

Environment template (REF5)

Institution: University of Wolverhampton
Unit of Assessment: 16 Architecture, Built Environment & Planning
a. Overview

This submission reports on the research achievements of the Architecture and Built Environment (ABE) Department. It is a multi-disciplinary Department, with staff from academic/professional backgrounds in Architecture, Civil Engineering, Construction Economics, Surveying, Construction Management and Environmental Sciences. At RAE2008 the Department was housed in the School of Engineering and the Built Environment (SEBE). It is now part of the Faculty of Science and Engineering (FSE), created by the amalgamation of SEBE and two other Schools. The reorganisation provided the opportunity to incorporate the Environmental Science discipline into the ABE Department to formalise and enhance collaboration between the environmental scientists and ABE researchers over many years

Our research was carried out in three research groups: Construction Management (*Ankrah, Chinyio, Heesom, Oloke, Ndekugri (Convenor), Renukappa, Suresh*); Technology and Environment (*Bagheri, Fullen, Georgakis, Heesom, Khatib (Convenor), Mushatat, Renukappa, Roberts, Searle, Young*); and Land and Property Management (*Hammond (Convenor), Lamond until 2012, Proverbs until 2010, Ndekugri*). These groups are part of the Built Environment, Information Systems and Learning Technology Research Centre. Within this structure, cross-cutting research (e.g., on health and safety and advances in ICT) has been undertaken in thematic clusters, with membership drawn from the research groups and other research teams within the Centre and the wider University.

b. Research Strategy

Strategic Aims and Objectives at RAE2008

The strategic aim of the Department at RAE2008 was to enhance the reputation and international impact of its three research groups. Evidence of our achievement of our strategic aim includes: most of our publications are in the international journals of the highest impact in the discipline; membership of editorial boards of a wide range of journals in the discipline; service as external examiners in universities in the UK and overseas; collaboration with industry and other HEIs across the globe resulting in contribution to practice guidance documents as outlined in the Impact section; and membership of the EPSRC College of Peers (Ndekugri).

The strategy required our research to be focused on:

- improving efficiency and cost effectiveness within construction supply chain;
- sustainability of the Built Environment;
- land management policies in developing countries;
- identifying under-research issues;
- increasing research investment.

Towards meeting the stated aim of responding to the regional, national and international drivers for research, most of our research activities were undertaken in collaboration with industry partners and researchers in other HEIs in the UK and overseas.

The research management style seeks to balance carefully individual and group autonomy against strategic control to ensure quality and conformity with the Department's strategic objectives. Each research group has a group research plan setting out the research areas, mentoring arrangements for new researcher and group deliverables with respect to publications, engagement with industry and other HEIs, and funding applications. The group research plans and achievements are subject to annual review by a Faculty Research and Development Committee. Using the group research plans as the framework, each group member prepares a Personal Development Plan which is monitored and reviewed annually.

Improving efficiency and cost effectiveness. Most of our research in this area was carried out within the Construction Management research group although virtually all our other research

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ultimately also contributes to this aim. The research carried out by this Group concerned: (i) contract and conflict management (*Ankrah, Renukappa, Ndekugri*); (ii) health and safety (*Ankrah, Hammond, Oloke, Ndekugri, Suresh*); (iii) application of advanced ICT to health and safety management, project planning and control, and collaboration (*Heesom, Oloke, Ndekugri*); and (iv) culture, collaboration and supply chains (*Ankrah, Chinyio, Heesom*).

Sustainability in the Built Environment: This prong of our research was spearheaded by the Technology and Environment research and addressed: (i) biodiversity within brownfield sites and other urban environments (*Fullen, Mushatat, Roberts*); (ii) use of digital media to demonstrate spatial urban ecology (*Georgakis, Heesom, Roberts*); (iii) novel use of alternative materials in construction products (*Fullen, Khatib*); (iv) vehicle efficiency and public safety from particulate matter pollution and its linkage to the deterioration of building stone (*Georgakis, Roberts*).

Land and Property Management: The themes in the research of this group were economic impacts real estate policies in Sub-Saharan Africa and flood damage repair and impact on property values. The Ghana Lands Commission (the central land policy formulation and implementation department in Ghana) took interest in our research into economic impacts of real estate policies. This interest resulted in a partnership in 2010 between the then School of Engineering and the Built Environment and the Ghana Lands Commission for training and research in the economic evaluation of aspects of land policies in Ghana. Under the arrangement, the University offers 'fee-waiver only' studentships to selected staff of the Commission, with the Government of Ghana funding the living expenses and travel of candidates. There are currently two PhD candidates under this arrangement.

