Institution: University of Strathclyde

Unit of Assessment: 16 Architecture, Built Environment and Planning

a. Overview

UoA16 at the University of Strathclyde is made up of 14.5 FTE staff within areas of research structured around **three main themes**. The main research themes for which we have a track record and a growing national and international reputation are: 1) **Architectural Design & Sustainability** (Agapiou, Bradley, Beverland, Charley, Gonzalez-Longo, Grierson, Murray, Suau); 2) **Energy Systems** (Clarke, Kelly, Strachan, Tuohy); and **3**) **Urban Design** (Ferguson, Porta, Romice).

b. Research strategy

The strengths of UoA16 at Strathclyde stem from being part of a strong Faculty of Engineering within a leading technological university. With buildings and cities as its focus and in keeping with the University's strategic direction, the unit has developed strong industry linkages, numerous European and international connections, and a capability to undertake multi-disciplinary research that integrates sustainable design, engineering & technology, cultural enquiry, and creativity.

Unit Vision & Strategic Focus

The vision of the unit is to be '*a leading-edge centre for research in architecture and urban design; one in which design & creativity and technology & innovation are central to the transformation of individuals, practices, communities, cities and nations'*. The mode of delivery of this vision reflects the changing balance of a research unit that is now staffed by 14.5 staff with a spectrum of interests and expertise that reflect the diverse multi-disciplinary basis of architecture and urbanism, with an emphasis on social engagement with real-world problems. Central to our strategic focus is the recruitment, retention and promotion of talented staff who can work well across disciplines. The deliberate development of a staff complement with discipline backgrounds in Architecture, Urban Design, and Mechanical, Civil and Environmental Engineering has helped bolster research performance in the UoA since 2008, as measured by a range of indicators described below.

Implementation of Strategy

The senior management of the unit (**Agapiou, Clarke, Grierson, Porta**) have recognised the need for the development of strategic programmes of research aimed at improving the quality of the research undertaken and establishing critical mass within interdisciplinary working groups able to tackle research in a wider context. A strategic objective lies in strengthening links between research and knowledge exchange activity aligned with the main and emergent themes (such as the **CIC Start Online** project, and the **Robert Adam/WSP KTA** project described below) and to build on the unit's record of science and scholarship in the history and theory of architecture and cities. The unit's three main themes have stimulated the development of focussed and strategic collaborations with industry and practice. The unit's activities in both fundamental and applied research, and through knowledge exchange activities, are targeted at the areas identified by '***Construction Scotland'*** as essential to the future of the Scottish Architectural & Built Environment Professions. Improvements in the unit's research metrics over the review period were achieved through the implementation of a co-ordinated strategy involving key support mechanisms, notably:

- Building the capacity of our research groupings (through e.g. a new PGR scholarship scheme);
- The provision of a modern & vibrant environment for research training (through e.g. new co-located space & facilities in the James Weir building); and
- Formal & informal mechanisms to promote engagement between academic staff, industry and practice (through e.g. consortia KE projects & CPD).

Since, 2009, the University has invested significantly in knowledge management software for internal dissemination of international funding programme announcements. Over the review period, the unit's senior management liaised closely with the University's Research and Knowledge Exchange Services to target this information to the most relevant researchers and to assist with the completion of more collaborative applications. In addition, a co-ordinated process of knowledge sharing was initiated to make the research funding administration process more robust.

Achievements since 2008

To provide a level of critical mass in priority areas, and grow the unit's PGR cohort, the **Centre for Research in Design and Sustainability (CRIDAS)** (**Agapiou, Bradley, Charley, Grierson, Murray**) was formed as a research cluster within Architecture following RAE08. The aims of the centre are to maximise the research potential of individual staff with wide-ranging technological, historical and cultural research interests, facilitate collaboration with partner research units and institutions, and to stimulate interchange amongst members of the centre and across the UoA. For example, within the review period, **Grierson** led Strathclyde's contribution to the **CIC Start Online** project (1 September 2009 – 1 February 2013), involving input from staff within the three main themes in Strathclyde's UoA16. The consortia project supported collaboration with SMEs operating in the construction sector in developing, testing and disseminating innovations for sustainable building design and refurbishment. In 2012, **Charley** directed Scotland's contribution to the Venice Biennale (2012). Funded by the Scottish Government and British Council Scotland, the exhibition and book publication was the recipient of the RSA (Royal Scottish Academy) Medal for Architecture (2012). Externally, **CRIDAS** has connected researchers more systematically with public bodies and research-led organisations such as Architecture and Design Scotland, Glasgow City Council, Glasgow Housing Association, the Ellen MacArthur Foundation, and other academic institutions.

