Institution: Bournemouth University

Unit of Assessment: 34

a. Overview

The National Centre for Computer Animation (NCCA) is a recognised centre of excellence and a pioneer in the establishment of the discipline of computer animation, fusing technical developments in computer science with underlying artistic principles and practice. We continue to develop innovative and creative work across disciplines, advancing technology and its applications; embedding, extending and consolidating core research strengths recognised in RAE 2008. During the 2008-2013 census period this UOA has:

- Received the Queen's Anniversary Prize for Higher and Further Education in February 2012 for our contribution to research and education in computer animation;
- Been described by the NESTA (National Endowment for Science, Technology and the Arts) report, Next Gen. (2011) as a 'a global leader in education and research in computer animation and visualisation';
- Been awarded over £4m in research funding, representing a five-fold increase in external income compared with the previous review period, from £800k in the previous RAE cycle to £4.3m in the current cycle;
- Secured and established an EPSRC-funded Industrial Doctoral Centre (£6.3m) in 2009 jointly with the University of Bath and successfully added a further EPSRC grant (£5.3m) awarded in the autumn of 2013 and to extend this significant development from 2014-2022;
- Supported a three-fold increase during this period in doctoral student numbers compared to RAE2008 from 10 in the RAE period to 28 in the REF and with completions increasing from 2 to 13 (Section c.ii).

This submission reflects the work of two centres, the Computer Animation Research Centre (CARC, led by Zhang) and the Experimental Media Research Group (EMERGE, led by White). The CARC, as the research arm of the NCCA, consists of the Computer Graphics and Visualisation Research Group, the Modelling Animation Games and Effects Group and the Visual Research Group. EMERGE links animation and digital media to a wider array of experimental arts practice and incorporates interdisciplinary research across the Media School. All research groups are active participants in both the Media School Research Committee and its Research Degrees Committee, contributing to and informing the development, monitoring and implementation of our research strategy. There is Professorial representation from across the UOA on the Media School Executive Management team.

b. Research strategy

Our research strategy during the last five years has built upon the approaches and principles laid out in RAE2008, which defined computer animation as an academic research pursuit, an art-form and an industrial discipline. These principles underpin our research direction, investment and support strategies. We have continued to produce a creative blend of art and science in applied projects, supporting arts practice-based cultural explorations and driving the active development of relationships with industry (Section e). In the period we have invested QR to support individual researchers as set out below, while also allocating QR (30% annually) into the specialist research groups across CARC and EMERGE, supporting groups' objectives around public engagement, project development and dissemination and international networking. Strategic investment in staff time has provided a carefully managed environment for researcher development, reducing teaching loads during the census period for ECRs and between 2008-10 supporting transitional salary costs for eight researchers as they progressed from Research Fellows into permanent posts ultimately being absorbed after 2010 into the Media School staff budget. Concurrently we have invested to increase PGR numbers and pursued PGR development via significant grants, notably an AHRC Capability Studentship Grant in 2009 (White; 2009) and an EPSRC Doctoral Training Centre (2009) with a further EPSRC grant in 2013 to continue this (Zhang). We have benefited from institutional initiatives to increase and enhance PGR activity (fully- and match- funded VC Scholarships; Section cii) and supervisory capacity. These grants and investments have

supported a three-fold increase in PGR numbers in the NCCA, have enhanced PGR experience and have supported strong completion rates (14 in the census period).

Establishing the Industrial Doctoral Training Centre (2009, Zhang £6.3m) provided a clear manifestation of our commitment to industrial partnership. This success has had an on-going effect on the networks, outputs and future potential collaborations within the unit, binding academic development through PGR projects to specific partnerships across industry sectors – as well as building critical mass within the UOA. This has generated momentum around PGR development across the UOA and with a further EPSRC grant recently awarded (2013, Zhang £5.3m) standing as endorsement of and future stimulus for this approach (Section c.ii).

