Institution: Glasgow Caledonian University

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

a. Overview

The UoA comprises three pooled research thematic areas, namely: Construction Management and Economics (led by Prof J Sommerville), Sustainable Urban Environments (led by Prof R Emmanuel) and, Environmental Technology and Management (led by Prof J Q Jiang). Building on previous RAE's **where "84%** of the work submitted was of international standing, of which 14% was world-leading, indicating a vibrant intellectual community" we planned to consolidate and enhance our research position and international status through focused staffing, resourcing, and dissemination (in response to RAE 2008' Panel comments we have also increased the spread of our **86 output** types: now with **24%** non-journal).

The unit is submitting the research work of **21.6FTE** staff for consideration by the panel (an uplift of **76%** on RAE2008, from the then 12.3 FTE). Outputs submitted include **63 journals and 23** others e.g. books, book chapters, or reports. Coupled with these 88 outputs, our PhD completions have increased from 3.85 per annum to **5.4 per annum** during the evaluation period, an annualised increase of **40%;**.the school's; completion rate **for PhD's within four years is 86%.** Within UoA16, we have appointed **5 new Chairs** (Cameron, Dimitrijevic, Emmanuel, Jafry and Jiang; we have secured **£2.58 Million in research income** and **£3.13 Million in allied consultancy and CPD**.

Our research strategy is articulated to all members of UoA16 and kept under regular annual review: it is informed by metrics derived from **PURE** on research performance, and monitored targets and KPIs e.g. journal outputs, PhD completions, and applications to "blue chip" funders, helps guide our progress. Membership of The Glasgow Research Partnership in Engineering (GRPE) links our research with complementary activities at other West of Scotland universities: funded by the **Scottish Funding Council** (SFC) and the Universities, it has helped create new academic posts, collaborative research studentships and built thriving strategic research groups in environmental rehabilitation and other areas relevant to individual partners. A key component of the Scottish Research Partnership in Engineering (SRPE), GRPE has supported pan-Scotland interdisciplinary research and knowledge exchange including: developing new moisture laboratory facilities; increasing Fire Risk Engineering staffing and resources; making CICStart online fully operational; co-organising International conferences e.g. COBRA, CIBW92, PRoBE, W078; and activity within **The Scottish Construction Convention** and **The Telford Institute** have all helped our presence on the wider stage. Funding from bodies such as: The Scottish Executive, **the Health and Safety Executive**, Energy Technology Partnership, industry, and generally widening the grants base have helped ensure a sustainable research unit **which has 10 up and coming researchers** (not included in REF2014).

Three pan-University multidisciplinary research institutes have been created as foci for thematic research across discipline boundaries. Specifically related to this submission is **The Institute for Sustainable Engineering and Technology** (ISETR) which supports and promotes research excellence within the School of Engineering and Built Environment; encompassing three cognate areas: Interactive Systems and Communications, Engineering and Energy Systems, and of particular relevance to this submission, UoA16, Sustainability in the Built Environment.

b. Research strategy

As noted earlier, ISETR provides supporting activities that aid the three research areas within UoA16 achieve the university's mission of **'common weal'**: Construction Management and Economics (CME) has as its Research Leader: Professor James Sommerville: the group investigates construction projects and how they are delivered (Baker K, Cameron, Craig, Dimitrijevic, Hare, Kumar, Lowe, Sanderson). Specific REF outputs have been given and these are supplemented by other works in specialisms such as: planning of projects; management of resources; protection of human life; process design and control; health, safety and environmental management; quality approaches and defects minimisation; materials and logistics control; building design and utilisation; and, IT systems for construction.

Sustainable Urban Environments (SUE) has as its Research Leader: Professor Rohinton Emmanuel: the group investigates and informs policy and practice of whole-life sustainability of built assets, from design to demolition and eventual reuse, at scales ranging from individual buildings to neighbourhoods and cities (Baird, Baker P, Burek, Jafry, Ramirez, Teedon, Thomson). Expertise includes: building performance; energy performance for building rehabilitation; sustainable building materials; fire risk and risk analysis; social and economic performance of cities; impact of climate change on buildings; urban climate; solar energy capture and use, sustainability assessment and knowledge; process management to deliver sustainability; and, environmental technology and management.

