Institution: University of Greenwich

Unit of Assessment: (UoA 16) Architecture, built environment and planning

a. Overview

This unit of assessment (UoA) is based in the School of Architecture, Design and Construction which delivers research- and professionally-driven taught programmes at undergraduate and postgraduate levels. In response to the University's strategic plan and in order to realign itself to the teaching and research demands of the future, the School has recently been reorganised with an influx of fresh staff. At an institutional level a new faculty structure has been established. The School is now within the faculty of Architecture, Computing and Humanities and one of the main current research initiatives is to seek out cross-discipline research projects and capitalise on collaborations between the faculty research groups.

The research agenda within the University is led by the Deputy Vice Chancellor for Research and Enterprise who chairs the University Research and Enterprise Committee (R&EC). Directors of research and enterprise for the constituent faculties and institutes of the University are members of the R&EC. Each faculty and institute is accountable to the R&EC through an annual report and strategic plan. Each faculty operates a research degrees committee which oversees postgraduate research programmes in the faculty and reports to the University R&EC. The University's research is also guided by a research ethics committee.

The School of Architecture, Design and Construction provides teaching and learning which has resulted in the award of professional qualifications of proven excellence; new staff appointments will therefore tend to be research and professionally driven. Newly appointed and well-experienced members of staff are actively encouraged to undertake research by attending conferences, presenting papers, publishing their work, and ultimately to register for research degrees as a means of promoting their research.

This submission is based on two established research groups that carry out research in the School of Architecture, Design and Construction:

- Sustainable built environments research group (SBERG) (including sustainable landscapes)
- AVATAR (Advanced Virtual & Technological Architectural Research)
- The groups represent research and academic interests across the School and provide leadership and mentoring to capitalise on individual research aspirations and develop a corporate research strategy. Research professors in the groups provide leadership and mentoring.
- The focus of the research is on applications to solve real-life problems experienced in the built environment.
- The research achievements are complemented by the strong professional ethos manifest in the quality of taught courses in the Schools which have succeeded in gaining excellent results from all HEFCE/QAA inspections. These have also been accredited by the key professional institutions.

b. Research strategy

The research structure for the UoA

The two key research groups comprise all research active staff and postgraduate research students in the School. These six members of staff are being returned as internationally research active. The submission involves a range of disciplines in the built environment and projects have a strong interdisciplinary emphasis. Professional, industrial and commercial bodies are associated with the research projects, as are overseas and national government agencies. Many projects have practical and professional applications and have attracted extensive funding.

SBERG builds on extensive collaborative experience, for instance on an Engineering and Physical Sciences Research Council (EPSRC) sustainable environments consortium. This has EPSRC funding of £1.6m which included four principal universities (Greenwich, Imperial College, Reading and Southampton) and 40 industrial/public-sector organisations led by Ove Arup. SBERG has a research subgroup in sustainable landscapes which has research initiatives in sustainable

landscape architecture. This group is led by **Professor Keith Jones** who is on the REF panel and a member of the EPSRC review college.

The second research group is AVATAR. **Professor Neil Spiller**, the Dean of School leads this. Over recent years AVATAR has grown into an international research collaborative centre. It attracts students from around the world and a critical mix of cultural, aesthetic and social agendas are encouraged.

A new area of research expansion is related to a new department called 'Design Futures' which extends research into digital design areas. Also significant at the moment is the move of the School to a prestigious new building in Greenwich within the World Heritage Site. This purpose-built new structure will reflect the esteem and aspirations of the School and provide space for research and development. The move will take place in 2014.

In the 2008 research assessment exercise (RAE) the School's research profile placed it second in terms of the various RAE submissions within the University and placed it well above many of its traditional competing universities nationally. The research profile was:
- Category 4* – world leading research 10%
- Category 3* – internationally excellent 30%

In detailed feedback the RAE 2008 panel judged nearly half the research outputs to be world leading or internationally excellent.