Knowledge Transfer Activities

The ABE Department has been fully committed to the technology and knowledge transfer objective which has been central in successive University Strategic Plans, as exemplified by its leadership of the £5.8M West Midlands Centre for Constructing Excellence (WMCCE) and by acting as the Midland Hub of the National Construction Knowledge Exchange (CKE) (in collaboration with five other universities). The Department's research, and that of collaborating colleagues, is fed into more than 300 construction and building products manufacturing companies via the 10 Innovation Circles linked to CKE, and five regional Best Practice Clubs associated with WMCCE. The Department has been awarded six KTPs during the census period and this portfolio of direct engagement with SMEs will continue to grow in the coming years due to the WMCCE momentum.

Evaluation of Performance during the Assessment Period

Headline achievements include: 142 refereed journal publications of outstanding international standing in relation to the discipline; 177 refereed conference papers; 18 books; 28 PhD completions; and an increase in the number of staff submitted in REF2014 compared with the position with RAE2008. Recent changes in immigration laws may account for the slight reduction in number of PhD completions.

Research Strategy for Next Five Years

The general research strategy for the next 5-6 years is to extend substantially and entrench our position as a centre of excellence in respect of the core areas of our research portfolio. The foundation for our strategy is close collaboration with a broad range of industry stakeholders and leading international research groups in deciding the direction and impact of our research. The strategy will be achieved by:

- attracting and retaining multi-disciplinary staff with excellent research track records or potential;
- providing strong leadership at stages of the research process;
- maintaining a strong research culture in which staff are empowered not only to conduct excellent research but also to disseminate outcomes widely;
- taking proactive steps to engage more with policy makers and regulatory authorities
- regularly monitoring our research performance and taking appropriate and timely remedial action;

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- vigorously pursuing opportunities to attract research funding from a wide range of sources; engaging in knowledge transfer;
- reviewing and updating the directions of our research in response to emerging priorities;
- using our expertise to maintain the currency of taught postgraduate courses and to offer new and innovative courses;
- and designing and delivering training and CPD events in collaboration with the professional institutions and societies and training organisations.

We believe that, in many ways, it is more supportive to delivery of our strategy to have two research groups (Construction and Property Management and Infrastructure and Sustainability) instead of the three groups we have operated under. It reduces the silo effect and ensures that leadership is concentrated. This structure also promotes organic formation of research clusters of research teams from across the groups and other parts of the University. The existing departmental research management arrangements have worked very well and will therefore not change unless compelled by changes at the Faculty/University level.

Priority developmental areas

Our priority developmental areas have been influenced by existing research strengths and national (e.g., *the Government Construction Strategy, The Government Infrastructure Plan and The Government BIM Strategy*) and international drivers for research in the discipline. There are three interlinked areas.

- 1 Our research has highlighted two particular problems in conflict management and dispute resolution on international projects. First, large numbers of people often have to travel by air from different countries to a designated location where dispute hearings and related meetings are held. For example a typical dispute may require attendance by party representatives, engineers in different country offices of the consulting engineer who contributed the design, home legal teams of the participants, local legal teams, and numerous witnesses to give oral evidence and be cross-examined on what actually happened on the project. The carbon footprint of the extensive travel to the agreed venue is unacceptable. This problem is compounded by huge volumes of information that has to be scrutinised. We now have the complementary expertise (linguistics, contract management, data mining, the internet of things, etc.) and the international networks to study how digital technology can be brought to bear on the problem.
- 2 The effect of reorganisation in the University is that all Environmental Science staff are now part of our department. The development provides the opportunity to extend considerably our research into green technologies and, carbon urban environments and urban biodiversity.
- 3 As evidenced by the responses to public outcry against price increases by the utilities, the cost of procuring and maintaining the infrastructure necessary for the generation, storage and transmission of energy affects general living standards. We believe we can contribute to the energy economics debate with research into models of the infrastructure cost element of energy prices.