Environmental Technology and Management (ETM) has as its Research Leader: Professor JiaQian Jiang (from UoA15): the group's research includes extensive expertise and experience that ranges from advanced environmental remediation technologies and policy and regulatory impact assessments (Baker P, Hytiris, Klemm, Jiang, Mickovski). Research projects and activities focus on: treatment of water and waste water, recovery of heat from mine-water, oxidation and absorption: enhanced removal of micro-pollutants, nutrients and heavy metals, microbiological evaluation, Eco-toxicity assessment of micro-pollutants; low-cost treatment of water developing countries; nutrient loads in agriculture and, stabilisation/solidification and composition.

Post RAE 2008, UoA16 took the opportunity to focus its research areas and recruit, retain and develop outstanding researchers to further a research culture that **embeds the Concordat to Support the Career Development of Researchers** and facilitates the highest achievements, whilst encouraging original work and innovation, and enriches our students' learning experience. We are aided in this effort by our new Institute for Sustainable Engineering and Technologies.

UoA16 is committed to producing and disseminating research which adds to the common good through practical application, moving public policy and economic activity such that it has a real and beneficial impact on lives and well-being in Scotland, and further afield. The Research on Indoor Climate and Health (RICH) centre has focused our delivery to, and engagement with, industry. Our **research strategy** has the following key objectives:

Ensuring the unit's research is geared towards delivering practical benefits and impact for society by developing research that addresses national and international priorities in collaboration with private, public and third sector organisations; http://safer.design.officelive.com
Generating innovations by collaborating with colleagues at interdisciplinary boundaries (via mechanisms such as our Institutes); such "crossover" creates innovations at knowledge boundaries, strengthening and unifying themes between the groups;
Developing an increasingly dynamic and structured research culture and environment;
Strengthening international collaborations that aid development of sustainable built environments by widening our range of collaborators, shaping strategy, recognising and adopting best practice from the likes of Stanford and Hong Kong, and recognising that solutions are often culturally contextualised.
Developing new approaches to partnership working with the many beneficiaries of our research to enhance impact e.g. through Mainstreaming Innovation http://www.mainstreaminginnovation.org/content/home/1/
Reinforcing research impact, reputation, and relevance through building structural collaborations with policy and decision makers, service providers, and expand our good relationships with government agencies across a variety of countries; and,.
Enhancing and augmenting the development of the next generation of enquiry-led graduates through research-informed teaching.

Compared to the position at RAE2008, it can be seen that we have consolidated and enhanced our strengths:
• We have increased the number of staff whose outputs are eligible for consideration from 12.3 FTE in RAE2008 to **21.6 in REF (a 76% uplift)** and secured **in excess of £2.58 Million** funding;
• The number of outputs put forward for consideration (**86**) has increased accordingly, with a strong focus on quality journal publications including: **63 journals and 23** others e.g. books, book

chapters, e-conferences, or reports.
• PhD completions have shown an annualised increase of **40%** within the REF period**:** even though 6 completions are lost in the twilight period from 1 Jan to 1 Aug 2008, and the school completion rate, **within four years, is 86**%.

Our research strategy over the next 5 years has been shaped in the context of (1) greater internationalisation of research activities (2) innovation in research methods (3) increasing the variety of funding models addressed and utilised and, (4) how we disseminate and transfer our knowledge. We will build on the current research platform and strengths. Over the next five years we will promote excellence and growth in the thematic areas (CME, SUE and ETM) by investing in new academic staff; by promoting collaboration between our researchers and research partners nationally and internationally, and proactively engaging in dissemination and knowledge transfer through the RICH centre.

Consequently, we have identified the following four critical drivers of our future research:
• Developing and integrating streamlined construction processes relevant to dynamic construction supply chains i.e. in competitiveness, sustainability, technological advances and, internationalisation (e.g. 'Improving construction safety: reducing accident rates' case).
• Driving forward sustainable built environments in relation to their physical environmental dynamism (bearing in mind climate change imperatives, and to optimise the use of scarce or dwindling resources: irrespective of whether the scarcity be taxation/fiscally driven or occurrence driven. The Sustainable Urban Environments program (EPSRC funded) facilitated representation at national and international conferences on whole life urban sustainability and its assessment (e.g. 'Driving Sustainable Waste Management practices in Scotland' case).
• Focusing on zero and low carbon buildings and the impacts on humans through the work of the RICH Centre (e.g. Improving the Thermal & Moisture Performance of the building stock case). designing technologies to achieve zero and low carbon buildings, enhancing methods for evaluation of actions, and carrying out evaluations of approaches to 0/Low c.
• Encouraging curiosity-driven research, providing our researchers with the freedom to explore ideas within the strategic priority and emerging areas.

