Bronze award in October 2013 and UoE will submit ESALA for a Bronze award in November 2013, aided by UoE's commitment and experience as the first Scottish University to have a department (Chemistry) achieve an Athena SWAN Gold award. Wider approaches to supporting equality and diversity include being responsive to individual circumstances and needs, e.g. through flexible working agreements when staff return to work following maternity leave (four such leaves of absence in the REF period) or paternity support after adoption (one case), or after extended illness (one case).

More generally to support staff in their working lives, there is access to: information for those new to Edinburgh, including a dedicated support office for international staff relocating here; Counselling Service; Occupational Health Service; LGBT (Lesbian, Gay, Bisexual, Transgender) Staff Network; Chaplaincy (for all faiths and none); Childcare support (University nurseries and Childcare Vouchers scheme); career transition support; redeployment guidelines and support, including a talent register (referred to in new RA appointments); and staff discounts and benefits.

ii. Research students

The rapidly growing number of postgraduate research students (PGRs) in the Alliance (over 160 FTE PGRs were registered in 2012/13, compared to a yearly average of 60.5 FTE in 2001-07) reflects both our strategic cultivation of the next generation of researchers and the international reputation of our researchers and research environment. The scale and diversity of the Alliance makes it well equipped to meet RCUK expectations for doctoral training. An average of 17 doctoral degrees per year were awarded in the REF period, compared to an average of 14.5 in 2001-2007

Research studentships

We have won support for a wide range of external and internally funded PGR studentships: 24 were available to Alliance PGRs in 2012 alone. As well as receiving Doctoral Training Awards (usually 3-5 per formula based on EPSRC income), we are part of the ESRC's Scottish Graduate School Doctoral Training Centre, which now provides all ESRC postgraduate research training support in Scotland (c.75 awards per year). In this competitive and multi-disciplinary framework, Alliance researchers won three ESRC awards in 2012 (including a collaborative ESRC-Sustrans studentship) and two in 2013 (including a project-linked studentship). Eight AHRC scholarships were awarded in the REF period, as well as two Scottish Overseas Research Student Award Scheme (SORSAS) scholarships and one Overseas Research Scholarship (ORS) award.

Internal studentships available competitively across our institutions include the 'Edinburgh Global' and Principal's Career Development fully-funded scholarships and the James Watt partially-funded scholarships (9 of the latter were awarded to Alliance PGRs in 2012). As an example of the former, a full scholarship was awarded in 2013 to a lecturer from Bangladesh to undertake her PhD on the impact of outdoor environmental design on children's physical, psychological and cognitive development, with supervision from world-leading researchers in our OPENspace research centre.

Other examples of Alliance PGR studentships include: a Historic Scotland studentship on energy modelling in traditionally constructed dwellings, 2009; two Energy Technology Partnership funded studentships on building energy performance simulation, awarded 2011; a studentship on energy assessment in the textile industry, awarded by Johnstons of Elgin, started 2012; two studentships on a virtual immersive training environment for craft-workers, awarded by Construction Skills, 2012; EPSRC project studentships covering 'binder loss in lime masonry' and 'energy-led refurbishment of non-domestic buildings'; an ESRC-Scottish Government studentship,

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in collaboration with the Forestry Commission Scotland, on 'Designing and Managing Forests for Health', held jointly with UoE's School of GeoSciences, 2012, and an AHRC Collaborative Doctoral Partnership with the Imperial War Museum London on Photography and Ruins, 2013.

Research methods training and student support

All academic staff are formally trained in supervision of PhD students and a rigorous system of mentoring ensures that newly trained supervisors are matched with experienced co-supervisors. Teaching is led and enriched by our research, and students at all levels have engagement with a dynamic research environment, e.g. in the internally funded project on innovative materials, engaging students from architecture, textiles and glass, and the EPSRC-funded *Mobility, Mood and Place*, engaging Alliance students in design for older people.

