Institution: University of Central Lancashire

Unit of Assessment: 16 Architecture, Built Environment and Planning

a. Overview

The University of Central Lancashire (UCLan) unit of assessment (UoA) C16 presents through the following narrative its research strategy, key people, principal research activities, research infrastructure, sample projects and contribution to the discipline. The unit's RAE 2008 submission focussed on its (then) main research themes of combustion, explosions, fire engineering and sustainable built environment. This fire research was later re-housed within the School of Forensics and Investigative Science, to allow the (former) 'Department of Built Environment', to expand and embrace the 'Natural Environment'. Hence, the present submission now represents the recently renamed **'Grenfell-Baines School of Architecture, Construction and Environment'.**

The UoA has made significant investment in the development and growth of its research base over the last five years. The return on this investment has considerably strengthened its position as a dominant knowledge generation assemblage within the field of Architecture, Construction and Environmental research. This is evidenced through several 'hard' and 'soft' metrics, including its: increased number of internationally-leading academic members; continual growth in PhD student numbers; recognition for effective knowledge transfer programmes and awards; international acknowledgement for its sustainability work pioneered through the Centre for Sustainable Development; extensive overseas collaborative developments and partnerships; and enviable research networks with industry. The following narrative elucidates all of these achievements.

The UoA is a cogent research community, uniquely embracing both the built and natural environments. In this capacity, it is continually raising the quality of its research provision – whose critical mass is enabled by succession planning aligned to existing and emergent research themes. This synergy between the built and natural environments allows these two core strengths to coalesce through one central theme of 'sustainability'. This is the main conduit of the UoA's research, the work of which is operationalised through three research foci: i) Architectural Planning and Design (AP&D); ii) Construction Management and Economics (CME); and iii) Environmental Management, Performance and Politics (EMPP).

b. Research strategy

The UoA is partway through its current strategic research plan with a clear goal that by 2017 it will be firmly entrenched as a mature research active unit with specific areas of uncontested international excellence, driven by an ambitious, innovative and inclusive research community. The UoA's current international recognition relates mainly to research in key, contemporary sustainability discourses. A major feature of this is evidenced through its strategic partnerships (with industry, commerce and the wider academic research community); and through an outward-facing approach that has yielded tangible and far-reaching impact across both academia and professional practice. The unit's vibrant research environment serves as a unique vehicle for its research-focussed academics, with expertise in various aspects of Architecture, Construction and Environment. Current research (and concomitant knowledge transfer) expertise synergises with several strategic STEM and non-STEM research areas; including, Risk Management, Procurement, Project Management, Business Modelling, Facilities Management, Sustainability, and Environmental Management.

External reports from a variety of acknowledged sources (e.g. Global Information Inc., Market Research.com, European Union etc.) confirm the competitive research landscape – the combined narrative of which continues to inform research investment decisions. In addition, major funding bodies are increasingly targeting the sustainability agenda, through such avenues as the Technology Strategy Board, Engineering and Physical Sciences Research Council, Economic and Social Research Council and European Commission for Research. Given this emphasis, the European Regional Development Fund recently awarded UCLan £1.2M for the development of a North West Construction Knowledge Hub (part of a larger £6M programme of research

investment). The UK Government's agenda has firmly embraced sustainable development (e.g. through '*Securing the Future – UK Government Sustainable Development Strategy*') and has emphasised the need for change. This remit was also endorsed by The Office of Government Commerce '*Achieving Excellence in Construction*' initiative and through the National Audit Office's '*Improving Public Services Through Better Construction*' reports.

Given the above, the UoA's strategic focus and forward trajectories openly acknowledge the importance of relationships, particularly between concertation and diversity, but also through proactive engagement with the wider international research communities such as the Conseil International du Bâtiment (CIB). This is especially important, as it resonates with CIB's priority themes of: i) Sustainable Construction; ii) Integrated Design and Delivery Solutions, and iii) Resilient (and Sustainable) Urbanisation. Whilst these are reflective exemplars, they can also be used as pivotal hubs for research engagement and dissemination; to not only achieve both public and private sector awareness (nationally and internationally), but also help inform government policy and develop the future research agenda in emergent areas.

