

Institution: University of Bath

Unit of Assessment: 16: Architecture, Built Environment and Planning

a. Overview

The Department of Architecture & Civil Engineering (ACE), which comprises this UoA, is part of the Faculty of Engineering & Design and brings together two traditionally distinct professional disciplines. The research culture in ACE greatly benefits from this joint nature, with a diversity of work ranging from theoretical studies of architectural history to the solving of practical problems concerning bridge design. Our consistent aim is to be an internationally-focused centre of research excellence in the fields in which we specialise. The Department is organised into three interdisciplinary research centres and each contains staff drawn from the two professional groups:

- The Centre for Advanced Studies in Architecture (CASA) – comprising 6 full-time academics, focused on research into the history of architecture and digital architectonics.
- The Building Research Establishment (BRE) sponsored Centre for Innovative Construction Materials (CICM) – comprising 16 full-time academics, focused on the use of natural building materials such as timber, straw and bamboo, the sustainable use of traditional materials such as concrete, and the use of new materials such as advanced composites.
- The Energy and the Design of Environments research unit (EDEn) – comprising 7.13 full-time academics, focused on the use of energy in buildings and on Low Carbon design.

Each centre is directed by a Professor (CASA, Hart; CICM, Walker; EDEn, Coley) and has a deputy. Each centre is responsible for the internal peer review of all grant applications, the support of its researchers and the monitoring of research targets. All research active academics, including probationers, are members of a centre, and may also be affiliated to another centre. All postgraduate research students also become members of an appropriate centre. The Department's research strategy is set by a departmental Director of Research (DoR; a new post since RAE 2008) in consultation with the HoD and the Faculty and Department research committees, the latter including the directors of the research centres. In 2010-12 the University reorganised its structure to place more emphasis on its Faculties and their role in co-ordinating research collaborations and the sharing of administrative and technical support. As a sign of the increased cross-Faculty collaboration during the REF period, we are submitting three staff from Mechanical Engineering (Hammond and McManus (environmental) and Ansell (materials)).

b. Research strategy

In RAE 2008 we reported a move away from the 'two groups' culture of architects and civil engineers, towards greater cohesion and inter-disciplinary collaboration in our research. This was encouraged by the fact that our centres cut across the two groups in ACE in terms of membership. The REF period has seen a continuation of this trend, focused however on one predominant and imperative research theme, namely sustainability. This theme has been at the very heart of our research strategy, and has informed almost all our staffing and resourcing decisions. The period has consequently seen a considerable extension in terms of the depth and breadth of our research into sustainability issues, and especially Low Carbon construction, Building Physics, Environmental Design, Innovative Materials, Strengthening & Life Extension, and Reuse & Conservation. For example, the theme of building conservation involves the work of the historians in CASA, on the one hand, whose humanities-based research addresses themes of historic conservation and heritage, and the engineers examining structural and building-physics-related retrofit, on the other. The assessment period has also marked the development of specific research targets for probationers and confirmed staff, in terms of grant income, publication quality & quantity, and conference attendance. For example, probationers and ECR are expected to apply for EPSRC First Grant awards where their fields of research are appropriate during the first two years of their appointment. These targets are monitored in the centres through a grant's register, and by the DoR. Staff migrations, through promotion or personal circumstances, have led to key new appointments and all leaving staff have been (or are being) replaced. As part of the Faculty strategy of research growth, we have made significant investments in new posts in timber

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engineering and low carbon design.

The following staff **arrived** during the census period: Coley (from Exeter, an additional Professor of Low Carbon Design); Harris has been upgraded from a 0.2 to 1.0 FTE Professor of Timber Engineering; Charrington (from UWE) has been appointed as a Lecturer (L) in architectural history. Chang (from Kyoto University, Japan), Ball (from Bristol), Fodde (from UNESCO: died in service on 30/10/2013, post to be advertised) and Lawrence (from a Post-Doc at Bath) have been appointed as new (additional) Ls in Low Carbon materials. Shepherd has been translated (in 2011) from a Research Fellow to a probationary L and McManus (in 2010) from a Great Western Research Fellow to a L. Harney has moved (in 2012) from pre-probation to confirmed L. Shea (L, from Oxford), McCullen (L, from Leeds) and Kjeldsen (L, from HR Wallingford) have also been appointed to new posts in sustainability-related environmental research. Orr (from Bath PhD) and Briggs (from Southampton) have been appointed as new (additional) Ls in geotechnical engineering, and Hayles (from Queen's, Belfast) has been appointed as a new (additional) L in sustainable construction. **Plus** within the next 6 months: 2 FTE approved in: Building Physics/Low Carbon Design and Civil Engineering plus (applied for) 2FTE. The following staff **left** to take up more senior appointments elsewhere during the census period: Samuel for a Chair and HoD at Sheffield, Nikolopoulou for a Chair at Kent, Nevola for a Chair at Exeter, d'Ayala for a Readership (R) at UCL, Anstey for a SL at Stockholm, Cruise for a permanent L at Sheffield, and Musau for L at the Mackintosh School of Architecture. The following were **promoted** during the census period, principally on the basis of their research as judged by international peer-review: Nikolopoulou (from L to SL), d'Ayala (from SL to R), Darby (from SL to R), Heath (from L to SL), and Zang (from L to SL).