Our innovative PGR research methods course aimed at students of architecture and landscape architecture has a focus on creative practice that also embraces art and design, history of art and music; the course has a practical work component that involves peer review and culminates in a student-led conference. The MRes programme entails four courses in advanced research methods in the social sciences which students take alongside other courses from the suite of Masters courses available in planning and built environment. This is core for ESRC-funded and other PhD students in the Urban Planning and Real Estate pathway of the ESRC DTC, with teaching also embracing management and languages skills. PhD students take elements of this programme to meet the needs of their research topic and methodology. In addition they can access the DTC's summer school and the advanced quantitative techniques courses of the ESRC-funded Applied Quantitative Methods Network (AQMeN).

Alliance PGRs also have access to short courses in generic skills (e.g. research writing, bibliographic software, presentation skills) provided at University level, as well as more specialist courses for individual or small group needs, such as tailored training in Geographic Information Systems (GIS) or in ethnographic methods. Internal research journals (*Edinburgh Architecture Research* for PGR students, '*Architecture &...*' for staff) promote and share research culture at every phase of the academic career. Each PhD programme has a seminar series dedicated to research students, where they can present their work alongside faculty and visiting speakers in a supportive context for shared learning and for developing specialist methods and practice in critiquing skills, e.g. the Landscape Architecture/OPENspace series, open to all Alliance students and their supervisors. PGR students run their own series, at which they and outside speakers present their work. External contributors include, e.g. Prof. Ganiatsas, National Technical University, Athens, and Prof. Wilson, University of Virginia. In addition, PGRs have access to a rich array of postgraduate seminars, School seminars and public lectures across both Universities.

Support for Alliance PGRs is being further developed to promote opportunities for internships, offer teaching experience, and provide training in public engagement and entrepreneurship. This includes: support for innovative communication approaches (e.g. explaining your research through stand-up comedy) via Edinburgh Beltane, a Beacon for Public Engagement; opportunities via HWU's Converge Challenge, open to staff and PGRs to support the next generation of Scottish research entrepreneurs in business and technology; as well as extensive online resources and advice covering all areas of the Vitae Researcher Development Framework. For international PGR students, the COMPASS programme offers: the opportunity to socialise, network and learn about studying and living in Scotland; visits to other parts of Scotland; transferable skills training; and professional and career advice.

PGR successes that testify to the quality of the Alliance research culture include RIBA 2009 joint best PhD award for Koutsoumpos; Ashgate's 2011 publication of Fortin's PhD, *Architecture and Science Fiction Film*; Sutherland's two-person show with Richard Parrish in Portland Oregon (2011); the NY-based Pamphlet Architecture Prize for work on *Resilience* undertaken by PhD student Ozga-Lawn (2012); and Karandinou's *Athens by Sound* project chosen to represent Greece in the 11th Venice Biennale of Architecture (2008). Further, PhD students have initiated the organisation of two international research conferences in 2013, securing funds (in part from the Alliance), and inviting peer-review panels of experts: *Shrinking Cities: Expanding Landscapes* had over 60 participants, including from Japan, Germany, Greece, Italy and Spain; *Plenitude and Emptiness*, on architectural research by design, had keynote speakers from Stockholm and Delft and an equally international range of participants.

d. Income, infrastructure and facilities

The research and commercialisation offices of both universities work very closely together and are jointly procuring a new research management and administration system to enhance effective and seamless support through all stages of the research cycle. Both operate the PURE database system, with access to each other's data, and liaise extensively over joint funding applications, with one routinely designated as the lead administrator for each bid but both providing support as required. They cooperate to host visits to Scotland from funders and share workshops/seminars on funding opportunities or strategies. They work closely with units supporting ECR and researcher development, with staff regularly attending both the Scottish Crucible and the HWU Crucible programmes, designed to promote interdisciplinary collaboration.