Research Funding

Although we have generally been successful in attracting research funding from the traditional sources, we are highly motivated to be more proactive and creative in seeking additional funding streams, such as the European Union and the CKE. We are particularly focused on greater utilisation of our extensive international networks with HEIs and major industry players, such as EIC and FIDIC, to access funding under 'Horizon 2020.' Also, as our reputation has grown in areas such as construction law and contracts, construction and engineering management and environmental issues, the University is becoming one of the preferred destinations of funded PhD students from overseas interested in these areas of study. More resources will be targeted at recruitment of funded PhD students.

c. People, including:

I. Staffing strategy and staff development

The University actively promotes the career progression of its researchers. Some of our ABE researchers have already developed into positions of academic leadership (e.g., Professor David

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Proverbs in the University of the West of England, Professor David Edwards in Birmingham City University), whilst others are progressing towards such leadership positions not only in Wolverhampton (Dr Ankrah, Dr Chinyio) but also in other universities, including Salford (Dr Suntriso), Coventry (Dr Soetano), Northumbria (Dr Samwinga) and Brunel (Dr Braimah). In 2009, in response to the Research Concordat, the University began working towards formalising these procedures to meet its specific standards. This work resulted in a University Concordat Working Plan (<http://www.wlv.ac.uk/PDF/WLV-Concordat-action-plan-Feb-2012.pdf>).

The FSE is continuing the policy of earlier Schools that housed ABE of recruiting staff with research backgrounds and the capacity to contribute to the School's research strategy (e.g. Dr Ankrah in 2007, Dr Suresh in 2008, Dr Georgakis in 2009, and Dr Bagheri and Dr Renukappa in 2013). All new academic staff to the Department are immediately integrated into one of the Research Groups and inducted through an individually-tailored development programme delivered at Departmental, School and University levels and covering all aspects of research activity (e.g. research supervision, PhD examining, grant writing/funding sources, and research collaboration). New staff are allocated a mentor (usually a Professor or Reader). To ensure continuity of their research work, each new member of staff is allocated: a research studentship (together with an appropriate supervisory team to provide guidance on procedures and management); a personal development fund to support or develop specific research projects that align with the departmental research plan; and funding to facilitate attendance at an international conference, international networking, external committee membership, bid preparation and industrial liaison.

All staff have a Personal Development Plan that contains a clear definition of the time allocated to research, as agreed between Departments and staff members. The plan is reviewed annually and is informed by reflection on research outcomes and the long-term aspirations and plans of both the individual and the Research Group(s) to which the person contributes. Annual performance reviews provide a regular feedback mechanism for ensuring appropriate progress.

There is a structured promotional route to Professorial level. Established staff are encouraged and supported to advance to Reader status and to apply for professorial status when they have sufficient academic standing and demonstrable and substantial outputs. Mentoring to achieve this position is provided directly by the University Professoriate. During this REF period, two departmental members (Ndekugri and Khatib) achieved Professorial status, whilst a further two (Hammond and Heesom) attained Readership status. Ankrah, after completing his doctoral studies in 2008, now has permanent membership with great promise.

Periodically studentships are made available to research active staff on a competitive basis. Early career researchers are particularly encouraged to apply for a studentship in order to further their research. The University also operates an Early Researcher Award Scheme (ERAS) for academics at the early stages of their research careers. A recipient of an award is entitled to a 6-month sabbatical and approximately £5000 for research resources. The recipients from 2008 onwards are: Suresh in 2008, Ankrah in 2012 and Renukappa in 2013.

The University takes its commitments to diversity and equal opportunities very seriously. This has now been recognised in our winning the Athena Swan Bronze national award for helping promote the role of women in science, engineering and technology. The makeup of the staff submitted (10 different national origins) provides further evidence of the University's commitment to champion diversity and equality.

c. II. Research students

PhD students are recruited onto new or existing projects and are thus closely integrated into the Research Group structure. All research students are allocated their own well-equipped workspace with a computer and access to software and all technical facilities. Supervision is by two/three-person teams, an approach which ensures continuity of supervision for the student, maximises the opportunities for cross-disciplinary and collaborative research, and provides a structured introduction to supervision for new staff. Research student progress is monitored both informally through the supervisors and members of the Research Group, and formally by a Student

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Management Sub-committee of the Faculty Research Committee. A special purpose open-plan Research Deck with space for 40 research students is provided within the new building. Space for a further 40 students is available in two research rooms.

The Department supplements research income from external sources with internal funds to support bursaries in our priority areas. Of the 28 PhD completions 17 were recipients of full bursaries from the Department.