The eight main 'milestones' in strategic development since RAE 2008 are:

- The financial support of the BRE Trust for Walker's Chair in Civil Eng (£50k per annum).
- The building of two high-impact and innovative buildings on campus: TSB/ModCell funded BaleHaus; and its sister-building, the HemPod project funded by DEFRA (see impact case).
- The mentoring of 7 probationary/ECR staff (Ball, Chang, Fodde, Shepherd, Lawrence, Orr, McManus) and the confirmation of 5 into lectureships since 2008 (Evernden, Natarajan, Zang, Shea, Charrington; Harney from pre-probation to lecturer (in 2012)).
- The steady growth in funding from £1.065M in 2008/09 to £1.919M in 2012/13, and an almost tripling of Research Council funding from £411K in 2008/09 to £1.178M in 2012/13. This has been marked by increased international funding from the EU, **as evidence of our international agenda**: The ECO-SEE project (Eco-innovative, Safe and Energy Efficient wall panels: FP7, budget to Bath in 2014-17 of 1.22M euros) and the Eurocell project (development of MODCELL eco-build system: budget to Bath in 2012-14 of 450K euros).
- The growth of research active staff in fields relating to sustainability, with the addition of 5.8FTE staff since REF2008.
- The growth in registered PhD students, many in fields relating to sustainability, from 26 in January 2008 to 85 in October 2013 (and from 5 graduations in 2008/9 to 12 in 2012/13).
- The establishment of two new MScs: in environmental design and in the conservation of cultural landscapes: plus the MPhil in 'Digital Architectonics' and the MSc in 'Innovative Structural Materials'. All rely heavily on research in ACE. The cohort growth in sustainability is particularly strong – with 36 overseas students alone on these courses in October 2013.
- The accelerating growth of our non-academic, public and industrial impact agenda.

The eight main objectives for the next five years are:

- The construction of a £24M Faculty research and teaching building (3,000m² to ACE; itself an example of Low Carbon design to be opened in Summer 2015) that will also significantly

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free up research space in our existing building (6E) and enhance our research environment and capacity, notably for Postgraduate students (approved in June 2013).

- Ten additional research-active FT staff, maintaining the momentum of growth achieved since REF 2008 (from 13FTE in RAE 2001, 23.3FTE in RAE 2008, to 29.13FTE in October 2013), as monitored by the DoR and HoD.
- The attainment of a minimum of 3 MPhil/PhD students per FTE at any time, fed from our MPhil and MSc programmes. The Faculty Graduate School administers funded studentships and is the focus of this activity since 2011.
- Research income of at least £2m per year (over £1m p/y achieved since mid-2005).
- The continuation of the trend, notable over the assessment period, towards a diversification of research funding, with a portfolio of projects funded not just by the RCs (principally the EPSRC and the AHRC) but also other agencies (the TSB, KTPs, Wellcome, EngDs etc).
- The further development of EDEN, with additional staff and research topics.
- Establishing a multi-disciplinary University Research Institute in the built environment, incorporating CICM and EDEN, and linking with other departments, including Psychology, Mathematics, Biological Sciences, and Computer Sciences. The scope of the new institute will be decarbonisation of the built environment, focusing on transformative changes in embodied and operational carbon impacts for new and refurbished buildings, and will also enhance identity of world leading research at the University.
- The maintenance of the cross-disciplinary ethos and culture in the Department, and in particular the work of the history group in CASA and its high-quality monographs. The potential loss in Urban Studies research in CASA, during the assessment period (Anstey and Nevola) has been addressed by incoming staff (Charrington and approved Chair TBA).