i. Research infrastructure – buildings, libraries and equipment

Both institutions have invested heavily in school and university research infrastructure. The Alliance received £440k from SFC towards cataloguing, archiving and curating UoE collections of early mediaeval and Middle Eastern manuscripts, the papers of major Scottish Enlightenment figures, and architectural drawings, all of special relevance to architectural historians and conservationists. £5.6M has been spent on other Alliance research infrastructure, including the first steps to refurbish the ECA campus, provide new 3D modelling and CAD/CAM equipment, and improve labs and PGR facilities in SBE, with further improvements scheduled for 2016-17 and planning underway for further, multi-million estate developments for ECA. Beyond direct investment, both Universities have invested in other, major infrastructure. The Main Library (£58M, UoE), Informatics Forum (£42M, UoE), Postgraduate Centre (£9M, HWU) and Edinburgh Centre for Carbon Innovation (£10M, UoE/HWU and Napier University) are examples, supporting the Alliance's conventional and historic knowledge resources, cutting edge new information technology and design/IT links, networking and collaboration between colleagues, research students and MSc students, and climate change research and knowledge exchange, respectively. UoE hosts the UK's JISC Data Centre "EDINA" (which provides a range of services and data in support of research and has advanced expertise in GIS technology) and the Digital Curation Centre.

ii. Major grants and awards

The varied nature of the research domains within the Alliance demand different levels of external funds for successful and innovative projects. While smaller grants have led to significant research outputs, we list here only a selection of major grants awarded since 2008 (some not yet reflected in REF4 data on expenditure) which have involved consortia of researchers and cross-disciplinary working. Such projects offer opportunities to: enhance the quality and impact of research outputs through synergistic working; create networks of expertise (often involving international advisors and collaborators); engage with a wider range of research users and beneficiaries through the range of disciplinary connections with industry, policy-makers and practitioners, and offer enhanced opportunities for ECRs and PGRs to learn new skills, experience placements in partner institutions, and identify new career paths.

- *MP4* (Smith, PI, Hull Co-I) focused on public place-keeping through transnational action-learning with city partners (€190k out of €2.9m), an EU INTERREG Project, 2008-12.
- *CALEBRE* (Banfill, Co-I) addressed energy and carbon reduction solutions for solid wall dwellings and involved ECR D. Jenkins (£172k out of £2.05M), RCUK EP/G000387/1, 2008-13.
- *GreenHealth* (Ward Thompson, Aspinall Co-I) explored links between green space and health, in collaboration with The James Hutton Institute and Glasgow University. Ward Thompson led the work package on deprived communities, green space and wellbeing, which also involved ECR Roe (£173k out of £1M), Scottish Government Rural & Environment Science & Analytical Services MLU/ECA/UGW/847/08, 2008-12.
- *ToTEM/Tales of Things*, Electronic Memory (Speed, PI) provided a digital platform to allow memories to be attached to existing objects and places and, for example, it significantly enhanced Oxfam shop sales. With Brunel, Dundee, Salford and University College London (£711k out of £1.2M), an EPSRC consortium project EP/H007318/1, 2009-2012.
- *Moving Targets: New models for new media audiences in the creative media industries*, in collaboration with the University of Abertay (Coyne, PI). Partners include BBC Scotland, Clash Music Group, Dynamo Games, TAG Games, Tern TV, Winterwell Associates and Skillset Scotland (£270k out of £1.08M), an SFC SPIRIT project, 2010-2013.
- *UK Poverty & Social Exclusion Survey*, (Bramley, Co-I), led by U. of Bristol, tested and refined

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state-of-the-art ways to measure poverty, living standards, social exclusion and their inter-relationships (£200k out of £4M), ESRC Major Grant Partnership RES-060-25-0052, 2010-13.

- *ARIES* (Banfill, PI; D. Jenkins (ECR), Co-I) assessing the resilience of energy supply systems (£1.16M), an EPSRC, ARCC programme project EP/I03534X/1, 2011-15.
- *NIHR/WIAT* (Ward Thompson, PI; Aspinall and Roe (ECR), Co-Is) evaluating whether Forestry Commission Scotland's woodland improvement programme - Woods In and Around Towns (WIAT) - improves psychological wellbeing in deprived communities, with Glasgow U., London School of Hygiene & Tropical Medicine. £984k, NIHR Public Health Research project 10/3005/18, 2012-16. An associated Scottish Govt/ESRC PhD studentship awarded 2013.
- *Sanctions, support and behaviour change* (Fitzpatrick, Johnsen, Co-Is) led by U. of Salford, involving large-scale, longitudinal, qualitative research with a range of social groups (£520k out of £2.05M), ESRC Major Grant collaboration, 2013-18.
- *Home Hub-of-all-Things (HAT)* (Speed, Co-I) a project on opportunities for a new Economic Model in the Digital Economy powered by the Internet-of-Things, including partners such as Dyson, GlaxoSmithKline and OSRAM (£80k out of £982k), EPSRC EP/K039911/1 2013-15.
- *Mobility, Mood and Place: a user-centred approach to design of built environments to make mobility easy, enjoyable and meaningful for older people* (Ward Thompson, PI; Coyne, Aspinall, Roe, Co-Is) a joint Research Council, interdisciplinary project under the Lifelong Health and Wellbeing programme (£1.27M), EP/K037404/1, 2013-16.