The unit's research strategy is directly operationalised through its primary research centre: the **Centre for Sustainable Development (CSD)**. CSD was established in 2009 as part of the University's strategic research investment programme – the work of which continues to be strengthened through the UoA's research excellence and the continual development of its critical mass. Its ongoing growth has included significant investment in senior research academics with the appointment of **Akintoye** (2008), **Goulding** (2009), **Holt** (2012) and **Hadjri** (2012) [see Section (c)]. These established researchers are pioneering a number of new research initiatives, and the UoA's combined expertise continues to reinforce and develop the Centre's position as a leading international hub of research and knowledge transfer excellence. CSD also serves as a formal conduit for championing the sustainability research agenda through interfaces with similar research centres within the University (e.g. The Centre of Energy and Power Management) – as well as more widely through industry (e.g. the Lancashire Construction Best Practice Club); government organisations (e.g. the Environment Agency); public/private bodies (e.g. The Eric Wright Group) and societal stakeholder institutions both in the UK and overseas (e.g. Malaysia, Hong Kong, India and Guyana).

c. People, including:

i. Staffing strategy and staff development

UCLan proactively implements the principles of the '*QAA Code of Practice for Research Degree Programmes*', and was (one of only 38 UK universities) awarded the European Commission HR Excellence in Research Award in 2011. In support of this, the UoA's staffing strategy focuses on attracting high calibre research-active staff to both strengthen and enhance its provision. The rationale of this aims to not only develop a mature concomitant nucleus of research expertise, but also, to maintain an incontestable unit of excellence that achieves our research aspirations.

Given the sustainability focus of the UoA, core research staff are directly aligned to the three main research strands of AP&D, CME and EMPP. This sustains our research capacity in a targeted way, whilst also maintaining an element of diversity in our research base. Such alignment is evidenced not only by the academic appointments listed in Section (b) but also, through two new Senior Research Fellow appointments: **Pour Rahimian** (2013) and **Isikdag** (2013). Combined, the UoA's research staff represent various research career stages, from early career researchers (ECRs), through to established professors and directors; who between them impart extensive academic, industrial and professional practice experience. For instance, **Goulding** is pioneering new approaches in offsite manufacturing and coordinating a CIB Task Group [TG74] in this area; **Akintoye** is a Coordinator of CIB TG72, and is developing a new procurement roadmap for future uptake; **Holt** is championing two research areas in plant management and research methodology – the products of which have directly influenced seminal thinking; and **Hadjri** is leading research on workplace design, cognitive impairment and ageing-related topics, such as interdisciplinary and inclusive design.

Succession planning and mentoring schemes maintain consistency and continuity. These are underpinned through bi-annual appraisals that engage structured career development opportunities, aligned to facilitate both personal and professional achievement. New researchers and ECRs undertake directed study leading to the award of a PGCert in Research Supervision; while support also includes joint supervision of research students, with experienced staff as mentors. Staff actively participate in the management of research projects, and are able to apply for University research funding through the School's Research Committee (directly funded by the School to actively reinforce the UoA). This support includes research conferences, field studies, research seminars, bid preparation, short sabbaticals, staff exchange and bespoke training – which further underpins commitment to research activity and, research-informed teaching. The Research Committee plays a pivotal role in promoting research engagement, from inception through to implementation and evaluation; while also overseeing the UoA's Research and Knowledge Transfer Strategy. This is governed by the School's Research Coordinator and is supported by two designated Research Degree Tutors.

The UoA's staffing strategy is reviewed every six months using the staff appraisal system. This monitors performance, research deliverables and personal development needs in line with the UoA delivery plan. For example, two staff members were recently funded for doctoral study, and six members of staff supported for PG certificate training and research student supervision mentoring. The importance of staff exchange can also be demonstrated within the UoA strategy, *via* for example, staff research sabbaticals in Finland, Turkey and Africa. Reciprocal arrangements are operationalised through CSD, the engagement of which has benefited from international research expertise from Germany, Greece, Turkey and Russia – the most recent being a Visiting Fellow (Benuzh) from Moscow State University of Civil Engineering on a Presidential Scholarship Award. Benuzh spent 10 months contributing to our research on construction environmental safety and sustainability indicators; and consequently, secured BREEAM international accreditation as direct result of this engagement.