All of the above will be monitored by the Head of Department assisted by the research committee, the DoR and the Associate Dean for Research and for Graduate Studies.

New and developing initiatives of strategic importance include:

- The monitoring of University buildings in terms of their UK environmental performance: seed funding of £105K from the Technology Strategy Board was awarded in 2011 (Shea).
- The further development of research into high-rise timber buildings (Harris, Walker and Chang) as part of our work on sustainable materials.
- The encouragement of cross-Faculty research collaborations into resource management and water engineering, exploiting CICM's links with Mech Eng. Faculty-based water engineering research is supported by Wessex Water with £2.7M over the next 5 years. Kjeldsen has been employed to develop work in flood risk analysis of urban areas.
- The establishment of the Building Research Park at Wroughton Airfield on land owned by the Science Museum; a particular emphasis will be on low carbon, low impact construction. The EPSRC have funded £810K towards the construction of a two storey research building (the HIVE), with a contribution from the University of £348K, to be completed in 2014.
- The growth in EU funded research through Horizon 2020 and other relevant international schemes, and through national partnerships including the GW4.

Priority developmental areas include:

- Enhancing applications for RC and ERC Fellowships (semester sabbaticals), and further develop AHRC funded research within CASA. In 2013 CASA received £80K from the AHRC for the development of Smartphone Apps (Nevola), and we wish to extend this work.

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- Enhancing KTP/TSB activity and the industrial and public impact of our research.
- Increasing the numbers of post-doctoral Research Officers and Fellows.
- Enhancing international collaborations and involvement in international collaborative research grant bids (such as the ERC grants) especially concerning sustainability issues.
- Enhancing engagement with policymakers, as part of our impact agenda.

As evidence of the success of our strategy, during the REF period we were the first researchers to show: that shear strengthening of bridges is possible without halting traffic, by inventing the 'Deep Embedment' technique, and Darby and Ibell's paper won the ICE Bill Curtin Award; The BaleHaus research was the world's first use of prefabricated straw bale panels in load-bearing construction (presented in best paper (Howard Medal) winner, ICE Construction Materials journal 2012), and was the basis for Walker's Royal Society Wolfson Research Merit Award in 2013; Hart was the first to demonstrate the influence of religion on the architecture of Inigo Jones, in work recognised by a Senior Visiting Fellowship at the National Gallery of Art in Washington in 2010; Charrington's pioneering work on Alvar Aalto won the RIBA President's Medal for Outstanding University-based Research 2013; and Coley was the first to establish a method for the production of probabilistic future weather files used on \$9b worth of construction projects, and was awarded the Napier Shaw medal for the work in 2012.

c. People, including:

i. Staffing strategy and staff development

The Department is keen to ensure that it offers staff a supportive, inspirational and ambitious environment in which to carry out their research. In particular, we see our research centres as the best way to foster this. Research active staff are allocated a minimum of quarter their time for research activities in the Department workload model. Research performance is central to our staffing strategy, from recruitment through probation (if applicable) to promotion. The University's Merit Pay awards scheme also closely considers research performance. This performance is measured in terms of agreed outputs, grant capture and impact targets appropriate to each grade, which are monitored at regular intervals. For example the Department conducts annual performance reviews that assess individual research outputs and plans, as well as standards, impact and esteem indicators. We seek to balance individual scholarship with a group research culture fostered around our themes within the three centres. Over the REF period we have maintained our group of historians at five FTE posts (in CASA), whilst expanding our FTE numbers in Low Carbon design and materials research. This policy has encouraged a growth in our portfolio of funded projects, as also outlined above, and in our RAs and PGRs.

The Department actively seeks to appoint and **support early career researchers**. New research-active lecturers join an appropriate research centre. Probationary lecturers are assigned mentors (a senior member of staff), and have regular meetings with them and senior staff to discuss the development of their research at this crucial stage. Further, the Deputy HoD also meets quarterly with each probationer to gauge progress informally and to provide advice, a practice that has now been adopted across the University. They are provided with travel monies to attend international conferences, and each receives a University-funded PhD studentship to help further their research career. Early-career lecturers benefit from a major reduction in teaching and administration duties during their three-year probation to maximise research development. Administrative duties are kept to less than 5% of time in the workload model. The Department provides pilot-study funding (up to £10K within the Department with further funding possible from the Faculty) for its probationary lecturers to work up potential research into major grant proposals. All probationary lecturers are required to complete the University's course in Enhancing Academic Practice which includes research training, and successful completion of each of the three years of probation is approved by the University's Academic Staff Committee with close regard to research performance. Staff are entitled to bid to the University for funded sabbatical leave at the rate of one fully-funded semester for every six of service: one was awarded to d'Ayala in 2010, and one to Nevola in 2012. D'Ayala was promoted from SL to R following her research whilst on sabbatical. We actively encourage the