e. Collaboration or contribution to the discipline or research base

While the diversity of expertise has offered rich opportunities for innovative collaboration within the Alliance, exemplified in Theodossopoulos' investigation of prehistoric Scottish brochs, which links contemporary engineering research techniques to new understandings of historic constructions, there is also a lively dynamic of engagement with colleagues in other Schools, other Universities, and beyond the academy. Alliance colleagues contribute, for example, to the seminars of UoE's Institute for Advanced Studies in the Humanities seminars (for which Dorrian and Whyte serve on the advisory board), the Medical Humanities Research Network, and in contributions towards an ongoing EdNeuro-ECA Collaborative, bringing together artists, designers and neuroscientists, with a £1.27M grant from EPSRC/AHRC/ESRC (2013) as early testament to its success. There are strong links with Informatics (Coyne, Lee, Speed, the latter now Professor of Design Informatics); History of Art (Whyte); Geography, Psychology and Health in Social Sciences (Ward Thompson, Coyne, Bell, Travlou); engineers and the Energy Academy (Banfill, D. Jenkins, Roaf, Wang, F.); Languages and Intercultural Studies (Galbrun); and Maths and Computer Science (Banfill, Roaf), as our many multidisciplinary research grants testify.

Interdisciplinary and international scholarly connections were strengthened by the appointment of David Simmonds, Alan Murie, David Mullins, David Hunter, Bo Bengtsson, Dorte-Rich Jorgensen and Douglas Smith as Honorary Professors within the REF2014 period. They were joined by Peter Eisenman (in 2010) and Joseph Rykwert (in 2012) who served as distinguished Visiting Professors. Other international connections include Pedreschi's work in *Limesnet (Low Impact Materials and innovative Engineering Solutions research Network, EPSRC)*, involving him in international research missions to link with academics and industry in Canada and Uruguay. Closer to home, external links between Alliance researchers, informatics experts and social and political scientists are being strengthened by, e.g. *Learning Energy Systems: A dynamic innovative solution to reducing energy demand*, working with pupils, teachers and janitors in 32 schools across Scotland on ways to reduce energy demand (Carter, EPSRC, 2013-14). ECR Roe's Beltane Public Engagement Fellowship involved collaboration with Edinburgh's Royal Botanic Garden to explore how to make such gardens more accessible to a socially diverse range of users.

Alliance initiatives such as EKEP and seed-funding and new Fellowship appointments for ECRs (e.g. Bastian, Fair, Fernandez-Gonzalez, 2012) (see sections b and c) have further strengthened our combined research capacities and synergies. This has led to Alliance leadership on innovative projects highlighted as exemplars by research councils, e.g. by AHRC under the cross-council *Connected Communities* programme. *Community Hacking Web 2.0*, led by Speed, involved urban planner and ECR Matthews, working to give creative control to deprived communities in Edinburgh and resulted in follow-on funding for *Ladders to the Cloud*. ECR Bastian has been PI or Co-I on 6 AHRC projects funded under the same programme, including leading a Pilot Demonstrator Project, *Mr Seel's Garden* (2012-13), and *In conversation with...: co-designing with more than human*

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communities (2013-14), leading to an invitation to contribute advice to AHRC's Advisory Group in developing their subsequent *Care for the Future* programme. Bremner's AHRC Early Career Fellowship (2010) and Fair's 2012-15 Leverhulme Early Career Fellowship reflect continuing enhancement of critical mass and research excellence in architectural history.