We are well positioned to address these drivers given our robust contacts with industry where we have secured some **£2.58 Million of research income** and £3.13 Million of industry relevant income through consultancy and CPD; also we have 80 industry sponsored students per annum (valued at over £390,000); and, our degree programmes currently attract 64 industry funded prizes from 36 differing well known industrialists e.g. Balfour Beatty, BAM, DTZ, GVA Grimley, Lend Lease, Jones Lang LaSalle, Sweet Group, Turner & Townsend, and other local industrialists who have engaged with us in research activities. The **prizes** also include awards from Bahrain (Cebarco) and our international reputation will be expanded through our college in Oman (CCEO), links with institutions in France (ESTP); China (University of Jinan); Qatar (Fire Training College); New Zealand (Auckland University of Technology); and, USA (Arizona State, Penn State, Stanford), reinforcing the international collaborations described earlier.
The four drivers of our research over the next five years will operate in the context of (1) greater internationalisation of research activities (2) innovation in research methods (3) increasing the variety of funding models addressed and utilised and, (4) how we disseminate and transfer our knowledge.

We are supported by ISETR whose role includes: identifying and disseminating international and national research priorities as identified by the Technology Strategy Board, Research Councils and Horizon 2020; promoting cross-disciplinary research over the institute themes, and collaboration with industry. It has **internal and external Academic Advisory Boards** (which draw from departmental advisory boards within cognate areas ensuring direct industrial relevance and contact: e.g. BAM, Brookfield, EC Harris, Sir Robert McAlpine, Balfour Beatty, others). The remit of the Boards being to provide guidance on strategic direction, quality of outputs, and targeted responses to research priorities. ISETR funding is provided for up to 5 PhD studentships per year for projects that can demonstrate strong and strategic academic and industrial links and promotion of research quality. Our efforts are also supported at institution and school level by a **PVC**

Business Development (BD), an Associate Dean BD, and BD managers.
Our Research on Indoor Climate and Health centre (managed by **former BRE staff**) acts as our direct industry facing research contact point (feeding all three research thematic areas), along with the Adjudication Reporting Centre (CME), allowing us to develop research capacity and create opportunities for engagement with stakeholders, communities and businesses. At the International level, research collaborations encompass a range of partners allied to each of the research thematic areas including e.g.:
• in CME there are **13 collaborations** across Africa, Asia, Australasia, Europe, Middle East, North America, South Africa (these are discussed in more detail in the collaboration section);
• in SUE: there are **10 collaborations across** Europe, Middle East, and Scandinavia; and,
• in ETM: there are **3 main collaborations** with IUT Josef Furrier University, (Grenoble); University of Jinan (China); VIA University, (Denmark).

These collaborations and appointments of Visiting Professors includes e.g.: (CME) Prof. S Rawlinson (Health and Safety, Hong Kong), Prof. V Brannnigan (Fire, USA), Prof. S O Cheung (CME, Hong Kong), Prof. A Gale (Health and Safety, UK), Prof. D Kashiwagi (BIM, USA), Prof. W Maloney (Health and Safety, USA), Prof. R McCaffer (Project Management, UK), Prof. C Egbu (Construction Management, UK), Prof. C Anumba (Building Information Modelling, USA); (ETM) Prof. D McStay, Prof. A Levy, Prof. J Choi and Dr G Masterton OBE (former President of ICE – Project Management). These links have been nurtured and developed and support the wide range of UK partner institutions collaborated with over the period; all of these linkages foster inter-disciplinary working in areas such as project management, BIM, sustainable waste management practices, health and safety, and wellbeing. all help in contributing to grant applications, project implementation, publications, dissemination and international collaborations. Internally, UoA16 has collaborated with researchers within the Institute for Applied Health Research in addressing the issue of **hospital acquired infection** (HAI). Also, work with colleagues within the Institute for Society and Social Justice Research (UoA36) on communication to **migrant workers** on H&S issues in construction about the use of language translations playing a role in maintaining and developing a form of **cultural citizenship**.
A paper accepted for ASCE by Hare, Cameron, Real & Maloney (2013) Exploratory Case Study of Pictorial Aids for Communicating Health and Safety for Migrant Construction Workers, Journal of Construction Engineering and Management, exemplifies the relationships. The developments indicated above, together with the broad span of collaborative disciplines within the unit, fosters cross-fertilisation of research areas, provides evidence of our strategic progress since the RAE2008 submission and shows a vibrant, forward-moving, research culture.