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development of international research links through these awards and other less formal study leave. D'Ayala was based in the Getty Centre in California, and during the summer of 2010 Hart was a Senior Visiting Fellow in the National Gallery of Art, Washington DC, for research on his monograph on Inigo Jones (Yale UP). Hart is also a Visiting Professor, Kent University (2010-13), Hammond is Honorary Professor in Sustainable Bioenergy, Nottingham University (2010-date) and Walker is a VP at the University Technology Mara (UiTM), Malaysia (2008-2013). Briggs is a Visiting Research Fellow at Southampton University (2012-date) and Chang is Visiting Associate Professor at Kyoto University, Japan (2008-date). The Department currently has 7.66FTE **Teaching Fellows** that carry a large teaching load on the undergraduate programmes, thereby supporting research-active staff. They also provide a conduit for our research to feed back into practice. Apart from these Teaching Fellows, in 2012/13 the Departmental budget for additional contracted bought-in teaching was £410K, providing further significant support.

The University is an equal opportunities employer, and all HR policies concerning Equalities & Diversity (E&D) are fully implemented in the Department. The Department has an E&D officer (Harney), and actively audits its procedures in recruitment and allocation of resources and duties in the workload model. Research staff are drawn from a diverse ethnic and international cultural background, including from China, Taiwan, India, Italy, Korea and South Africa. Maternity leave is fully allocated (Nikolopoulou). The University has an Athena Swann Bronze Award, and the Department is submitting an application for an individual Athena Swann Bronze in November 2013. Wherever possible we have ensured a gender and ethnic balance on all our key committees. The University is fully committed to implementing the Concordat to Support the Career Development of Researchers (<http://www.researchconcordat.ac.uk/>) in order to provide a productive and supportive working environment. As recognition of this, the University was awarded the 'HR excellence in research' badge from the European Commission in 2011. In support of the Concordat, each probationer within ACE is awarded a studentship for a PhD candidate. In addition, the Department actively seeks to recruit industrially-based researchers as Visiting Professors: we currently have eight VPs, including a Royal Academy of Engineering sponsored visiting chair (Doug King from DK Consulting), and two visiting research fellows. The Department currently has six Research Officers employed within the centres on various research projects. It also has one Category C staff member entered in REF 2014: Visiting Professor Robert Tavernor (Emeritus Professor at the LSE) is based in CASA and collaborates closely with its members (Hart, Charrington and Wilson Jones). His research is encouraged through presentations in seminars within the Department, in collaborating with our international exhibitions (at the Sorbonne in 2009 for example, see *section e* below), and in turn he contributes to our research environment and international standing.

Members of the Department are required to pass the University's online Equality and Diversity Training Module. The director and deputy director of each of the three research centres are responsible for promoting and monitoring ethical policies and good practice in research. The University's policy on ethical research is maintained and referenced in every grant application. The Department has a research ethics officer (Paine). All grant applications are peer reviewed within the appropriate centre, and for larger grants by an appropriate member of the University's peer-review 'college', and all publications are periodically graded internally to ensure the quality of outputs. Collaborations in authorship of papers is encouraged, especially with research students, and fully and equally acknowledged in the publication. It is our policy that the first author is the staff member or PhD student who carried out the research and who wrote the first draft.

ii. Research students

All graduate students in the Department become members of the Faculty's Graduate School. The Graduate School provides a range of graduate programmes and pathways at masters and doctoral level. It manages graduate recruitment, webpages, admissions, subject-specific and generic skills training, research seminars and a host of social activities, and provide a stimulating space to explore ideas (eg PGR showcases, poster competitions, and invited eminent speakers (as but one example, Keith Clarke, former CEO of Atkins Global, in 2011 on sustainability)). The Graduate School runs compulsory taught courses in research methodology, ethics and academic integrity (how to avoid plagiarism) attended by all research students. In addition, the University runs courses throughout the year, available to all postgraduates, in developing skills in research and

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languages (especially English). The Graduate School Committee oversees the strategic development of PGR programmes and opportunities for students, whilst the Faculty Research Students' Committee chaired by the Associate Dean (Graduate Studies) monitors registration, annual progress and training issues. In 2010 a Fellowships Academy was created in the Faculty to mentor ECR doctoral students and RAs who have ambitions to pursue research careers: in ACE, one Academy student has successfully become a L (Orr) and another is completing his PhD.