ii. Research students

The UoA's research community has expanded significantly over the last three years. This exceptional investment in staff has been matched with an unprecedented increase in our expanding research student base (currently **38 full- and part-time PhD research students**), with resultant research degree completions set to grow markedly from 2014 onwards. Research students are supported within the UoA and through a university-wide dedicated Research Student Registry (RSR). Student selection criteria mirror staff expertise identified in the three thematic sustainability research foci (AP&D, CME and EMPP). This approach maintains a cogent critical mass of students and supervisors within these themes; which not only ensures research vibrancy and the cross-fertilisation of ideas, but additionally nourishes our knowledge-sharing culture. All research students benefit from fully equipped rooms with dedicated workspaces for full-time students and hot-desking arrangements for part-time candidates. In addition to the University's RSR abetment, the School's Research Committee also plays an active role in student support, from furnishing specific research-related advice, through to facilitating rolling research presentations/seminars, and dealing with quality, resource, ethics and governance issues. The Research Committee meets five times a year, and actively engages student feedback in the form of a nominated student representative at each meeting. It also hosts an annual Research Seminar Series, where PhD student work is formally presented to peers, academics and external stakeholders. The seminar series also confers awards to celebrate research student excellence. The RSR offer research skills training compliant with RCUK, HEFCE and QAA. All full-time and part-time students are required to attend a comprehensive induction day (provided with Student Handbooks, Vitae publications etc.). Additionally, all full-time students attend a compulsory two-week block, the 'Graduate Research Skills Programme'. Part-time students may attend, or complete the on-line Research Masters Programme from Epigeum. The Postgraduate Research Society, 'PROGRESS', acts as a support group to enhance the research experience by bringing together students from across the institution via a range of academic and social activities. Students also develop bidding skills by applying for funding to the 'Progress' Research Grant Scheme.

Research students are financially supported to disseminate their research findings through national and international conferences and other high-profile events such as the Association of Researchers in Construction Management (ARCOM), the Construction, Building and Real Estate Conference (COBRA), and specialist panel sessions. Examples of this include: the 9th International Detail Design in Architecture Conference (at the UoA, 2010); 1st International Conference on Revisiting the Socio-Political and Technological Dimensions of Climate Change (at the UoA, 2011); CIB TG72/ARCOM Doctoral Workshop (at the UoA, 2011); 2nd International Conference on Revisiting the Socio-Political and Technological Dimensions of Climate Change (Universiti Putra, Malaysia and the UoA, 2012); and the International Conference on PPP Body of Knowledge (at the UoA, 2013). Other examples of student research excellence include: PhD student (Hughes) being awarded a prestigious three-month Fellowship to study in Japan (Graduate School of Engineering, Fukui University) through the Japanese Society for the Promotion of Science; a PhD student best paper award (Gunathilake) at the 6th International Engineering and Construction Conference in Egypt for work on 'Sustainable construction: a conceptual framework for transforming policy into project level practice'; a formal invitation to appear on an expert panel of the 2nd International Conference on Revisiting the Socio-Political and Technological Dimensions of Climate Change extended to PhD student (Thakore); and recognition of a leading UoA CSD-sponsored PhD student (Cooper) to attend the launch of the Million+ postgraduate Strategy at the House of Commons in 2010.

d. Income, infrastructure and facilities

Following UoA structural changes outlined at the outset in Section (a) and resultant concentration on strategy, theme development, investment in new people and growth in PhD students, the unit revisited its research funding requirements in line with its new research strategy. Given this, a number of significant investments were made to support the unit, including: £2.5m for the development of Architecture, £400k for dedicated PG research facilities; £350k to establish a new research centre (CSD); and £215k for laboratory equipment and modelling support (hardware and software). These investments, have not only pump-primed growth in strategic areas of research need, but have also helped secure funding from a variety of external sources. Income generation through bidding success includes small grants (e.g. £5,000 for work with Mercury Recycling PLC in Manchester), through to major ERDF projects (e.g. £1.2M for the development of a North West Construction Knowledge Hub). The audited spend on research grants during this REF period by staff returned to this UoA is **£0.5M.**

e. Collaboration and contribution to the discipline or research base

UoA research staff are widely acknowledged experts in their respective fields, a selected sample of which includes the following:

Professor **Akintoye**: Over 150 refereed publications on construction economics and procurement (including cost modelling, risk management and public-private partnerships); Co-Editor of three books, Investigator on eight funded projects; Joint Coordinator of CIB TG72 Public-Private Partnerships; Editor-in-Chief of the Journal of Financial Management of Property and Construction; former Chair of ARCOM;