Building on previous collaborations and in line with emerging synergies, during 2013 the UoA was augmented and greatly enhanced by the incorporation of the internationally recognised BRE Centre for Excellence, the **Energy Systems Research Unit (ESRU) (Clarke, Kelly, Strachan, Tuohy).** ESRU specialises in the development and testing of new methods and technologies for energy reduction and supply, alongside the evolution of computational tools which aim to assist designers in their attempts to devise clean and sustainable solutions. The inclusion of ESRU brought a new complementary theme to UoA16 in Energy Systems, along with a significant research capability and track record of numerical modelling studies on energy demand reduction, and the introduction of sustainable means of energy supply within the built environment. It also enhanced the unit's capacity for close engagement with industry, public bodies, European institutions and national governments in 30 countries. Staff with expertise in travel behaviour, transportation modelling **(Ferguson)** & environmental health (**Beverland)** also joined the unit at this time, thus broadening the expertise within the unit's research themes on Urban Design and Sustainability.

The work of the **Urban Design Studies Unit (UDSU) (Porta, Romice)** on Multi-Centrality Assessment (MCA), masterplanning, urban regeneration, sustainable transport and development, community engagement in design, and Post-Occupancy Evaluation supports a growing number of PGR students and additional colleagues. In 2011, **Porta** and his team were awarded KTA funding for the construction of a software platform for the use of MCA in professional Urban Design, in partnership with **Robert Adam Urbanism**, a world leading practice in masterplanning and architectural design. MCA is now developing in the constitution of a larger research and commercial venture named "Place Logic", which will involve the globally renowned WSP Engineering in further R&D initiatives, along with services in professional practice. **Porta** is a member of a consortium that, along with researchers from Cambridge University & Queen Mary College University of London, has been awarded substantial EPSRC funding to explore a scientific definition of fluid neighbourhoods and the use of geo-social network metrics on data harvested from mobile phones and online social networks to inform the construction of innovative recommender systems for urban users.

Collectively, the developments within the main themes of Design & Sustainability, Energy Systems, and Urban Design that comprise UoA16 have substantially reinvigorated architecture and built environment research at the University of Strathclyde and broadened its international reach since 2008.

Plans for the next five years

Strathclyde's UoA16 is committed to building a range of approaches to supplement our core strengths and build additional research capacity over the next 5 years. The unit will form strong research links to Strathclyde University's major new research investment, the **Technology and Innovation Centre** (TIC) and to the University's **Institute for Future Cities** (IFC), a world-leading cross-disciplinary venture linked to the Technology Strategy Board's Future City Demonstrator and City Observatory. In particular, plans for the unit that will be assisted by these developments include:

- Expanding the recently established research theme in Architectural Conservation, identified as having significant long-term, inter-disciplinary potential within the Faculty & University;
- Improving current levels of per-capita research income within and across the main themes, whilst diversifying funding sources, and sustaining the quality of output;
- Actively engaging with University, Faculty-wide and unit-level initiatives to further increase the recruitment of International PGR students within the main research themes;
- Strengthening collaborative links with national/international partners where there is potential for research activity (e.g. the Prince's Foundation; the Cosanti Foundation, USA; and MOM "Mora de Outras Maneiras", Brazil)

The methods for informing decision making and monitoring progress within the unit over the next five years will involve the University's annual ***Accountability and Development Review*** **(ADR)** & the annual ***Research Audit***. Through new staff appointments, research student recruitment and a revised management structure, the unit is well placed to capitalise on its research strengths and its strong links with practice & industry. Furthermore, the unit will continue to act as a forum for the exchange of ideas and knowledge relating to architecture & the built environment, and urban design, along with the needs of the professions. Progress will be internally measured by the **Research Committee** every six-months. The Committee will report to an inter-departmental UoA meeting to be held twice a year. Benchmarking the UoA against International competitors will continue to be part of this process. Success will be measured by our ability to promote research through 'live' projects and historical and theoretical work that will be disseminated via a range of media, outputs and publications. Evidence of the effectiveness of research will also be shown by the unit's influence in informing planning and policy matters. In particular, success in recruiting staff with high research potential will be an indicator of progress, as will increases in funding and the retention of key research staff; progress in these areas will be reviewed formally on a six-monthly basis. We also intend to review the incentives for those staff performing well according to key performance indicators developed by the unit's senior management.

c. People, including:

i. Staffing strategy and staff development

One of the University's key priorities is to develop all staff and help them realize their full potential, and this is reflected in our policies to develop existing staff and recruit and develop outstanding researchers from outside of the institution to enhance our research culture & community. Both strategies were successful during the assessment period.