University research strategic plan
The University of Greenwich strategic plan is implemented through the School strategic plan and drives the School's research and enterprise strategies through the two research groups. The University of Greenwich is a strongly research-informed institution. The strategic plan (http://www.gre.ac.uk/governance/vc/strategic-plan-2012-2017) aims to build on its success so far in creating this research-informed environment to increase the quality, volume, and intensity of research activity. Key themes of current and future strategies are:
- to ensure that the University has a critical mass of excellent researchers through the appointment and retention of high-quality staff
- to develop at least 20 research groups with an international reputation for excellence as measured by the significance, originality, rigour and impact of their work
- to develop a vibrant community of high-quality postgraduate research students
- to increase the national and international impact of its research.

Progress and initiatives to complete this strategy are discussed in subsequent sections.
The University structure includes a central support organisation, Greenwich Research and Enterprise (GRE) which provides administrative control and support of research and enterprise in the University. They resource meetings and workshops related to developing and operating research projects and provide staff development programmes. In addition they have specialist staff to help with bidding and funding, including particular areas of funding such as EU funds and knowledge transfer partnerships (KTP).

Research groups and strategy
The key research strategies agreed by the research groups in the School are to:
- Develop interdisciplinary activity, developing research across traditional boundaries that will enable us to enhance our research strategy and gain esteem.
- Develop collaboration with other universities, employers, public sector and professional organisations to foster industry-facing research.
- Encourage and support staff to become research active, plan for a research intensive career and ultimately apply for readerships and professorships within the institution.
- Mentor new and existing staff in order to fulfil the above strategies in three directions: to encourage them onto research degree programmes; to encourage the writing up of

research interests and advance professional practice (including the recording and collecting of other media such as art/drawings) and to encourage the development of individual research programmes by attachment to existing research groups.

- Disseminate research findings through research forums and symposia using staff, research students and external experts.

Performance indicators of research quality have been improved since the 2008 RAE. This is most apparent in three areas: the academic status of the publications, the number of completions by research students, and the research income generated in the current research excellence framework (REF) period. The quality of published output has been improved since 2008, particularly in terms of refereed journal articles, chapters in books, and authored books. Successful PhD and MPhil completions have risen to a regular throughput of graduates during the current period and cohort of nine existing research students. The total external income increased dramatically for the RAE 2008 and for this REF will be exceeded.

SBERG
SBERG has three main areas of activity which impact on sustainability: sustainable building, sustainable environments and sustainable landscapes, the latter being a subgroup. SBERG was established in 1998 to provide a focus to researchers interested in improving the sustainability of the existing built environment.

AVATAR
The AVATAR group investigates the full range of impacts of emerging and new technologies on architectural design and encourages a critical mix of cultural, aesthetic and social agendas through design. The research group is organised into five sub-specialties: digital technology and surrealism, synthetic biology, film and video, interaction and digital manufacturing. The group has built up a rich portfolio of high profile, international, interdisciplinary partnerships that actively contribute to the research.

More details on the research groups, collaboration and contribution are included in the section 'Collaboration and contribution to the discipline or research base'.

c. People, including:
i. Staffing strategy and staff development
To increase research activity among staff at 1* and 3*/4* in accordance with the School plan (s.2.1) we have consolidated all research activities in the two key research groups and linked resources to them. New and developing staff are linked to the groups for mentoring. The groups provide a 'buddy' system for bidding, publishing, supervision of research projects, and development of staff for postgraduate research student supervision. The recruitment strategy encourages new staff who are research active. A recent School reorganisation has evolved new contracts for staff including those that cover research active staff who have a smaller teaching commitment (30%) and teaching staff who also carry out research (30%). Staff appraisals reinforce these activities and set targets for staff in terms of PhD completion, publication or research income targets.

A consistent balanced academic workload model is operated across the University which is designed to provide each member of with dedicated time for research work against research development goals which are agreed with departmental managers. The University also operates a sabbatical programme which allows staff members to take periods of time to concentrate on particular research projects, or to develop their research experience by working at other institutions (http://www2.gre.ac.uk/about/policy).