All research students are also affiliated to an appropriate research centre. They are well-provided for, with a desk, new PC with access to the University network, telephone and a minimum of 7m² of office space within dedicated PhD student offices. The Department has a continuing commitment to providing adequate space to support expanding PGR numbers. Each research student is allocated two supervisors on registration, in order to promote inter-disciplinary and collegiate collaboration. The main supervisor is the primary expert in the chosen research and assesses training needs, whilst the second monitors progress and provides additional relevant expertise and support, and is expected to be able to stand in for the primary supervisor in case of illness, departure, and parental leave. Each student's progress and training are also reviewed annually by the Postgraduate Director of Studies. A formal viva takes place after one year based on a 'Confirmation Report' from MPhil to PhD, and doctoral registration is dependent on its successful completion. Following a very thorough review of work done to date, and of proposals for the path to completion, advice is given by two examiners on methodology and anticipated training needs. The Departmental Librarian will make publication purchases required by postgraduate students and research officers, and reviews physical/online journal subscriptions. It is Departmental policy to provide scholarships worth £1500 per year to self-funded PhD students on the basis of need.

During the REF census period a number of registered PhD candidates have progressed from our taught Masters degrees in Conservation of Historic Buildings (2), Cultural landscapes (6) and Environmental design (5). In 2010 the Department was awarded two AHRC bi-annual MSc studentships in Conservation, which are offered with the expectation that these will lead to PGR status. Funding for research studentships has been received from the following international bodies: EPSRC Case Awards, TSB, Exeter University, the Science Museum, the National Trust (EPSRC EngD Centre partnership), the EU, Marshall Aid Commemoration Commission, Leverhulme Trust, the Kurdistan Government, Republic of Indonesia, the Iraq Government, Silvanus Trust, Great Western Research, as well as EPSRC project studentships. The following internationally-leading industrial-research organisations and industrial sponsors have also provided funding for research studentships: BRE Trust (9), Lime Technology Limited (1), Lhoist (1), Network Rail (1), Arup (1), Atkins Global (1), Wates PLC (1), Ramboll (2), Buro Happold (1), Foster & Partners (1), Kingierlee Holdings (1), Natural Building Technology (1), Ibstock (1), and Schlaich Bergemann & Partners (1). These partners provide technical and strategic support (see the Impact Statement). In addition the University has provided 9 fully-funded research studentships.

The Department has appointed 4 postdoctoral researchers, funded by DEFRA, TSB, AHRC/EPSRC, and the EC, whilst a further 2 post-doctoral researchers in the field of computation were funded through the Japanese company Informatix. In 2012 one of these (Lawrence funded by DEFRA) progressed to a HEFCE-funded Lectureship in the Department and another (Shepherd funded by Informatix) also progressed to a Lectureship as part of CASA's further growth. The career development of this CASA Research Fellow has been an important indicator of what the Department can offer, in that he was encouraged to engage with the new-lecturer probationer process, including making an excellent contribution to research and outreach activities. Some undergraduate teaching by postgraduates is encouraged within the Department, to develop presentation skills and communication. This teaching is reinforced by presentations at weekly seminars (attended by academic and research staff and students), at which each research officer and student is required to give a presentation of an aspect of their research, with an emphasis on its quality and impact. Research students are expected to submit journal papers co-authored with their supervisors. We encourage them to write the first draft, and thereby become the first author. They are expected to submit a paper to a conference in the UK or abroad on an annual basis. Additionally, the University hosts an annual cross-disciplinary postgraduate student conference, organised by the students to share good practice and to initiate collaboration. This makes a useful

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contribution to our vision of encouraging the next generation of researchers. It is expected that all research-active staff submitted to REF contribute to PhD programmes by supervising PhD students (as first or second supervisors) and contributing to the Faculty-led training programmes.