Our strategy includes the following priorities: contributing to the growth in ***new techniques and technologies*****;** production of internationally recognised ***creative theories and artefacts****;* and the ***multidisciplinary application of computer animation***. Much of our work represents the fertile intersection between rigorous mathematical investigation and the understanding of practical application in creative industries, digital arts and in an array of application areas. You and Zhang's work has led to over 40 journal publications (2003-13) introducing innovative techniques in modelling and animation (***new techniques and technologies****).* Stephenson has led to new rendering techniques guided by artistic principles adopted in industry. Interdisciplinary projects have progressed techniques for studying car crash simulation (Chang), medical simulation (Yang) and technology supporting virtual applications for behavioural psychology (Southern).

EMERGE facilitates work between artists and creative practitioners within the Media School supporting the production of internationally recognised ***creative theories and artefacts*****.** A practitioner lab space ("co-lab") opened in Autumn 2011. Co-lab provides a facility for new practice-led collaborations exploring knowledge and experimentation in contemporary culture. The UOA deploys QR to support staff to generate ideas and exhibit new work in national and international settings: the "Broken Stillness" exhibition at the International Symposium on Electronic Art 2011; "Fieldworks from the Museum of the Void" at the Chelsea Space 2010; and "1 x 1" at the Cherry Blossom Festival (Washington DC, Arts and Humanities Commission, 2012).

We have prioritised ***multidisciplinary applications of computer animation*** aiming to increase innovative activity and income. QR investments in networking (up to 30% of QR annually) have been used to support international conference participation and event hosting; for example, Computer Graphics International in 2012. This has contributed to strengthening our collaborations across industry and academia (Section e). Our work demonstrates the application of computer animation technology in innovative settings, directly addressing user needs. For example, the EPSRC-funded "Bystander Project" (Zhang, £290k in collaboration with University College London and University of Lancaster) validates the use of Virtual Reality for studying behavioural psychology. The EU-InterReg-funded SHIVA project (Sculpture for Health-care: Interaction and Virtual Art in 3D; Pasko, £175k) involves creative collaboration between five EU institutions. It explores intuitive gesture interfaces for virtual sculpting for rehabilitation for children with disabilities. The Augury (Augmented Reality Surgery) project (Zhang; £25k Bournemouth Hospital, £58k Higher Education Innovation Fund) developed a sophisticated colorectal surgery simulation, receiving positive feedback from consultant surgeons from Bournemouth and Poole NHS and from medical instrument manufacturers. The successful delivery of these strategic priorities emerged from commitments laid out in RAE 2008 foregrounding creative innovation, cultural-theoretical exploration and multidisciplinary applications of computer animation in academic, industrial, cultural and social settings.

Strategy for period to 2018 and beyond

The Bournemouth University (BU) Strategic Plan (*BU2018*) focuses on the fusion of education, research and professional practice while investing in our academic community. It stresses the importance of societally relevant research alongside continuing excellence. In this context our unit's strategy is to continue established approaches but with a more explicit focus on creative innovation and engaging productively with societal challenges. We aim to:

- Enhance our societal impact by prioritising impact oriented research outcomes and to implement mechanisms which capture impact at project inception. From 2014 we will offer structured seed funding (a ring fenced 20% of QR supporting internal bids allocated via a

Media School review panel) to stimulate impact-rich projects. We will align our research priorities with RCUK guidelines while focusing on BU's eight cross-disciplinary research themes, particularly: Creative Digital and Cognitive Science, Technology and Design, Lifelong Health and Wellbeing, Communities, Cultures and Conflicts.

- Develop further multi-disciplinary applications and artefacts through maximising national, EU, and international collaborations. We will seek further funding from external sources, including Horizon 2020, to build on current success with FP7 and InterReg. We will continue to invest to support staff through BU's dedicated EU staff development programme.
- Engage in further cross-disciplinary collaborations. The multi-disciplinary nature of computer animation offers opportunities for exploring creative spaces between disciplines. We will develop synergies between BU research groups to exploit these opportunities through a continuing programme of research seminars within the Media School's constituent groups (including media, communications, and culture). The structuring of cross-institutional research themes as well as co-lab will support institutional-level collaborative work connecting arts, animation across new fields of practical and conceptual research.
- Invest in PGR and ECR development though an active strategy of support and funding, expecting to grow PGR recruitment by at least 30% and expecting to meet an institutional Key Performance Indicator - a ratio of 1:1 between PGR numbers and academic staff FTE across the UOA area by 2018. We will enhance experience and completion rates, building on expertise gained within the UOA via the EPSRC-funded Industrial Doctoral Centre and through encouraging further engagement with the Vitae-based BRAD scheme (Section c.i) and benefitting from the University's £290k investment in ResearchPAD (PGR experience management system).
- Work to develop and trace commercialisation and dissemination routes, expanding capacities to capture industrial and public engagements with our research. This will include direct QR investment of £10k p.a. for archiving and curating digital work (code and artefacts). We will pursue funding to reflect industry engagements including Knowledge Transfer Partnerships and via networks developed through supervisor-PGR collaborations on the EPSRC-funded Industrial Doctorate and via the UOA's knowledge exchange incubator "Rock. Paper. Film" which produces VFX and motion graphic content for cinema, broadcast, mobile and web.