Professor **Goulding**: Over 120 refereed publications on training, VR simulation, and Offsite Manufacturing; Co-Editor of one book, Investigator on 13 funded projects; Joint Coordinator of CIB TG74 New Production and Business Models in Construction; Editor of Journal of Construction Innovation: Information, Process, Management; Associate Editor of International Journal of 3D Information Modelling;

Professor **Hadjri**: Over 50 refereed publications on Inclusive Design and the influence of the physical environment on various user groups including ageing and people with cognitive impairment. Investigator on 20 funded research and consultancy projects;

Professor **Holt**:	Over 200 refereed research papers, investigator on three EPSRC and numerous (recent) industry-funded research projects; author of several textbooks and a suite of industry-facing technical guidance documents; Editor of the Journal of Financial Management of Property and Construction;
Dr **Liyanage**:	Over 40 refereed publications on Knowledge Management and Facilities Management in the Control of Healthcare; Investigator on three funded projects.

In addition to the above, the unit is also supported by its 'up-and-coming' researcher complement, including three Early Career Researchers, and two Guild Research Fellows.

Collaboration and contribution to the discipline is managed through several conduits, including CSD's seminars, formal research workshops, and research 'master class' sessions supported by external domain experts. This engagement helps share best practice in the pursuance of research excellence. These activities also facilitate the cross-fertilisation of ideas in order to engender inter-theme collaboration and focus. CSD reinforces this philosophy, with direct industrial engagement; as this is seen as a fundamental part of the UoA's contribution to the discipline - which includes such activities as Building Information Modelling (with the Lancashire Construction Best Practice Club), through to bespoke funded projects such as the COST EU Networking Grant Project on 'Public Private Partnerships (PPPs) in Transport: Trends and Theory' – a four year project developing a knowledge base for PPPs in the transportation sector (**Akintoye** and **Liyanage**).

Internationalisation and outreach activities embrace the three core themes [Section (a)] and include collaboration with several overseas institutions, including: Hong Kong (procurement), Malaysia (sustainability), China (procurement) and Guyana (environmental). Recent UoA engagement activities include the launch of a Public-Private Partnership (PPP) conference in March 2013 (hosted by CSD), which demonstrated how our research is at the vanguard of both academic and industry boundaries. This work in particular builds upon the UoA's world-renowned PPP research expertise (**Akintoye** and **Liyanage**). Similarly, the impact and outreach of the UoA's work is further evidenced by the numerous high profile invited keynote lectures, presentations and industry-led workshops delivered by our staff. This engagement strategy helps bring academia and industry together to not only foster critical debate through established 'conventional' channels, but additionally through innovative dissemination media such as live-streaming approaches, blogs, and interactive media (**Goulding**). These initiatives combined, sustain continuous maximum outreach and dissemination of the UoA's research products.

Further examples of collaborative research include the discovery of 'micro'-balls of mercury within cold cathode lamps that significantly impacted the Environment Agency's position statement on the treatment of LCD displays containing mercury backlights. In addition, the North West Construction Knowledge Hub ERDF project continues to achieve high-level impact through its knowledge transfer and engagement activities with construction businesses. Similarly, the OPAL Programme (**Toogood**) is a collaborative research project between the UoA and eight other universities (Birmingham; Herefordshire; Imperial College London [Silwood Park and South Kensington]; Newcastle; Nottingham; Plymouth; York) – each with a particular research focus. OPAL also involves national bodies such as the Meteorological Office, the National Biodiversity Network, The Royal Parks, and the Natural History Museum in London (nb. OPAL is explained in one of the REF3b case studies). The UoA (through CSD) has also been pivotal in shaping interdisciplinary research into sustainable futures, pioneering such events as the first International Conference on Revisiting the Socio-Political and Technological Dimensions of Climate Change (**Goulding**), the 9th International Design in Architecture Conference (**Akintoye** and **Goulding**), and the PPP Body of Knowledge Conference (**Akintoye**, **Liyanage** and **Goulding**).