Staff Development & Review Processes: The University was shortlisted for the Times Higher Education (THE) Awards 2011 for **'Outstanding Support for Early Career Researchers'** and the unit's senior management strongly encourages researchers at all levels to engage with the University's extensive **Researcher Development Programme (RDP)**. This has at its core the "My CPD" online tool which has been developed for implementation of the Concordat to Support the Career Development of Researchers. The tool helps researchers to identify, plan and record their CPD and allows researchers to identify their development needs and includes a mentoring

scheme, which supports researcher career development. Unit staff have benefited from participation in the **Strathclyde Programme in Research and Leadership (SPIRAL).** Launched in 2012, this is a tailored programme designed to support staff at various career stages to develop and strengthen leadership skills across research and knowledge exchange. The programme provides an extensive range of seminars, courses and tailored tools, designed to directly support and align with the strategic ambitions of the University for research and knowledge exchange enhancement, increased collaborations, and international partnerships. The RDP & the SPIRAL programmes provide constructive feedback for all staff on outputs from research (particularly in relation to journal writing), and on grant applications. This has led to successful publications by mid-career researchers **Agapiou, Bradley, Romice** and to funding bids by **Agapiou, Gonzalez-Longo, and Romice**.

The **ADR** provides all staff with a critical opportunity to gain constructive and supportive feedback on research performance from trained senior colleagues and to establish the basis for cases for promotion. In addition, meetings are held annually between each individual and the unit's senior management at which future plans are discussed and guidance offered. Internal promotions have recognized the increased contribution of colleagues' work, with research performance playing a pivotal role in the institutional decision-making process.

New staff appointments: The appointment of **Porta** in 2009, to lead the internationally renowned **Urban Design Studies Unit (UDSU)** has significantly enhanced research activity within this theme**.** Since 2010, a shift in our recruitment strategy has supported the appointment of full time academic staff to replace part time staff or external seconded teachers, therefore strengthening research-teaching linkages and reinforcing the overall research potential. The departure of staff has been addressed at Faculty and University levels through co-funding of key, strategic appointments with the unit, demonstrating confidence in the future of architecture and built environment research within the Faculty of Engineering. For example, this process co-funded the replacement of a Lecturer (**Gonzalez-Longo**), and also provided additional funding for a strategic appointment at Senior Lecturer level (**Suau**) to support the unit's growing research base. New researchers are assigned to experienced mentors for general support. In addition, senior researchers take part in joint research applications and PhD student supervision. New researchers also attend a two-day Faculty-based training event on research proposal writing. Other activities include support for researchers to organise/participate in conferences, workshops and seminars. The unit has recently recruited 2 early career academic staff (**Gonzalez-Longo** and **Suau**) in key strategic areas (**Energy Systems and Architectural Conservation**) – both of whom have benefited from Faculty training and support.

Equality and Diversity: In 2011, the University achieved the **Athena Swan** Bronze Award in recognition of good practice in recruiting, retaining and promoting women in STEM subjects and, more generally, in providing a solid foundation for developing an inclusive culture valuing all staff irrespective of gender. There has been a significant shift in the gender balance with the unit since 2008. Of those submitted for the RAE2008, the ratio of male to female was 10:1 FTE. In REF2014 the male to female ratio is 11.5: 3FTE. Currently, 33% of PhD and 25% of MRes students are female. Further improvements in the gender balance are expected in the unit in the period following REF2014.

ii. Research students

PGR Population: Since RAE08, Strathclyde's UoA16 postgraduate research (PGR) population has grown significantly and we have been highly successful in attracting 10 externally funded scholarships and 16 competitive University & Faculty-funded scholarships. There are **now 36 research students attached to UoA16 compared to 8 in 2007/2008,** with supervision distributed across the three main themes**.** New strategic initiatives will see this growth continue. For example **Grierson** has initiated a new international collaboration in Architecture & Ecology with the Cosanti Foundation (USA) & Arizona State University's Global Institute for Sustainability. This has led to the recent award of a jointly funded PhD (2013 – 2017). Two new PhD students have also just been recruited in 2013 to support the emergent theme of Architectural Conservation (**Gonzalez-Longo**). All PGR students have personal workspaces within the newly-refurbished James Weir

Building, with computing, laboratory, workshop and library facilities close at hand.