c. People, including:

i. Staffing strategy and staff development

UoA16 fully endorses and utilises 'The Concordat to Support the Career Development of Researchers' and gives due recognition to the importance of recruiting, selecting and retaining researchers with the highest potential to achieve excellence in research. In doing so, researchers are openly recognised and valued as an essential part of the human resource pool and vital components in achieving the university's overall strategy for development and delivery of world-class research. The recent **award** of the **HR Excellence in Research Award, by the European Commission,** recognises our adherence to the principles of the European Charter for Researchers and the Code of Conduct for their Recruitment (including Early career Researchers, ECR). All our researchers are supported in their efforts to be flexible and adaptable in what is an increasingly global, diverse, and mobile research environment. Their personal and career development, and lifelong learning, is recognised within our Professional Development and Review process (PDR, discussed later) and promoted at all stages of their valued career. Individual researchers take, and share, responsibility for being pro-active in engagement within their life-long learning, career, and personal development.

Diversity and equality is promoted in all aspects of the recruitment and career management of all of our researchers and PhD candidates. We strive to ensure that our regular and collegiate progress reviews strengthens the attractiveness and sustainability of research within UoA16. The University's **Equality and Diversity and Dignity at Work** policies and practices are deployed

across all aspects of the recruitment, career management and exit of all of our researchers and PhD candidates. The policies ensure that each person is treated equitably and with respect and that decisions made are transparent and sound. All staff subscribe to these policies and undergo engagement and training to ensure that individual and collective approaches to such matters are robust. All university policy documents are available on the GCU website. Local champions lead the implementation and raise awareness of the policies. The University continues to be an active member of the **Athena SWAN** *Scottish Regional Network and we will submit our application for the* ***Athena SWAN bronze in April*** **2014**. Our REF submission (across all UoA's) will be underpinned by our institution's high percentage of **female professors (33%)** compared to a sector average of 20.5%: in **UoA16 we have 29% female** professors which sets us well above the HESA published values for professors. In terms of inclusivity and diversity, vis-à-vis **part-time staf**f, we have doubled the number of staff being submitted in the overall cohort.

Researchers submitting work for external consumption engage in our **Peer Review process** which seeks to aid them in ensuring their work is high standard. The University has actively enhanced support for the PGR student community by creating an institution wide Graduate School. It has the task of integrating the PGR culture and works with all supervisory teams to plan and deliver research training programmes **aligned with the *Vitae Researcher Development Framework*.** All PhD students must satisfactorily complete a **research skills programme prior to completion**. The University Higher Degrees, and Ethics committees, oversee the process of progression though to the award of research degrees. The Graduate School is currently piloting, **in partnership with the University of St Andrews**, a new system to support mentoring for research staff across the university. Mandatory courses are also run for research postgraduate supervisors The ***Caledonian Research Excellence Development Opportunities (CREDO) supports*** more experienced staff and the CREDO programme offers interactive mentoring workshops aimed at supporting the development of a culture based on international research excellence and addressing nascent research strategy and policy initiatives. Staff performance is assessed annually via a formal appraisal process. The University has also engaged in cross-sector research staff development and sharing of training provision via the Scottish Researcher Career Developers Forum.

In terms of career development support, ECR's are supported through Subject Groups (support and mentoring by established staff): the Subject Group and Research Group Leaders (S/RGL) advise the Head of Department on **appropriate relief from normal duties** to allow the ECR to focus on their outputs. A **managed round of development & performance** reviews take place between the ECR's and their S/RGL, usually at the beginning, mid, and end points of an academic year. Formal, confidential, records are maintained and submitted to the university's HR department. In 2010 the Graduate School received a UK **Times Higher Education Award** for its Outstanding Support for Early Career Researchers. In the recent HEA Postgraduate Research Student Survey (2013), **82% of postgraduate research students were satisfied with their student experience**.