To increase the numbers of internationally excellent research active staff, the University has organised a recruitment campaign to attract established professors and readers from other institutions. This recruitment campaign is continuing on an international basis. Research fellowships are available to international researchers and a programme related to research exchanges of staff from collaborating international universities has been initiated. New staff are appropriately inducted and this will include an introduction to key people and support in the research areas across the University and in the School itself.

To increase the number of doctorate-level staff we are recruiting new staff with PhDs and encouraging staff to take on PhD research projects through mentoring in the research groups. Staff are also being mentored in publication, these publications then being peer reviewed with feedback in the groups to raise standards of publication to 3*. In some cases those with a good publication record are being enrolled into 'PhD by publication' programmes.

To seed fund project and encourage early career researchers (ECR) there are funding streams from the University's central funds. Income is available on a competitive basis and this is useful for new researchers and new areas of research. Researchers bid for funds on the basis of an agreed plan with measurable outputs. Other funds are available on the basis of bidding for capital investment and enterprise activities (higher education innovation funding (HEIF)). These funds can provide the infrastructure on which other research and enterprise can be developed and encouraged. Business development managers are available to each School to mentor staff, especially in bidding, structuring projects and collaborations. In recent years, the University has organised a wide-ranging programme of courses for researchers and ECRs and there is a separate initiative to encourage ECR research (http://www2.gre.ac.uk/research/ecri) which includes awards.

The School's research strategy is to encourage equality and diversity; research meeting are open forums to accommodate ECRs, part-time and visiting staff. Key staff have undergone training on University policies and all involved in the selection of staff for the REF have additionally undergone specific web-based diversity training followed by attendance at specific courses. Those staff that have had career breaks, maternity leave or other consideration which have affected their research careers are mentored through close attachment to the research groups so that they are able to regain their research momentum.

The University supports the career development of researchers through its engagement with the Concordat to support the career development of researchers. It published its gap analysis and action plan in October 2012. Responsibility for working toward compliance with the Concordat rests with the Concordat implementation working group. Additionally, the university received a HR Excellence in Research Award in January 2013 (www.gre.ac.uk/hr/concordat).

From September 2013 the researcher development framework (developed by Vitae, an organization which champions the professional and career development of postgraduate researchers and research staff in higher education institutions and research institutes) will be underway, providing a systemised development tool for researchers from postgraduate through to professorial level. This will help researchers identify their expertise and capabilities, to personalise their professional development and to set themselves targets. This aids the cultivation of all the attributes that make a successful researcher – communication, impact planning, financial understanding, innovation and entrepreneurship. The framework enables the University to have a strategic and coherent approach to researcher development and links up the training that is being undertaken centrally with the bespoke training offered within research units.

The results from the Careers in Research Online Survey and Principal Investigators and Research Leaders Survey undertaken by Vitae have been used to inform the strategic direction of the University in development and leadership training as well as to ensure that equality and diversity is adopted and maintained across the institution as whole.

ii. Research students

The University has a well-established procedure for registering and monitoring approved research degree programmes. The management and administration of research student registration is overseen by a central research degrees committee (RDC). The RDC approves proposed research programmes and supervision arrangements for research students to ensure a research environment in which students can prosper. It monitors their progress, makes examination arrangements and generally assures the quality of the process and student experience. All students are supported by a team of three supervisors; these usually have complementary

expertise and are paired so that experienced research supervisors mentor other members of staff who act as second or third supervisors, and consequently gain experience before they become fully qualified. A third supervisor will have additional experience and will be more skilled in the administration and general development of the students' progress.

In each School and Institute, the Director of Research and Enterprise chairs a research and enterprise committee, which reports to the School/Institute board. Each School and Institute also has a postgraduate research tutor who is responsible for the management and administration of research students within the School, keeping track of their progress and providing pastoral care. New supervisors attend University and School research meetings as appropriate to their new roles. There are regular meetings of supervisors and students related to their projects and research groups and formal research meetings at a school-wide level which students and their supervisors attend.