Training & Monitoring: Research students are provided with generic skills training to complement research-specific training. All new PhD students are provided with a PGR handbook and required to attend the Faculty of Engineering Induction event, which introduces the University's research ethos and objectives. The induction also covers topics including research protocols & methods, use of the library and other information resources, good laboratory practice, research record keeping, and health and safety issues. Activities are coordinated at the thematic level by the UoA senior management and student training now forms an integrated credit-bearing course, tailored to a student's needs. All student progress is monitored on a 6-monthly basis, with a major assessment due at the end of year 1 accompanied by a "Viva-style" interview undertaken by a non-supervisor staff member. All PhD students are required to participate in the **Faculty Research Presentation Day** (**FRPD**) at which students give oral and poster presentations with prizes awarded for the best submissions. Presentation at department and faculty events is credited, and students can also get credit for helping to organise the **FRPD.**

PGR Funding: The unit's senior management operates a **PGR Activity Fund** to support attendance and presentation at conferences. Any award is conditional on confirmation that the student will be presenting a paper. These awards represent a significant contribution to the CV of each student and promote confidence and experience in proposal writing.

Planning for the future: To enhance the interdisciplinary expertise within the unit, there are plans to launch an MSc in Architectural Conservation in 2014 (**Gonzalez-Longo**) to underpin the growing interest in Built Heritage internationally. We anticipate that this development will provide the basis for establishing a vibrant Architectural Conservation research group in the future, with successful Masters' students continuing on to doctoral study. This emergent theme is expected to substantially increase our international reputation/outreach and student intake, while enhancing our KE performance (OSR and CPD in particular). Plans are also at an advanced stage for the development of a new Masters provision in Architecture & Ecology, in partnership with the Cosanti Foundation and ASU's Global Institute of Sustainability in the US (**Grierson**). It is expected that this provision will augment our growing international profile in this area and enhance PGR recruitment.

d. Income, infrastructure and facilities

Income

Since 2008, Strathclyde's UoA16 has been proactive in developing interdisciplinary ways of working and promoting research collaborations leading to growth in research income during the REF period. The unit has been awarded research funding from EPSRC, RCUK, Scottish and UK government bodies and UK-based charities and has attracted research funding to support established research themes. Research work within ESRU has attracted significant funding since 2008. For example **Clarke** was **awarded £327,000** by EPSRC as PI on *Building Management linking Energy Demand, Distributed Conversion and Storage using Dynamic Modelling and a Pervasive Sensor Infrastructure.* **Clarke** was also PI for the establishment of *The BRE Centre of Excellence in Energy Utilisation,* which was **awarded £220,000** funding from BRE. **Strachan** has been **awarded £101,000** by EPSRC as PI for the *Validation of Dynamic Thermal Simulation Programs with Data from Full-Scale Buildings.* **Tuohy** has been **awarded £62,000** through TSB as PI on a KTP project with IES Ltd. Within UDSU **Porta** has been **awarded £231,000** by EPSRC as PI on *GALE: Global Accessibility to Local Experience.*

There has also been funding success from sources not previous anticipated in 2008. For example, in 2012, **Suau** was awarded a **£150,000 Marie Curie Intra-European Fellowship** to study the recovery of existing voids produced by current shrinking cities at the Euro-Mediterranean coastline. Another notable unanticipated award was the **£30,000 Medical Research Council grant funding** to **Ferguson** to examine the lack of physical activity opportunities related to health behaviours associated with adult obesity in Scotland. Over the review period the unit has also generated more

modest research income from various national awarding sources. For example **Beverland** was **awarded £35,674** by NERC as PI on *Air pollution & weather-related health impacts.* **Grierson** was awarded **£27,000** by the Royal Academy of Engineering as PI on a project to support a *Visiting Professor in Engineering Design for Sustainable Development.* **Romice** was **awarded £12,000** by ADS as PI on *Ann Commann: Scottish Small Towns - Past, Present and Future`.* **Agapiou was awarded £6,297** by the Royal Institute of Chartered Surveyors as PI on *Construction clients and mediation: a follow-up study of attitudes and experiences,* and **Kelly** was **awarded £5,205** by EPSRC to participate in *IEA Annex 42 FC-COGEN-SIM: The Simulation of Building-integrated Fuel Cells and Other Cogeneration Systems*

The unit's success in gaining international funding is a relatively recent development, pointing towards a growth in the internationalisation of research activities over the REF review period. Plans for the future mentioned previously will promote and support this growth.