d. Income, infrastructure and facilities

There has been a significant growth in research income in the assessment period: in 2008/09 the Department received £1.065M, in 2009/10 it received £1.161M, in 2010/11 it received £1.259M, in 2011/12 it received £1.677M, and in 2012/13 it received £1.919M. During this period, staff have received funding for research totalling over £7.082M from a host of international bodies, including: AHRC (Nevola), the British Academy (Nevola), EPSRC (Ball, Briggs, Coley, Darby, Heath, Ibell, Paine, Walker, Zang), Environment Agency (Paine), the BRE Trust (Chang, Paine, Walker), DEFRA (Walker), British Council UKIERI (Ball, Paine), Royal Society (Ball), EU, EACI, FP7 & COST (D'Ayala, Harris, Lawrence, Paine, Walker), Leverhulme Trust (Ibell), Kurdistan Government (Ibell), Republic of Indonesia (Fodde), Rakennustieto, Helsinki (Charrington), Bard Graduate Center, New York (Charrington), Royal Academy of Engineering (Ball, Heath, Harris, McCombie, Zang), Great Western Research (Zang, Harris, Walker), English Heritage (Ball), US National Science Foundation (Heath), Institution of Civil Engineers (Heath, Orr), Institution of Structural Engineers (Darby, Evernden, Orr), National Trust (Harney, Shepherd), CONYCI: Chile National Commission for Scientific and Technological Research (Shepherd), UNESCO (Fodde, D'Ayala), The Concrete Society (Darby), National Lottery (Harney), the TSB (Walker, Shea, Coley), Carbon Connections (Walker). The breadth and range of the Department's research arising from this funding is demonstrated by major outputs such as: books and monographs with international publishers (Charrington, Fodde, Hart, Wilson Jones), societal and environmental benefits of saving previously structurally-condemned infrastructure (Darby, Ibell) and practice-related dissemination for the design of low-carbon buildings (Natarajan, Coley, Walker). For engineering research activity, our approach to grant income is to seek a diversification in international funding agencies (as listed above), to reduce where possible the sole reliance on the RCs. For historical research in CASA, we encourage applications for fellowships and travel awards, and small grants to support specific contracted book projects, alongside major grants.

Our research is supported by well-resourced infrastructure. The Department is based in a purpose-designed building (6E) by the Smithsons (1985). It has structures, materials, timber, geotechnical, hydraulic, concrete, acoustic, computer and lighting laboratories. The research activities of the CICM are also supported through laboratories across the Faculty and at the BRE. The Faculty structure now provides access to wind tunnels, a rapid prototyping machine, autoclave, a virtual reality suite, scanning electron microscopes and timber testing equipment. The Department has eight dedicated technical support staff, including lab technicians, timber workshop technicians and a computer technician. The University Library is open 24 hours a day, 7 days a week, and is well resourced with electronic journals. The Library budget for the Department alone in 2012/13 was £132,657, which is a 12.94% increase on the 2011/12 allocation. In 2011 the University's Research Development and Support Office (RDSO) with funding from EPSRC created an equipment database (for items over £10K), which allows for the sharing of cross-campus research facilities and equipment. The Faculty allocates resources to the Department on the basis of an Annual Planning Cycle. Twenty per cent of Department operating budgets are reserved for investment in major equipment and refurbishment, and the Faculty has a 5 year plan to renew and re-furbish all our research labs. Since RAE 2008, examples of University financial support include the overhaul of the laboratory space (£211K in 2008/09 including a new hydraulics flume, and £50K in 2012 for water engineering lab equipment), and support for BaleHaus (in-kind provision of land & £60K to relocate). In addition, 400m² of centrally-located campus land has continued to be provided for use as an outdoor research facility in support of an EPSRC dry-wall project in the CICM. The Department also provides funding to the centres in terms of staffing, computation, travel, laboratory equipment and consumables. The University has undertaken to match-fund any RCUK awards of equipment above £10K and below the Official Journal of the EU (OJEU) threshold limit.

e. Collaboration or contribution to the discipline or research base

The Department has aimed to make a significant contribution to the advancement of research in the fields related to its centres principally through developing its international profile. International