With the merger of two academic schools to form the School of Engineering and Built Environment, and the appointment of an Executive Dean/Pro-Vice Chancellor, so the increase in physical facilities and central support service has enabled researchers to focus on specific work and to utilise these enhanced facilities e.g. laboratories, technicians, funds. The staff complement has been bolstered by recruitment of specialist researchers in sustainable urban environments e.g. Emmanuel, Thomson, and Philipson. Staff mobility fosters broadening of the research base: to this end we have encouraged and supported links with a range of institutions where they complement our research activities in CME, SUE and, ETM and are discussed in the collaboration section.

ii. Research students

All PhD candidates have a Director of Studies appointed at the outset of their journey, along with a number of academic/mentor Supervisors. All Directors of Study and Supervisors have secured PhD's in their own cognate areas and undergo initial and ongoing training in the guidance and management of PhD candidates. The **Graduate School** at Glasgow Caledonian ensures that this training regime is consistent, coherent, and fair across all disciplines. The supervisory team are encouraged to facilitate their candidates attending and presenting at colloquia, symposia,

conferences, and publishing in respected journals, and embedding employability skills.
Support for postgraduate students, via the Graduate School, includes the provision of a workshop programme for researchers that has been recognised by a **THES award** and which is aligned with the **Vitae Researcher Development Framework**. The Graduate School operates dedicated facilities which create a sense of community in which postgraduate students can mix across disciplinary boundaries leading to an enriched research experience. Postgraduate research facilities include new laboratories with environmental chambers and a suite of furnished workstations, each equipped with top-of-the range computers and storage facilities. The Graduate School offers specific research skills training including an academic writing centre and utilises both internal and external facilitators in workshops: it also supports an MSc programme in research methods and a professional doctorate programme. **All PhD students** must formally, and satisfactorily, complete a research skills programme prior to completion.

The PhD completions were **66% male, 34% female** and the ratio of **international to home** is also 66% to34%: the school has a total complement of some 180 PhD candidates which provides a depth of experience for each of the candidates. Of this total cohort, UoA16 has some **63PhD** candidates of whom **79% are male, 21% are female** and the ratio of international to home is also 79% to 21%, reflecting investment and planned growth of postgraduate research provision. This growth has been aided by the recruitment of new staff with specialised expertise. Also, our weekly research seminars series provide a platform for external and internal speakers to interleave with presentations of work on progress by research students. Allied to this body of candidates there is a per capita budget for travel and development which fluctuates around £1,000 per annum per person. PhD candidates are encouraged to disseminate their research to the wider academic communities by publishing in a range of refereed journals and through attendance and presentations at national and international conferences, for which full provision is made for. We have a lively CIB Student Chapter through which research students maintain active international links. One of our research students **won The Association for Project Management, Herbert Walton Award (sponsored by BAE Systems) for the best PhD thesis, 2013**. Our other research students have been **Winners of the CIB Guyla Sebestyén** Award and the CIB Chapter organises regular seminars, doctoral workshops, and social events, which bring together students from the UK and overseas.

GCU is one of Vitae's original university partners that helped create the Researcher Development Framework RDF to give guidance to researchers across the UK developing their research careers: we were instrumental in the creation of the Scottish Researchers Career Coordination Forum (SRCCF) (2009 to present) and currently convene it.
http://www.sfc.ac.uk/research/researcher_career_development/researcher_career_development.aspx GCU is newly elected convenor (2013 – 2016) of the Universities Scotland Research Training Sub-committee which focuses on the development of strategy, policy and planning in the area of research development, providing advice to Universities Scotland and Scottish Funding Council. All UoA16 staff are directly involved in doctoral programmes and in wider PG research student development i.e. **96% of the submitted staff** have successfully supervised a completion and/or are currently involved in supervision of PhD candidates.

d. Income, infrastructure and facilities
Over the period covered by the REF, the unit has secured some **£2.58Mn** from **research funding** bodies including FP7, SEEKIT, REMADE, NHS Scotland, HSE, and KTPs, (Baker, Burek, Cameron, Craig, Emmanuel, Sommerville, and Teedon). Our **Impact Case Studies** show how the research outputs have brought about change in the wider environment and the supporting text to the outputs shows that **9** derive their funding from 'blue chip' UK sources, **7** from EU funding, and **9** from UK/USA government departments. Also, the unit has generated over £3.13 Million from consultancy and CPD directly allied to our underlying research, with clients ranging from Strathclyde Fire and Rescue, to BVT, Howden, Scottish Water, Knauf, City Building Engineering Services, local authorities and many smaller organisations. During the assessment period we have carried out over **100 CPD events**, driven by underlying research, with some 3,600 participants from a range of industry practitioners and researchers. These events help inform us of industry needs and ally us with individuals and organisations whose research needs tie with our capabilities. http://www.cicstart.org/content/knowledgebase/250/
In relation to the facilities available to researchers, the environmental chambers within GCU