The school has had five PhD completions over the REF period and several recent successes among graduating research students. One graduate has already established a substantial portfolio of publications and as a staff member was recently successful in the recent round of research funding with a COST (the intergovernmental framework for European cooperation in science and technology) proposal to the EU which brought in £400,000. Another recent graduate has a senior appointment in Vietnam and his project was funded by the Vietnamese government. Another graduate has a patent for an oil pipeline sensor which is being funded by Shell Oil and a further one, already established in industry, is a visiting professor to a leading research university. Finally, a recent graduating student's thesis in facilities management was a finalist in an international competition for theses in this area.

Research student training is provided through the supervisory team within the research groups and by the University (through the research degrees committee) which has set up online resources through its Moodle virtual learning environment. The skills development of postgraduate researchers has been central to the University's and School's research strategy. There is mandatory engagement with Epigeum, the online training company based at Imperial College, for research skills online modules and also modules for preparation for teaching, ethics training and subject specific skills. Careers advice and employability skills are provided through the University's guidance and employability team (see www.gre.ac.uk/get) and Reed Employment who have an office on site. From September 2013 there will be a Greenwich 'Postgraduate researcher development programme' designed specifically as a holistic programme to address the requirements of the researcher development framework.

Statistics for the school show relatively good completion rates for the number of students and, as we increase research student numbers, we ensure we continue to maintain quality through appropriate interviewing procedures and monitoring of student progress. Student progress is monitored by the supervisory team but there is a formal annual meeting which appraises the progress of the student. This takes place with the Director of Research and Enterprise, the Postgraduate Research Tutor and the head of the research group. This leads to the completion of a form which is then passed on to the RDC to show the progress and any problems (problems arising of course will be dealt with at school level if possible before any referral).

As the status and esteem of the research groups increases we are able to recruit more research students. New staff are being recruited with PhDs and with research supervisory experience to increase the numbers of supervisors. New students are also being attracted by a new University-wide PhD scholarship scheme established by the Vice Chancellor which will fund bursaries for good students in each school, and through this two new outstanding students have been recruited. Central funding from the University is also used to fund bursaries for students in certain projects.

To improve the research culture there are regular research seminars within the groups which research students have to attend when required. In addition there are conferences organised by the School and a weekly lecture series. Research students are encouraged to attend these. Social and cultural events are organised for the students by the School, their supervisors and by the

students themselves.
Ethical considerations are dealt with through the research groups and reported to a University research ethics committee which has a membership team from the School. Ethical issues are debated within the research groups before going on to the University Committee where applicable.

d. Income, infrastructure and facilities
The audited income levels are shown in the REF4 statements:

- Audits for the REF show income over the REF period to be more than £1.5m.
- School research and enterprise income has been cyclical and relates to changes in the economic environment and market opportunities among other factors.
- Bidding activity has increased, as has the numbers of researchers bidding, and these have resulted in some prestigious awards (Royal Academy, TSB). Bidding totalled £1.7m in 2012–13 with a total of £4m from 2009–13.

To increase research and enterprise income, bidding strategies are being improved and a key strategy pinpointing funds and sources has been developed. The number of bids and bidders is being increased by mentoring by established bidders in the research groups. Bids are written within the research groups and groups of successful bidders will check the applications. There is also external peer review where advisers from other schools of the University will also check the applications, leading to much better quality bids and more success across the board.

Bidding strategies
SBERG will refocus its portfolio away from general sustainability (not a recognised theme for future funding) to low carbon energy provision (where Research Councils UK have identified £530m of available funding in next five years) and develop international partnerships to bid for EU and international collaborative funding.

Strategies include:
- Joint commercialisation with industrial partners (KTPs and TSB projects).
- Joint dissemination of good practice through professional bodies, government agencies and third sector organisations to encourage collaboration.
- Joint enterprise activities with a network of business-focused users through a practice office.
- Bids including a COST proposal in 2013 on 'Sustainable futures' and work towards a 2020 bid in 2014, while continuing bidding to UK research councils and TSB.