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visitors, for example, testify to the Department's status as an international research centre of excellence. The Department has hosted important **international visitors** in the field of sustainable materials including Professors Ghavami (PUC Rio, Brazil), Reddy (IISc, India), Molins (Universitat Politècnica de Catalunya Barcelona Tech, Spain), Dick (Manitoba, Canada), and Drs Morel (ENTPE, France), Nordby (NTEU, Norway) & Lamezon (CAPES, Brazil). The Department funds the Sir Edmund Happold Senior Visiting Research Fellowship, awarded to a visiting scholar from academia or industry for up to 8 weeks in the summer vacation, with the aim at fostering collaborations (Dr Paul Jacquin (Ramboll) in 2009, Dr Alan Forster (Heriot Watt) in 2011, Dr Paulo Borges (Sheffield) in 2012 and Prof Darren Robinson (Nottingham) in 2013). In 2012 we hosted the University's David Parkin Visiting Professorship, awarded to Prof Climent Molins (UPC Barcelona Tech). Staff have hosted five major **international conferences** at Bath on sustainability themes, namely NOCMAT (2009), ACIC (2011), LimesNet (2012), Fabric Formwork Concrete (2012), and FutureBuild (2013). We have further contributed to the discipline through the publication of some 25 books, 115 chapters, 279 articles and 216 conference papers during the census period.

Support for and contribution to the research base has been further maintained through **invited public lectures** and **Keynote addresses**. These have taken place in all five continents and at some of the most important research institutions in the world. For example in **Asia** at HKUST (Ibell), HKPU (Ibell), Moratuwa University (Walker; Ibell), UiTM (Walker), Mumbai University (Ibell), Delhi University (Ibell), and Chennai University (Ibell); in **Africa** at Stellenbosch University (Ibell, Zang); in the **Americas** at Johns Hopkins University (Hart), University of Manitoba (Walker), Getty Centre, USA (Wilson Jones), Princeton University (Williams), Queens University, Canada (Walker), George Washington University (Ibell), Georgia Tech (Williams), MIT (Williams), US National Science Foundation, Colorado (Heath), and the University of California at Davis (Heath); in **Australasia** at the University of Christchurch (Harris), University of Wellington (Harris), and the University of Auckland (Harris, Walker); and in **Europe** at the University of Oxford, (Hart, Wilson Jones), Sorbonne, Paris (Hart), Courtauld Institute of Art, London (Hart, Annual Lecture of the Society of Architectural Historians, 2009), National Gallery of Art, Washington (Hart), The British School at Rome (Hart, Annual W.T.C. Walker Lecture, 2010), University of Cambridge (Walker, Williams, Ibell, Hart, Wilson Jones), British Museum (Wilson Jones), The British Academy (Wilson Jones), Stanford University (Wilson Jones), Columbia University, NY (Wilson Jones), American Academy, Rome (Wilson Jones), University College London (Walker), and the University of Edinburgh (Walker). The research centres have also actively disseminated their research in the **popular media**, and the University's Online Publication Store (OPUS) allows free public access to our journal articles.

Staff have also contributed to their research fields by serving in international **peer-review colleges**, most notably: Ansell, Ibell, Heath and Walker (EPSRC); Heath (Royal Society); Ibell (the Fulbright Commission); Hart (AHRC); Wilson Jones (ANVUR-VQR Italy); Hart (Royal Academy of Finland, the Finnish Research Council for Natural Sciences & Engineering, Council for the Humanities of the Netherlands Organization for Scientific Research, and the Leverhulme Trust); Shepherd (the RAEng 'Ingenious' grants scheme); Walker (National Science Federation, USA & National Research Council, Canada); McCombie (La Direction de le recherche du Ministère de l'Ecologie, de l'énergie, du développement durable et de la Mer, France). Staff have served on the **editorial boards of scholarly journals**: Ansell, *International Wood Products Journal*, *Journal of Wood Science* (2008-date), Walker, *Building Research & Information* (2011-date), ICE's *Construction Materials* (chairman since 2012); Wilson Jones, *The European Architectural History Network Newsletter* (2012-date), *Workshop diarcheologia classica* (2010-date); Ibell, *Magazine of Concrete Research* (2008-date), *International Journal of Architecture, Engineering and Construction* (2010-date), *International Journal of Structural Engineering* (2010-date). Hart is a member of the **advisory board** of the Helsinki Collegium for Advanced Studies, University of Helsinki, Finland (2012-15); Wilson Jones was on the grants and publications committee of the British School at Rome (2006-11). The Department has engaged with extensive **networks of research clusters**, including hosting the EPSRC funded Low Impact Materials and Innovative Engineering Solutions Research Network (LimesNet) in 2011/12, with over 20 industrial partners (see Impact Statement). Harris Chaired the EU COST Action FP1004 Network in 2011-12.