(unique to the northern UK) are fully operated and maintained to a level where we can undertake industry specific research and consultancy (£125,000 upgrade) and at the same time provide opportunities for 'blue-sky' work. The chambers are supported by full-time technicians who encourage researchers to fully utilise the infrastructure. Allied to these we have invested significant sums in thermal other imaging technology. The University has also invested over £130 K in desktop information systems to support academic staff in their research activity. The PURE and Digital Commons research information systems are used to manage research group activity and to monitor progress by capturing and associating research activities in relation to publications, impact, esteem funding applications, projects and press clippings. As an institution, we spend 47% (£1.6m) of our library budget on information provision, 84% of this spend is on access to electronic content (SCONUL mean for 2012/13 is 77%). We were early adopters of **EThOS** (Electronic Theses Online Service) and have more than 300 PhD theses digitized and freely available for download. Since 2007/08 our users have downloaded over a million articles every year, and in 2012/13 over a million ebook chapters. We have refurbished much of our physical space for research use e.g. the environmental chambers £130,000, and created a new PhD students room, a dedicated IT research lab as well as enhanced office space, all estimated at between £500,000 and 600,000. Since 2008 the University has made **over £2.3 Million** of strategic investments in infrastructure and capital projects to support research activities within the school and invested over £650,000 in staff development for research active staff to support travel to conferences, Doctoral Studies and CPD courses.

The Construction Improvement Club (CIC) Start Online (collaboration between **7 Scottish** universities, led by UoA16, was funded by the European Regional Development Fund and Scottish Government): supporting interaction between academia and SME's in developing innovations for sustainable building design and refurbishment. CIC Start Online was listed among the **top twenty** projects in the Scottish **Green List 2010;** it was **also shortlisted among ERDF** funded projects for best partnership working and best contribution to a "greener" Scotland. It has attracted **over 1,790** members (from in excess of **1,200** organisations of which over 600 are Scottish SMEs) across the UK and in **46 other countries**. It has supported 50 feasibility studies and 20 academic consultancies undertaken for the benefit of Scottish small to medium size enterprises (SMEs). http://www.cicstart.org/

e. Collaboration or contribution to the discipline or research base

1• In terms of interdisciplinary research:

Collaboration with **other disciplines**, specifically; engineering, agriculture, material science and climatology. Our **EPSRC funded** SUE-MoT project partners included Civil Engineers from University of Dundee, Loughborough University and, St. Andrews University. We are involved in: Civil Engineering with The Federal Technological University of Parana, Brazil; Lund University, Sweden. Our staff development and travel budget encourages national and international networking, which has resulted in collaborations with The Federal Technological University of Parana, Brazil and Lund University, Sweden. Recruiting international academics has brought collaborations as follows: Material Science – University of Salento, Italy; Climatology – University of Freiburg, Germany; sustainability in geotechnics; hydrology, geology, landscape architects, town planners, material scientists, drainage engineers, agricultural engineers, foresters. Recruitment of industry practitioners has yielded collaborations with others e.g.; Ministère de l'Agriculture, WASWC, France, Landcare Research, New Zealand, Halcrow Group Ltd (a CH2M Hill company).

2• In terms of existing networks and clusters and of research collaborations:

Co-founders and correspondent at the International Network of Soil Bio- and Eco-Engineers (http://inbe.cirad.fr/). Established working relationship with Scottish Govt., resulting in consultancy advice services to the Community Analytical Services Division (CASD); and contribution to policy review in energy efficiency in buildings. Work with the Glasgow Clyde Valley Green Network Partnership (GCVGNP) led to the urban overheating adaptation strategy. Partnership with Scottish Power capturing energy from mineworkings, has **led to new academic collaborations** (CIRAD, France; INRA, France; Utrecht University, M. Ghestem, Ministère de l'Agriculture, France).Long-term partnerships with Heriot Watt University has led to: The Highly Efficient Anidolic Concentrator Solar Thermal System (HEATS): Energy Technology Partnership – ETP, and Low energy consumption illumination sources based on collimating optics.