The 'Built Environment and Engineering Research Seminar' (BEERS) series is central to dissemination of good research practice within the ABE Department. Seminars are presented on a monthly basis during lunchtime. Each research student is expected to make two presentations during the course of his or her research. The forum accommodates diverse researchers from new starters to students near completion and provides collective support and scrutiny to individual research undertakings. Through our discussions, new lines of research also evolve and collaborations with other institutions are developed and nurtured from the collective networks of our research community.

d. Income, infrastructure and facilities
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Income

Total research income generated within the ABE Department during the assessment period is nearly £600K, a considerable reduction from the income at RAE2008. The main explanation for the reduction in research income is that some income streams treated in the past as research income have had to be omitted in the calculation of our total research income. This has meant that two large EU projects with high research content have not been counted, thus omitting about £1.5M. The first project was a consequence of the high profile of the group's sustainability research, which was an important factor in our winning EU funding under the 'Cradle-to-Cradle Business Innovation and Improvement Zones' (204G C2C-BIZZ) Interreg IV programme. Partners are from seven EU States. Total funding is € 8,997,898.08, of which Wolverhampton's share is € 568,021.93. This project is supporting two strands of research: (i) the economic valuation of C2C inspired buildings and business sites (Hammond); and (ii) socio-cultural barriers to C2C adoption on business sites (Ankrah).

The West Midlands Centre for Construction Excellence, a spin-off company of our research reported in RAE2008, continues to champion new building products by providing a focus to sustain regional manufacturing of building products. The Centre has enabled staff (principally Oloke and Georgakis) to work with UK housing companies and other universities to determine suitable building adaptation measures in response to future climate change. Building on the strength of our sustainability research, the ABE research team (in conjunction with Coventry University) have won a £1M EU project to assist SMEs to develop innovative climate change solutions with a focus on products and services for housing retrofit (www.wolverhamptonbsc.com/becci). The research component of this project includes investigation of the technical and business competencies necessary for the development and marketing of products and services for housing retrofit. WMCCCE funded four PhD students to completion within the assessment period.

We strongly believe that our research in some of our core research areas is internationally leading and therefore needs to be entrenched and expanded. We will therefore focus on: greater EU funding by empowering staff to engage with the activities necessary to win such funding; research/teaching workload balance more conducive to research; and working closer with the Project Support Office to take advantage of research funding opportunities.

Infrastructure

The 2012-2017 University Strategic Plan (<http://www.wlv.ac.uk/default.aspx?page=11707>) aims to enhance this engagement by fostering a **research culture** within the University and nurturing greater opportunities to develop knowledge transfer with employers. In furtherance of the strategy a 'Research Hub' has recently been opened in the University. This brings together a Research Policy Unit (RPU), a Project Support Office (PSO) and Research Librarians and activities that provide training and support to postgraduate research students. This facility has been designed to

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maximise contact and interaction between research students, staff researchers and the support services to make sure that research is as easy as possible to undertake in the University. It provides support for both established researchers and an environment to mentor and support younger researchers trying to establish a research career and especially a track record for funding. There is a research student area for private study and research student networking.

The RPU develops, implements and monitors the University Research Strategy. It also has responsibility for research ethics, research governance, policy, management and reporting of research-related management information, and development and dissemination of institutional research publications and other communications. The remit includes management of institutional submissions to research assessment exercises (e.g. RAE 2008, REF 2014), statutory returns, co-ordination of research and management of institutional strategic research investment. It works with the International Centre to internationalise our research and assists with the development of networks for Horizon 2020 and other European initiatives. It works with others in the University to address questions around gender imbalance in research leadership positions and is responsible for providing the framework to support the development of researchers at all stages of their career in collaboration with HR and the University Careers Service.

The Project Support Office provides expertise and support for the development and submission of research grants with emphasis on European Funding. It provides a framework for post-contract management of projects, ensuring that reports and other statutory returns are made in the correct way and in a timely manner. The co-localisation of these activities with other research support services will allow the development of new services to be developed in collaboration with the Finance Division around grant costing, financial monitoring and management of research awards. The PSO has recently enhanced opportunities to secure European funding by opening a Research Office in Brussels.

The FSE Research and Development Committee oversees all research activities in Applied Science, Architecture, Built Environment, Engineering, Computer Science and Information Technology. This Committee, through various sub-committees, ensures that proposed research activities are feasible and accord with the Faculty Research Strategy, and that research is conducted within agreed procedures and processes (funding management, staff development, student management and compliance with requirements for ethical approval).

Facilities

The ABE Department's laboratories have been significantly enhanced, in terms of space and facilities, as part of the procurement brief for the new home for the reorganised Faculty. The laboratory facilities are used by both staff and postgraduate students, with controlled access for undergraduates. Most materials research and geotechnical investigations are undertaken within these laboratories. Researchers also have access to a Scanning Electron Microscope, X-ray fluorescence and X-ray diffraction spectrometers, Inductively-Coupled Plasma Spectrometry and a laser granulometer. These facilities are supported by dedicated technical staff.