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The Department's three centres have also participated in important **international academic collaborations**. In CASA, the most notable collaboration during the assessment period was the public exhibition of computer-history projects with the Sorbonne, held at the Réfectoire des Cordeliers, Paris, on 12-25 October 2009. In the CICM, Walker has sustained the following international collaborations: with PUC Rio (on bamboo construction); ENTPE (on hemp-lime; earthen architecture; dry-stone walling); University of Auckland (on rammed earth); University of Manitoba (on straw bale construction); Queens University, Canada (on straw bale construction); and with the Indian Institute of Science (on earthen architecture). These have all led to staff and student exchanges, guest lectures and jointly organised events. For example, members of CICM have aimed to draw on existing Colombian knowledge of bamboo to exploit it in the construction industry, working with the National University of Colombia, the Andes' University and the Colombian Bamboo Society. In 2012, staff went on a fact-finding mission to Colombia run through the EPSRC funded LimesNet (fully outlined in the Impact Statement). EDEN has long running research collaborations with the Universities of Manchester, Napier, Northumbria and Sheffield, as evidenced by its successful joint research project COPSE (Natarajan), and it is now working with Oxford University on the ENLITEN project (Coley). EDEN research staff have contributed to 3 EU FP7 research proposals in the last 3 years, collaborating with all 4 of the European academic institutions specialising in advanced building façades (TU-Delft, Hochschule Ostwestfalen-Lippe, Universidad del Pais Vasco, and Lucerne University of Applied Science). This forms the core of the European Façade Network. The associated industry collaborators include: Acciona (Energy Service Company), ARUP Spain, CWCT (UK), Kawneer (France), Oskomera (Denmark), Prefacada (Poland), Selektif (Turkey), Schott Glass Europe, and Tecnalía (Spain).

Staff have also contributed research to **professional associations**, most notably to the IStructE where Harris chaired the sustainable construction panel until 2011 and Ibell was Vice President in 2010-14, and will be President in 2015; the RAEng where McCombie co-authored 'Case for Centres of Excellence in Sustainable Building Design' in 2012 and Ibell was a member of the RAEng/EPSRC Leadership Fellowship panel since 2010; the Institution of Civil Engineers where Heath has helped develop field test kits; the Queen's Anniversary Awards Panel for 2013 where Ibell is a member; the BRE where Ibell has been chair of the Fellowship since 2012; The Concrete Society where Darby has chaired meetings; Earth Building UK where Walker was inaugural chair in 2009-11; RILEM where Paine is on their Technical Committee 224-AAM; the Institute of Materials, Minerals & Mining where Ball is a member of their Cement and Concrete Science Group & Ansell and Lawrence are Fellows; the West of England Metals and Materials Association where Ball is Secretary; the Garden History Society where Harney is a Trustee; the IOM3 Wood Technology Society where Ansell is on the board. In 2014 Ibell was elected a Fellow of the RAEng.

The quality of our contribution to the discipline has been recognised by the receipt of a number of **prestigious international prizes**: Charrington won the RIBA President's award for Outstanding University-located research for his book on Aalto in 2012; Coley won the CIBSE Napier Shaw medal for 'best paper' on a research topic published in *Building Services Engineering Research & Technology* in 2012; Hart's book on Inigo Jones was the only architecture book listed in *Apollo's* Book of the Year; it was also shortlisted in 2012-13 for The William Berger Prize, The Art Book Prize and The Historians of British Art Book Prize; Orr received third prize in the IStructE 'Young Researchers of the Year' competition in 2011; Heath won the IStructE 'Model and Full Scale Testing' award in 2010 and (with Walker and McCombie) the Institution of Civil Engineers' John Mitchell Medal in 2010; Ibell won the Institution of Structural Engineers' 'Husband Prize for Best Bridge Engineering Paper' in 2008, the Institution of Civil Engineers 'Bill Curtin Award' for best paper in the *Journal of Structures and Buildings* in 2010, and the IStructE 'Henry Adams Diploma' for best paper in 2011 and 2012; Walker won the Institution of Civil Engineers 'Howard Medal for Best Construction Materials Paper' in 2012; Harris received the IStructE Oscar Faber Diploma in 2008. Ball received the Institute of Materials, Minerals, and Mining outstanding service award in 2013. Hammond won the IMechE George Stephenson Prize for best paper in 2008. Wilson Jones was elected a Corresponding Member of the Archaeological Institute of America in 2010 and Walker received a Royal Society Wolfson Research Merit award in 2013.