3• Evidence of national and international academic collaborations:
Examples of staff working with the broader discipline include: Hong Kong (Rowlinson) secured HKRC funding; University of Kentucky (Maloney) to produce papers (2 x ASCE published) and funding bids (£114k funded to date); Penn State (Anumba) to develop a BIM centre; Auckland (Sommerville & Craig) producing papers and funding support and Journal of Construction.

4• Seminar series, contribution to journals, and conferences and research-based CPD:
Int. J. of Advances in Engineering Software (Kumar), Int. J. of Advanced Engineering Informatics (Kumar), Engineering, Construction and Architectural Management (Sommerville); Scientific committee memberships: 20 for conferences or workshops held outside the UK. This excludes committee memberships of annual conferences of e.g. ARCOM, COBRA. Members of the Knowledge-Based and Intelligent Information & Engineering Systems (KES) Journal Review Board. **SUE-MoT international conferences** have been hosted at Loughborough University: conferences achieved over 100 international delegates. The Journal of Urbanisms: International Research on Placing and Urban Sustainability held a special issue showcasing improved versions of the best papers submitted to the 2009 conference. The E & T project held two large workshops in 1) **Royal Statistical Society** (London), 2) Loughborough University, approx. 50 senior industry attendees. These were dissemination events /CPD for those from industry and policy circles. A presentation by Thomson (2010) at EPSRC project (SURegen) resulted in 1 year secondment (2 days per week) to develop/deliver a work package held by University of Dundee. This represents the transfer of knowledge from one EPSRC project to another of which GCU were not a partner in; .Journal editorship (special issue): Int. J. of Climatology (vol 27, issue 3); J. of Urbanism (vol. 3, issue 3); J. editor: Built Environment – Sri Lanka (10 years); Scientific Advisory Panel Member – 7th Int. Conference on Urban Climate (ICUC7, Yokohama, Japan); 8th Int. Conference on Urban Climate (ICUC8, Dublin).

5• Contribution to professional associations or learned societies:
Staff are Research Grants Reviewers for: EPSRC (12 staff), BBRC (Pahl), EU, Executive Agency (Sommerville). The staff participate /facilitate the Scottish Construction Convention Workshop on Winning New Business; CIOB Conf. of Sustainable construction, Chairing Herald / RICS Property Awards; Scientific Committee for ARCOM; Scientific Committee for RICS COBRA: and actively engage in CIB Task Groups and Working Commissions: TG 67, W014, W065, W099, W102, W108, and W116. Staff **Peer review** for a range of journals e.g.: Construction Management & Economics, Building Research & Innovation, Engineering, Construction and Architectural Management, Int. J. of Project Management, Int., Ecological Engineering, Plant and Soil, European J. of Soil Science, J. of Flood Risk Management and, J. of Geophysical Research.

6• In terms of co-operation and collaborative arrangements for PGR training:
External examining for MPhil/PhD qualifications: Burek (UK), Craig (UK), Emmanuel (Sri Lanka, UK, India), Kumar (India, UK and USA), Sommerville (UK and New Zealand), Hosts for post-doctoral / sabbatical visitors from Brazil for 1 year each, and hosted 6 exchange students as part of the IAESTE / Science Without Border (Brazil) and Erasmus Exchange. Staff undertake Secretariat for the Int. Assoc. for Urban Climate, have relationships with Lahti University of Applied Sciences (Finland) ERASMUS programme, led to the successful development of an ERASMUS Mundus Curriculum Development Grant with the University of Salento (Italy). Working with Prof Dawood of Teesside University in Building Information Modelling (BIM) resulting in joint PhD supervision (2 x GCU; 2 x Teesside) and joint bid proposals. Prof Bill Maloney (University of Kentucky) collaborating on EPSRC, HSE and CITB bids (Cameron/Hare as PI's), assisting with PhD'. **Cross discipline** (extending beyond construction): Renewables industry, corporate member of Renewables UK, forging links with their H&S Committee. This has resulted in collaboration on PhD research extending previous research on work at height to the wind turbine industry, as well as joint consultancy with Hightec (a work at height training provider) on developing work at height standards for the industry. Waste industry: involved with the Waste Industry Safety & Health (WISH) Forum, working extensively with Local Authorities (e.g. Glasgow City Council; Aylesbury Vale District Council (AVDC)) on safe methods of waste collection. Specific research on Musculoskeletal Disorders arising from waste collection methods has led to PhD supervision of AVDC safety personnel.