AVATAR has three important strands of bidding:
- Architecture, digital theory and surrealism. 'Reflexive urbanism' is a project being developed with a range of businesses including Shell, British Gas and Arup.
- Architecture and synthetic biology. Bids to EPSRC, TSB and collaborations with Procter and Gamble, Estee Lauder and L'Oréal on living materials and sustainability.
- Architecture and science fiction. The Persephone project acts as a research and development project for the production of novel technologies in product development for the built environment and includes collaborations with Arup and WSP.

Infrastructure and facilities
Research development on the present site has been restricted by space, however a clear research community and culture has been developed with allocated space for research. In 2014 the School will move to a prestigious new building in Greenwich within the World Heritage Site providing space for research as well as facilities for exhibition and dissemination.

e. Collaboration and contribution to the discipline or research base
The School has shown an increase in research and enterprise activity over the REF period and the esteem in which this is held is evident in the prizes, awards and publications. Along with showing academic merit, these have also had a major impact on the professions and industry. We have developed more extensive links with the professions and industry through students' employers, external examiners, community activities and a school advisory board of key employers and professionals. We have developed new programmes to link more closely with industry and provide work placements.

A recent School reorganisation has applied new contracts to some teaching staff to take on industry- and professional-facing roles and the establishment of a project office linked to research and enterprise activities, student projects and placements, has also helped with this. Collaboration and contribution is discussed below under the two research groups.

SBERG's research over the past 13 years has supported the development of a range of outputs that have had an impact across the built environment. Work undertaken as part of the EPSRC projects looking at social housing laid the foundation to the uptake of large panel timber frame construction in social housing. Following on from this project, the research group became part of an EPSRC consortium investigating the role of 'Innovation in the design, construction and operation of buildings for people' (IDCOP). IDCOP was a multidisciplinary project undertaken in partnership with Southampton University, the University of Reading, and 15 large commercial organisations led by Arup. The application of the building-in-use philosophy developed through the EPSRC project was applied to the maintenance planning activities of the Royal Bank of Scotland. Over two years the research team worked with members of the bank's built asset management team to develop a new approach to maintenance planning that better matched the bank strategic business objectives.

The current EPSRC project into community resilience to extreme weather is another multidisciplinary project investigating the potential impacts of climate change on the vulnerability and resilience of communities. The project involves 14 universities and industry/public sector representatives including the Greater London Assembly. Finally, the team also engaged in a multidisciplinary project co-funded by the EPSRC and EoN to examine ways of reducing carbon emissions from homes while retaining levels of thermal comfort.

The Sustainable Landscapes Group (subgroup) has contributed substantially to research in the School. Research carried out by the staff in the landscape department has reached worldwide audiences and publications have become standard reading for students internationally. Past research places the group in a very good position to grasp the opportunities afforded by the new School building at Stockwell Street and the 'Green Cities' and sustainable environment agendas of the School.

AVATAR has generated a number of high profile research projects including: Communicating Vessels (drawings, publications, exhibitions), Protocell Architecture (Exhibition series: Bio Fiction, Hylozoic Ground, Future Venice), Augmented Reality (design with industry) and Living Claddings (collaborative project with industry).

AVATAR regularly publishes in peer review journals across disciplines such as Protocell Architecture AD, Living Architecture TED Book, Kerb Journal (RMIT), Nature and International Journal of Nanotechnology & Molecular Computing (IJNMC). AVATAR exhibits internationally, showing work at the Victoria and Albert Museum, Venice Biennale, Global Design New York University, Natural History Museum, Vienna and often has reviews in cultural magazines. AVATAR attends high profile conferences taking the form of public discussion/debate on cultural and technological themes in conversation with notable commentators. Industrial applications of AVATAR's research include collaboration with the Cronin Group and two paint manufacturers regarding the design and development of carbon fixing paints for building exteriors, ship hulls and electrical equipment. AVATAR is also working with Astudio architects and Yuanda to design a range of model 'living claddings' that may be suitable in a commercial context.

To summarise, the School's agreed external research strategy is to:
- enhance research in the key groups to national and international levels of excellence
- engage with industry, the professions and the community to create outstanding research and impact
- collaborate with other researchers and institutions, national and international, to achieve continuing high quality research.