c. People, including staffing strategy and staff development

The staffing strategy for this UOA group supports four principal aims:

- Research Excellence: Continue to ensure that research excellence or potential are key criteria in staff appointments;
- Inclusive research community: Fully support all staff in defining and developing research appropriate to career stage and expertise via mentoring and structured staff development;
- Expand PGR supervisory capacity: to support projected PGR growth and to enhance PGR experience – including structured on-going supervisory development via the Graduate School and increasing the number of staff involved in active supervision in the UOA from 12 (as at July 2013) to 20 by 2018.
- Embedding research strategy: Encourage and support staff to develop skills required to enhance impact, engagement and networking capabilities and further developing academic excellence – to support and develop continuing and future strategic priorities across the UOA.

Overview and implementation of these aims aligns the priorities of the UOA with its academic vision and with the BU's Research Concordat Action Plan (granted the EC HR Excellence in Research Award). We provide staff and PGR students with facilities, funds and training to support career development and intellectual and creative productivity. Structured opportunities allow staff to build research capacities, enhancing staff retention, organically growing collective strength and reducing reliance on a few individuals within the UOAs. Our HR policies permit flexible working and career breaks and provide generous maternity, paternity and adoption leave. BU abides by the provisions of the *Fixed-Term Employees (Prevention of Less Favourable Treatment) Regulations* (2002) and is committed to ensuring the proper use of fixed-term contracts. Our Code of Practice – *Use of Fixed-Term Contracts* - provides guidelines for appropriate use of fixed-term contracts. Other than in exceptional circumstances, BU will transfer fixed-term staff to established status after

four years. Academic, support staff and research assistant appointments are made in accordance with BU's Equality and Diversity procedures. New staff have lighter teaching and administrative loads in their first year to allow them to build their research (reductions of between 25-40% depending on prior experience). The Media School supports new and existing staff working towards doctoral qualifications, including appointees from practice or industry, in line with BU policy. The school operates a research mentoring policy ensuring staff can receive structured peer support. This approach was effective in gaining recently awarded EU funding for the AniNex project (€433k), with Zhang as PI and Chang as co–investigator. Research is actively reviewed within the annual appraisal process. Appraisals assess performance against targets, identify development needs and ensure appropriate balance of workload. Staff have access to:

- The Bournemouth Researcher and Academic Development (BRAD); a University scheme for ECR's based on the Vitae Researcher Development Framework;
- A Grants Academy, with the University providing intensive training and expert mentor support for bid writing and PI development. This scheme resulted in three bid submissions from this unit in 2012/13;
- The University's EU Academic Development Scheme (EUADS); an annual initiative to develop a small group of researchers over 12 months to bid for EU funds; for example, Chang who is chief scientist on the EU funded AniNex project.

There is a variety of sources of funding to support research project development at University and school level and within the UOA:

- The University Fusion Fund supports the BU2018 Strategic Plan, worth £3m per annum to support start-up projects, project support, research-focussed international travel and study leave;
- A school-funded staff development budget, with an annual budget of £15-25k per annum across the period supports networking and training;
- Research groups across CARC have received an annual development budget from QR to invest in project development, each group receiving between 4k and 10k between 2009-13;
- QR also supports individuals' conference participation, exhibition and performance.