Core to the Department's research and knowledge transfer activities is its Geographical Information Systems (GIS) and Virtual Reality (VR) facility within the Virtual Design Enterprise Centre. The Centre, built in 2001 at a cost of £300k, was one of the first simulation centres for the Built Environment in the UK. In recent years, the Centre has benefited from significant investment to upgrade the infrastructure and to create links with distributed simulation centres at other institutions. The Centre currently houses a 3m flat screen with a single projector. The recent hardware upgrade has enabled the development of the TeamVR framework in conjunction with the West Midlands Centre for Construction Excellence (WMCCE). This system allows collaborative working, the VR environment linking the Centre with sites in Birmingham and Dudley, including a portable stereoscopic system for 'on site' operation.

The ABE Department has a full range of hardware devices for advanced work in design and other creative digital applications. The WMCCE server runs several web-based applications, including a content management system, a CPD management system and e-Forms system. Such applications

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are used to support research activities (e.g. as support for the conduct of on-line surveys). The applications are also used to host the regional WMCCE ResearchNet portal (<http://research.wmcce.org>), which serves as a central repository of construction-related activities.

The Department provides researchers with access to an extensive range of industry-linked databases/contacts (through external organisations such as WMCCE, best practice clubs, FIDIC and the Flooding networks), travel and subsistence budgets (to overseas locations when appropriate) to facilitate data collection, access to specialist data processing software, and financial and technical support for specialist software when needed.

e. Collaboration and contribution to the discipline or research base

The problems and issues ABE research aims to address are multifarious and complex. Collaboration with industry and other HEIs nationally and internationally has therefore been a driver of our research activities. We also work very closely with professional bodies. For example, Paul Hampton, Head of our Built Environment Division, is President of the West Midlands Branch of the RICS. Through FIDIC-NET, very strong links have with established with international bodies, such as FIDIC, European International Contractors' Group, the Seattle-based DRBF, International Chamber of Commerce and UK professional associations such as the Chartered Institute of Arbitrators, the Society of Construction Law and leading practitioners across the globe (see www.fidic-net.org).

As detailed in the Impact Section, 17 past PhD students from the ABE Department moved on to become research leaders in other HEIs. Also, the ABE Department team hosted an ARCOM doctoral Workshop on 25 June 2010.

ABE staff have and continue to perform External Examiner roles in many universities in both the UK and overseas. Examples during the assessment period are: Fullen (Cardiff, Exeter, Lancaster, Cranfield, Amsterdam, Federal University of Rio de Janeiro, Leuven, Gembloux (Belgium) and Valencia (Spain)); Khatib (Plymouth, Sheffield Hallam, Leeds Metropolitan, Napier, National Institute of Technology, India); Ndekugri (Manchester University, Cambridge, Heriot Watt, Putras Business School (Malaysia) and West of England); Oloke (University of Granada - Spain, Free State Central University of Technology - South Africa) and Suresh (University of Salford). Our staff are also in demand as external advisors to panels undertaking curriculum development and review exercises in other universities: including Fullen (Coventry University, Edge Hill University) and Ndekugri (Brunel, Leeds Metropolitan University, Manchester University and University of Central Lancashire).

The following are a sample of international collaboration.

- 1 ABE operates an International Sabbatical Scheme that funds overseas academics to spend up to three months working with our research staff. Recent beneficiaries are Professor Oluwoye (University of Alabama), Dr Coker (University of Ibadan) and Dr Marcinkonis (University of Vilnius).
- 2 There is a reciprocal arrangement for research staff exchange with Bradley University (USA) under which Suresh spent six months in Bradley's Civil Engineering and Construction Department.
- 3 Oloke has collaborated with colleagues in Spain and Turkey on health and safety and under the EU Climate Change Project (Knowledge Innovation Community – KIC). As part of these projects the University of Wolverhampton hosted seven visiting fellows for periods of 2-3 months (Nilgun Gumasay, Monica Lopez, Richard Snowden, Alejandro Mustieles, Ma Gonsale, David Chapman and Marta Braulio Gonzalo).

The international collaboration has facilitated joint EU proposals and joint research which has resulted in joint publications. For example, Chinyio worked with colleagues in other HEIs to produce an edited book on stakeholder management (ISBN ISBN-10: 1405180986). ABE staff webpages demonstrate that they contribute to the discipline in many other ways.