Key UK HEI partners are associated with many of the major awards listed above, and include the Universities of Bristol, Cambridge, Cardiff, Glasgow, Liverpool, Loughborough, Manchester, Queens, Salford, Sheffield, Warwick, Ulster, and York. Key international HEI partnerships include University of New South Wales, Sydney (top-rated centre for urban research in Australia), where Bramley was expert panel member, 2011; University of British Columbia, where Ward Thompson advises on a major Canadian Institute of Health Research project (2010-15); Tianjin University, China, where Dorrian is visiting professor (2011-date); the Universities of São Paulo, Maputo and Witwatersrand where P. Jenkins has undertaken joint research (e.g. the Home Space in Africa programme); TU Delft (Stephens, leader of EU Study on Housing Exclusion, 2010); and the Alice Kaplan Institute for the Humanities, Northwestern University, USA (Whyte was Visiting Scholar in 2011). In an increasingly globalised knowledge economy these links are key to world-leading research and knowledge exchange.

Commitment to promoting the research standing of the disciplines embraced by the Alliance is exemplified by editorships of leading journals in the field, e.g. *Housing Studies* (Leishman), *Art in Translation* (Whyte founding editor, shortlisted for the Best New Journal award 2009), *International Journal of Housing Policy* (Fitzpatrick), *Urban Studies* (Stephens co-editor), *Urban, Planning and Transport Research* (McCarthy), *Architectural History* (ECR Fair, co-editor), and *Ubiquity: Journal of Pervasive Media* (Speed co-editor). Staff serve as guest editors and on advisory boards for 30 other international, peer-reviewed journals, from *Architecture and Culture* and *Landscape & Urban Planning* to *Proceedings of the ICE - Engineering Sustainability*.

The Alliance is active in organising international conferences both in Edinburgh and elsewhere, e.g. ERES 2012 (the largest academic real estate conference in the world), and will host ENHR's European Housing Research Conference in 2014. Design and practice-oriented exhibitions and seminars include: *The Aerial View: Spatial Knowledges and Spatial Practices*, Edinburgh 2008; *Cold War Neons and Socialist Modernity* (Glasgow, 2009); *SaltCity: Cádiz Field Work, 2006-08* (Edinburgh International Art Festival, and Cádiz, 2009); *Seeing from Above: Surfaces, Scans, Smears and Subjectivities* (Wellcome Institute, London, 2010.); and *Venice Takeaway* (13th International Architecture Biennale, Venice, 2012).

In addition to public lectures and national events, staff have presented 36 keynote addresses at international research conferences, on topics ranging from drawing and Renaissance architecture (Campbell, Rome 2011) to rapid urbanisation in Africa (P. Jenkins: Madrid 2011, Durban 2012). Individual excellence in research is recognized in offices in professional and scholarly societies: Banfill: President of British Society of Rheology; Bell: President of the European Council of Landscape Architecture Schools; Fitzpatrick: Academician, Academy of Social Science; and Whyte: Chair of the International Association of Research Institutes in the History of Art (RIHA).

Invitations to join advisory panels reflect national and international standing, e.g.: Bramley, Board of National Housing and Planning Advice Unit (2007-10); P. Jenkins, advising the Angolan government on new urban & housing strategies (ongoing); Ward Thompson, Scottish Government's *Good Places Better Health* Evaluation Group, (2010-12) and National Walking Strategy Working Group (2013), assessor for the Portuguese Foundation for Science and Technology (2012), Australian Research Council (2013/14), and RCUK's *Lifelong Health and Wellbeing* Advisory Group (2013-14); D. Jenkins, working group to rewrite CIBSE Guide A section 2.0 to use UKCP09 climate projections (2011-13); Matthews, Equalities Action Group of the Crown Office and Procurator Fiscal Service (2012-14) and Fitzpatrick, Joseph Rowntree Foundation Task Group to develop an anti-poverty strategy for the UK, and Research Advisory Group on establishment of International Homelessness Observatory, DePauls Foundation, Chicago, 2012.

As the above contributions and commitments demonstrate, the Alliance offers researchers in cognate but traditionally separate disciplines both the example and the institutional mechanisms to support future research development in new, exciting, and previously unanticipated directions.