Staff and PGRs benefit from access to library, information and online training resources. During the REF period BU invested c. £3m per annum on library staffing and information provision. Staff and PGRs have access to online databases including Research Professional, Scopus and Web of Science. BU has an Open Access fund for rapid publication. A structured system for Institutional peer review of grant applications enhances bid quality and trains staff. All staff and PGRs are required to complete a mandatory online research ethics module. Career and development opportunities are broadcast via an award-winning University research blog (HEIST, 2012). The NCCA runs a weekly seminar with talks from national and international companies (e.g. Dreamworks, Pixar and Electronic Arts) and attended by postgraduate students and staff. Four staff members have developed knowledge transfer activities, including delivering a five month training programme for a Chinese animation company in motion capture technology and graphics programming. Since 2008 the NCCA has employed three post-doctoral researchers and an artist-in-residence (from SCAN) as part of on-going projects co-funded by QR investment. SCAN is funded by the Arts Council and led by arts curator Helen Sloan (2008-10) with individual staff developing public and social engagement activity, regionally and at International Festivals and events.

i. Research students

The Graduate School develops policy and practice as well as overseeing the recruitment, monitoring, and skills development cohort development of students. The Graduate School also provides development awards (c. £50k per year) and 100 funded doctoral opportunities available each year. One fully financed and three match-funded doctoral students have been awarded to this UOA. PGR experience will be enhanced from 2013 with the roll out of a new PGR monitoring system "Research Pad" representing BU investment in PGR development of £290k.

The School Research Degrees Committee works to the Graduate School codes of practice to

support PGR admissions and allocation of supervisors, monitoring student progress through to award. All PGR students are managed through BU processes – with additional admissions processes reflecting industrial partnership. Since 2008 the PGR community has grown from 10 to 28. Completions have increased from 2 to 13 in this current REF cycle. Research students form a major component of our strong research culture, pursuing innovative and specialist lines of enquiry and application. The composition of our research community is diversely multi-cultural (56% international), with students originating from China, Russia, India, Turkey and from across Europe. Our UOA's PGR population is a focus for further development, with a 32% of PGRs female and 68% male. PGR students have dedicated space and computing or workshop facilities.

The now well-established £6.3m Industrial Doctoral Centre with the University of Bath, funded by EPSRC, the Centre for Digital Entertainment (CDE) has a unique remit within the United Kingdom focussing on the digital economy and the creative industries. This funding supports 50 doctoral students over five years, equally divided between Bournemouth and Bath universities. The CDE is managed by a full time administrator. Each student is supervised by an academic and an industry supervisor. A biannual CDE conference allows students to present their findings to the group, and encourages the development of a cohort culture. This program offers excellent opportunities for participants: one CDE funded student, Steve Willey, based in Double Negative, co-supervised by Prof. Willis (Bath University) and Zhang, contributed to the production of the film *Inception*, which won an Academy Award for its Visual Effects in 2011. The UOA has been awarded further EPSRC grant (£5.3m) awarded to Bournemouth and Bath Universities in the autumn of 2013 ensuring that we can extend such significant development between 2014-2021/2 and providing a core focus for sustainable growth.

Further PhD funding has been significant. The AHRC-funded EMERGE project, the InterReg-funded SHIVA project, and the Arts Catalyst London (Section e.) each support a PhD student. In addition, as part of our outreach programme, we have successfully assisted international students in the preparation of research proposals in order to secure funding from their home governments; thus the UOA has secured funding for six students from the Chinese Scholarship Council and two students funded by the Portuguese Government.

Research students also benefit from BU Post Graduate Research fund, administered by the Graduate School, supporting conference travel or external training. The typical award is about £2k over a six month period. Since 2008 two of our research students have benefited from internships in leading companies. One of these students, Rudra Poudel, secured a six month internship with Siemens Corporate Research, Princeton USA, where he established strong industrial contacts while working on ground-breaking techniques for the detection of breast cancer cells in CT and fMRI images.

Full-time students are required to attend the Graduate School training programme in research methods, and are supported by a dedicated Research Student Administrator. We support supervisors' development. The Graduate School offers a training programme for new supervisors, leading to a PG Certificate in Research Degree Supervision. Since 2011 it has been a BU requirement for all new supervisors to undertake this course within their first year – with a suite of short courses available to refresh established PGR supervisors.