Knowledge Transfer

This represents an integral part of the UoA's ethos – the work of which is maximised through effective platforms that benefit from industry, business, third-sector and societal engagement. Knowledge transfer directly underpins the School's research-informed teaching policy, and helps

nurture formal conduits through which other activities benefit (e.g. research projects, design and delivery of professional practice modules, site visits, seminars and workshops). Similarly, industry partners gain from these formal and informal arrangements, as they help shape and facilitate new business solutions. Informal events tend to be managed through CSD, with formal relationships cemented through Knowledge Transfer Partnerships (KTP). Examples of recent informal events include the North West Construction Knowledge Hub Dinner (March, 2012) which celebrated the successful conclusion of the ERDF funded North West Construction Knowledge Hub project. This project commenced in 2009 and has positively impacted small and medium sized construction enterprises (and their associated supply chains) to reduce waste, cut carbon emissions and increase resource efficiency. Other examples include the UoA hosting of *Trampower* (February 2012) on its plans to introduce a Preston tram system (**Goulding**). KT engagement also capitalises upon other linkages, such as the Lancashire Construction Best Practice Club; where for example, the '*Green Deal Consortia*' was formally launched in February 2012 (**Akintoye** and **Goulding**). Additional formal engagement is evidenced though successful KTP relationships with the Eric Wright Group (EWG) on sustainable construction practices. This unique collaboration led to the development of a 'sustainability toolkit' (**Goulding**); and research findings from this project also impacted discussion at industry level, through the '*Energy and Carbon Efficiency in Construction*' workshop, held jointly with EWG and the Construction Industry Research and Information Association (**Goulding**).

Recognition

Several of the UoA's research areas have received National and International recognition. This is evidenced by for instance, staff being invited as keynote speakers at prestigious events, formal awards, and regular appearance of staff in the media. Examples include: **Goulding** who gave a keynote address on 'Innovation in Construction' at Beykent University, Turkey in 2011; **Akintoye** who received an award for his contribution to construction research at the 2011 Plant and Equipment Management Innovation Conference (PEMIC) in Birmingham; **Goulding** receiving a 'Leading Editor Award' in 2010; and **Holt** being a joint recipient of the U.S. Department of Defense Ergonomics Working Group medal in recognition of his research on managing hand-arm vibration exposure (2012). Staff are also engaged in several high profile activities, including journal editorship (**Akintoye**, **Goulding**, **Holt**, **Isikdag**, **Pour Rahimian**); leading influential high profile CIB Task Groups [TG 72 and TG74] (**Akintoye** and **Goulding**); editorial advisory boards (**Akintoye**, **Goulding**, **Holt**); scientific and technical committees (**Akintoye**, **Goulding**, **Holt**); external committee membership (**Goulding** and **Holt**) and membership of learned and professional institutions (**Akintoye**, **Goulding**, **Holt, Liyanage**). **Holt** also holds a Fractional Professorship in Construction Machinery Management at Birmingham City Business School, and is presently conducting collaborative sustainability research on Malaysian highway maintenance with the Malaysian Institute of Transport at University Teknologi MARA; while **Goulding** and **Holt** are finalising a joint research initiative on sustainable housing solutions for developing countries, with Gnanamani Engineering College, Tamilnadu, India.

Further UoA recognition can be evidenced through members' engagement in chairing high profile events, leading scientific and technical committees, and through bespoke industry events. Additional contribution to the discipline includes the UoA's membership of CIB, with research staff currently actively involved in over 30 Task Groups and Working Commissions. Recognition can also be acknowledged through several external events, including championing the 9th International Detail Design in Architecture Conference (2010), launching the 1st International Climate Conference (2011), delivering the TG72/ARCOM Doctoral Workshop (2011), and co-hosting the 2nd International Conference on Socio-Political and Technological Dimensions of Climate Change with the Housing Research Centre of Universiti Putra, Malaysia (**Goulding**). The International Conference on the PPP Body of Knowledge (2013) [in association with the Lancashire Best Practice Club] is another example of driving the research agenda forward through collaborative industrial and academic collaboration (**Akintoye**, **Goulding**, **Liyanage**). A notable key element of this conference was the inclusion of several industry roundtable workshop events, steered by academic leads and international industrial partners, to consider the changes in management and working practices across key areas of PPP working: nuclear; infrastructure and transport; health

and sustainability. This led to the launch of a formal report “Public Private Partnerships: Towards New Innovative Collaborations” (**Akintoye**, **Goulding**).

Summary

The active engagement and direct collaboration of UoA staff not only underpins the sustainability agenda across the three research strands, but has also helped to proactively pioneer new areas of research. This combined body of work has been openly disseminated through traditional avenues (journals, reports, conference proceedings etc.) and bespoke events such as ARCOM, COBRA, CIB, and other leading sector-specific discipline conduits that engage research end-users.