Infrastructure & facilities

The University has made a significant investment in UoA 16–related infrastructure since 2008. Since 2013, all staff, research assistants, and research students are co-located within **purpose-built facilities in the newly refurbished James Weir Building representing an overall investment of £25M.** The accommodation comprises centrally managed lecture rooms, computing facilities, laboratories, design studio space; offices: and engineering workshops. ESRU's facilities within the James Weir Building include laboratories covering all aspects of energy and environment research - from the fundamental properties of solids, liquids and gases, to the production of power and heat from fossil fuels and renewable energy sources. The laboratories comprise seven physical areas hosting thematic experiments in properties and states of substances, heat transfer, fluid flow, air & combustion mixtures, HVAC systems, power and propulsion systems, and weather and environment.

The provision of state-of-the-art infrastructure underpins excellent research, but crucially helps to attract leading research staff into the unit. Further strategic investment has been made over the review period to enhance the student experience and to improve the computer modelling capacity across the unit. The unit also has a shared interest in other Faculty resources such as the Digital Design and Manufacturing Studio – a laboratory equipped with computer controlled laser cutting machines and 3 and 4 axis CNC milling machines. Similarly we have a joint investment, with Civil & Environmental Engineering, in a structures laboratory where we utilize a DARTEK computer operated hydraulic rig which can apply point loads to a range of materials in order to monitor and record load, deflection and shear forces. This facility supports **Bradley's** timber engineering interests. The combined investments in world-class research facilities for new and established research themes reflect the aspiration of the unit to become a leading centre for architecture and built environment research in the UK and internationally.

e. Collaboration or contribution to the discipline or research base

Over the review period academic staff in the UoA have acted as UK and international peer reviewers on a regular basis with **Clarke**, for example, being a member of the peer review college of the EPSRC. **Strachan** has been a research proposal reviewer for the EPSRC, Swiss National Science Foundation and City University of Hong Kong. Over the review period, staff have been recruited to a number of international journal editorial boards across the architecture and built environment disciplines. **Grierson** has acted as editorial board member and peer reviewer for three international journals in the area of design and sustainability. **Porta** has been editorial board member of two international journals and peer reviewer on various national and international journals in the area of urban design. **Agapiou** has been editorial board member of one international journal in the area of construction management. The unit is also proud of its long, continuing and developing international collaborations. UoA staff members have been appointed as Visiting Professors internationally (**Clarke, Charley, Grierson, Porta, Romice**) during the review period. **Grierson** has recently been appointed as the first Visiting Professor at the internationally renowned urban laboratory, *Arcosanti,* in Arizona, USA. The international standing

of the unit's staff within the architecture and built environment research community is widely recognised by the level of engagement with professional bodies, (e.g. **Clarke** is Director of the BRE Centre of Excellence in Energy Utilisation; In 2009, **Strachan** was recipient of a Fellowship from the International Building Performance Simulation Association; **Romice** is Past-President of the International Association of Planning Studies; **Murray** is Past-President of the Royal Incorporation of Architects in Scotland). Advice is regularly sought by official organisations, and invitations made to deliver keynote lectures. **Beverland**, for example, is an invited member of National Health Service in Scotland (NHSiS) working group on medical aspects of Scottish Government 'Know and Respond' Air Quality Alert system. In addition, keynote lectures have been delivered by unit staff at a number of international symposia including for example the World Summit on Energy Simulation in 2013 (**Clarke**)**.** The growing international reputation of the unit is further evidenced by recent invitations to host a number of major congresses with staff engaged at all levels in the organisation & delivery of conference events. In 2012, for example, the unit hosted *IAPS 2012 Human Experience in the Natural and Built Environment: Implications for Research Policy and Practice* **(Romice)**.