We have hosted six visiting scholars (8 to 12 months each, doctoral and post-doctoral) from China in this period, funded by the Chinese Scholarship Council or Chinese Universities. For example, Dr. Liang, from Communication University of China, developed the evaluation platform for virtual surgery training which complements the Augury project at BU (Section b.) and collaborated with BU's psychology research group to develop a software tool for the study of dyslexia.

d. Income, infrastructure and facilities

For the period since 2008, the NCCA has been awarded over £4m in research funding, representing a five-fold increase in external income compared with the previous review period. The majority of research funding is the result of the EPSRC-funded Doctoral Training Centre (Section c.ii). Of the remaining funding, approximately 80% was awarded to finance research projects developing techniques and applications, while the remainder has been awarded to projects relating to the generation and research of digital media. These successes can be attributed to an increase in the use of institutional peer review processes, mandatory for large grant

bids. Examples include the EPSRC-funded Bystander project, awarded to Zhang as principal investigator in collaboration with UCL and the University of Lancaster (£290k), the InterReg-funded SHIVA project, awarded to Pasko as principal investigator with five European academic and industrial project partners (£175k), and a AHRC Capability Studentship Grant (£100k) awarded to White to undertake research in Film and Digital Media production. In 2013 two FP7 grants were secured: the AniNex project involves five international partners and aims to develop next generation animation technology (433k Euros, with Zhang as PI and Chang as Chief Scientist); the Dr Inventor project involves eight European partners (320k Euros, Zhang as PI) and aims to develop innovative information visualisation and processing technology to enhance computer animation and graphics research. We have also secured many smaller grants, including a Royal Society grant awarded to You (£12k) and a BIS grant awarded to Yang (£36k).

The dedicated Research and Knowledge Exchange Office (RKE) facilitates research activities at the University level. The remit for the responsibilities of their dedicated development officers include EU and EC research award management, impact and public engagement, and training. BU signed the National Coordinating Centre for Public Engagement's Manifesto for Public Engagement in 2012. Staff contributed in BU's first annual Festival of Learning. Similarly staff in the area were guided by commitments to public engagement in activities including a national festival run by the HEIF-funded VFX Hub in 2013 – with researchers, students and the public exploring animation arts in a week-long event. Social engagement projects, such as the "1x1" project for the Cherry Blossom Festival (Washington DC, 2012), actively break down categories of artist and audience and researcher and researched and support public engagement.

The NCCA has access to specialist items of equipment and work spaces including a full industrial grade motion capture system maintained by support staff, valued at £100k; a suite of state-of-the-art 3D printing devices worth approximately £30k, supported by a technical specialist; a high end laser scanner, valued at £40k; a studio space for art group projects, seminars and networking events; and annual licences for numerous software packages Maya(Autodesk), Renderman (Pixar) and Houdini (Side Effects) for animation production and software development – maintaining software licences relies on manual investment of £80-100k. We have secured BU investment of £197.5k to upgrade hi-specification render farm facilities. Researchers and students are equipped with high-end workstations. Our equipment and the working environment is supported and maintained by the centralised BU estates and IT infrastructure. Access to specialist equipment has directly influenced the research environment; for example, our expertise in motion capture technology was instrumental in the Sino-UK higher education research partnership (£36k) and the Digital Beijing Opera project (£58k).

e. Collaboration or contribution to the discipline or research base

Key international partners: In collaboration with the Beijing New Media Park and one of their partners Beijing Advanced Technology College (ATC), and financed by the Chinese Government (£58k), NCCA researchers Xiao, Vanner and Cousins exploited our research in computer animation and applied motion capture techniques to create a unique 3D archive of the intricate movements and postures of character poses used in Beijing Opera. The Digital Beijing Opera project raised awareness of this important aspect of Chinese cultural heritage, which was awarded UNESCO world heritage status in 2010. This work was exhibited at MIPCON in Cannes 2008, and led to the development of new production techniques, published in the journal Computer Animation and Virtual Worlds. Since 2002 White has developed a partnership with Arts Catalyst, London, an International non-profit organization. White has also collaborated with the Geography Department at UCL and the Chelsea College of Art and Design, UAL, London. Pasko and colleagues have contributed to the HyperFun project, a long-term international free and open source software project for geometric design and visualisation. This established collaboration has contributors from UK, Russia, Japan, France, USA and Norway. We have joint research projects with China, one of the most rapidly developing countries in computer graphics and animation research. You's recent Royal Society-funded project enables joint research with Zhejiang University in China, which has a strong track record in computer graphics research. Yang has won funding from the Department for Business Innovation and Skills to work with the Key State Laboratory of CAD/CG at Zhejiang University. We have established a collaboration with HKU (Hogeschool voor de Kunsten Utrecht) supporting 12 PGR students and an MoU supporting the development of future EU-based bids in

the areas of digital media design.

Key national/industry collaborators: The CDE Doctoral Training Centre (Section c.ii) is a close collaboration between the NCCA, Bath University and industrial partners from the computer games and film industry. The EPSRC-funded "Bystander Project" (Section b) allowed us to develop strong academic ties with the Virtual Reality research group at University College London and the psychology department at Lancaster University (REF3a). The Augury project (see Section b.) has established strong collaborations with Poole Hospital and Bournemouth Hospital. In addition, Zhang has also been involved in a number of projects with the University of Glasgow, the University of Nottingham, the University of Edinburgh, the University of East Anglia and Brunel University. Newly obtained FP7 grants mean our collaborations now extend to more European and international institutes. The establishment of long term relationships with leading international researchers and industrial practitioners is manifested in our hosting of industrial and academic practitioners as visiting professors. These include Prof Mike Milne from the leading animation company Framestore-CFC, who was the initiator and production leader behind the well-known TV documentaries, *Walking with Dinosaurs* and *Walking with Beasts*; Prof Cary Phillips from Industrial Light and Magic, who has twice won the prestigious Scientific and Academy Award for Technical Achievements. Paul Franklin (Double Negative), who recently won the Academy Award for his work on the film Inception, was awarded an honorary doctorate for his contribution to the discipline. In addition to industrial visiting professorships, we also appointed Professor Nadia Magnet-Thalmann as Visiting Professor. She leads the Miralab at Geneva University, Switzerland, a pioneering and internationally renowned centre for research in Computer Animation. Zhang has in turn been made a Visiting Professor in a number of prominent research institutions, including the Chinese Academy of Sciences.

The International VFX Hub was launched in February 2012, and is a HEIF-funded (£280k) joint initiative from the Media School at BU and the Faculty of Media and Performance at the Arts University Bournemouth (AUB). The project was a response to the 2010 NESTA report on the UK VFX industry; it aims to raise the profile of Bournemouth as a centre of excellence for animation and digital VFX, build links with industry for both universities and provides commercial opportunities to students, graduates and academic staff. The Hub has co–created an international film and visual effects festival (http://www.bfxfestival.com/) and has set up the local animation production company "Rock. Paper. Film."

Our Industrial Advisory Board consists of practitioners from leading animation, special effects and games companies including Industrial Light and Magic, Dreamworks, Double Negative, the Moving Picture Company, Framestore-CFC and Sony Computer Entertainment Europe. The Board meets regularly, sharing industrial experience. The involvement of Dr. Josh Knight of NaturalMotion provided research direction for our work in the generation of techniques for synthesising realistic character locomotion, for which we have secured PhD funding leading to a recently submitted research proposal.

Editorial work and positions: Collectively UOA staff have chaired 10 international conferences, and given 10 keynote and invited talks (e.g. Zhang, Yang). UOA researchers are editors of eight international journals (including *Computers and Graphics*, *The Visual Computer* and *Virtual Reality*), have acted as external PhD examiners at least 15 times and are (or have been) on the programming committees of at least 30 international conferences since 2008. We have been responsible for reviewing well over 100 journal and conference papers for publication over the same period.

Measures of esteem: The NCCA hosted Computer Graphics International 12-15 June 2012, one of the oldest and most established conferences in the area of computer graphics, with Zhang as conference chair. The NCCA also hosted Shape Modelling International 10-12 July 2013, with Pasko as conference chair. Members of our research group are participating in professional bodies which shape the discipline of Computer Animation. The NCCA was in 2011 awarded the **Queen's Anniversary Prize for Higher and Further Education** recognising research and education. NESTA presented a report to the Minister for Culture, Communications and the Creative Industries in February 2011, describing the NCCA as a "a global leader in education and research in computer animation and visualisation".