Institution: Staffordshire University

Unit of Assessment: 15 – General Engineering

a. Overview

During the period 2008-2013 this UoA attracted circa £2.4 million funding; it is submitting 7.4 FTE staff, which equates to over £278k per FTE. The group has produced 130 outputs of which 85 (11.5 per FTE) were articles or peer reviewed conferences, 6 granted (and exploited) patents. 9.5 PhDs (and 3 MPhil) have been successfully supervised and there are 20 registered PhD students actively conducting research. New academic staff have become active researchers are included in this submission and another has progressed to independency. The staff associated with this UoA have moved to their new home in the Stoke Campus. Since the last submission three new research laboratories have been funded and developed, one specific to organic semiconductors, one specific to biomass, and a third supporting digital systems.

This UoA's research falls under the management of the Centre for Energy Efficient Systems (CEES). It has three themes: Sustainable Energy; Medical Engineering; and Digital Systems. Furthermore this UoA hosts the EU centre of Excellence in Biomass: ARBOR. A new Postgraduate Centre has been developed to enable all postgraduate students to access high quality facilities, and collaborate and support one another.

A:1 Research Outputs

Since the last audit this group has produced 156 research outputs (Table 1): this is equivalent to 16.6 outputs per FTE.

Table 1: Research outputs 2008-2013

	2008	2009	2010	2011	2012	2013	Total
Articles and Journal papers	5	4	4	11	9	9	**42**
Conference papers	12	7	7	13	6	2	**47**
Book Section		1		1	1		**3**
Books		2	3	2	2		**9**
Patents			3		1	2	**6**
Keynotes	4	4	8	7	1	2	**26**
Technical Authoring	1			2			**3**
Confidential Reports				1	3	3	**7**
Products/Artefacts					1		**1**
Show/Exhibition		2	1			1	**4**
Government Reports			3	1	1		**5**
Prizes and awards		2			1		**3**
TOTAL	**22**	**22**	**29**	**38**	**26**	**19**	**156**

We have been awarded 3 prizes for our research work and contribution to the knowledge economy; and we have been awarded "outstanding" for two of our KTPs.

b. Research strategy

B:1 Comparison with plans presented in RAE 2008

In the 2008 submission this UoA was delighted to receive the highest ranking in the University. The University has restructured and formed a smaller number of faculties. To this end a new Faculty of Computing, Engineering and Science has been formed. A brand new £24 million STEM building has been opened in Stoke which houses some of this UoA's new research centres; a further £3million re-fit houses the remainder of the engineering provision.

The University has funded dedicated engineering research laboratories. A £500,000 spend on thin-film deposition equipment has built a centre for organic semi-conductors in the new STEM building. This laboratory supports, for example, the development of new, higher efficiency, photo-voltaic cells. This building also contains a new postgraduate Telecommunications laboratory. The University allocated space and equipment to support the development of the EU centre of Excellence in Biomass (ARBOR); eventually this too will migrate to Stoke. In addition, the University has funded the redevelopment of a new Engineering resource in Stoke, which was opened in September 2013. This move contained a £1million investment in new equipment that will support research activity.

The research has evolved since the last RAE exercise. New researchers have been trained and developed; existing researchers have been motivated to support new staff as well as developing their own portfolios. More importantly the drive has been to focus activity to ensure that the research is cutting edge and world class. To this end three distinct areas of expertise exist. Medical Engineering remains and is developing into a centre of excellence for Medical Devices Design; Sustainable Energy has two distinct foci: Biomass and Energy Harvesting (including photonics applied to photo-voltaics); and the new Digital Systems group concentrates on the fusion between modern electronics, computing and telecommunications; itself having a new telecoms laboratory in the new STEM building.

B:2 Strategy

The Centre for Energy Efficient Systems' single aim is to design products, systems, devices and services that contribute to sustainability through either sustainable energy production or through designed in energy efficiency. Our future strategy, therefore, is to use this core philosophy as our driver to develop further the three themes described above. For example, we have supported and advised the University in achieving excellent energy efficiency rating for the new STEM building and the Faculty in obtaining Gold in the University Green Impact awards.

In the past, we focused on regional and EU funding and were successful. Our new focus is to take our success in this arena and develop more grants from research councils. We have developed a number of new independent researchers and our immediate strategy is to support them to obtain new researcher's funding. Equally we wish to grow our RC funding per se. To this end our key active researchers will be working, closely, with our ECD department (see section D:2) to facilitate training, bring in examples of good practice, and use our existing collaborations (see E) to re-invigorate our RC funding profile. The ethos of the group has been specifically selected to enable this to happen.

We intend to utilise our ability to confer Emeritus Professor status to retiring researchers in order for them to support the new independent researchers. Indeed we already have two recently retired 0.2 FTE Professors and one Emeritus Professor for such a purpose. We also have been fortunate to attract high quality Visiting Professors who, again, provide valuable support for our researchers. In this way we believe our research profile is sustainable. For example Prof Burrows is supporting

the research in thin films and DSP using his expertise in mathematical modelling. Prof Thomas supports our medical engineering activities, Prof Davis supports research in manufacturing systems but provides an external strategic view; and finally Prof Shammas is supporting new researchers in power electronics to carry on his mantel.

Our networks enable us to develop research projects of a collaborative nature, for example we are collaborating with Harvard University and Imperial College. We enjoy links with SMEs and following the government's guide we support their R&D activity in order to facilitate the UKs economic growth. An example is a confidential project that has started from an Innovation voucher that is now leading to an applied research project between 2 UK companies, 1 Swiss company, and ourselves; as a result at least one new ASTM/ISO standard is being written.

c. People, including:

i. Staffing strategy and staff development

This UoA submission falls within the School of Engineering that hosts three, subject based, departments: Mechanical Engineering, Electrical and Electronic Engineering, and Mathematics. Active researchers (those named in REF1) are encouraged to support less active researchers, through collaborative research projects and postgraduate supervision to achieve this goal. All staff have access to staff development through the University but have the opportunity to undertake specific training through the ARC funding. All new teaching staff, if they do not already have one, are encouraged to register for a PhD. Many of the forthcoming IRs (who will appear in the next exercise) have come through this route. Our group has University funding for two Post Doctoral Research Fellows (currently vacant); the previous two fellows have moved on to take substantive posts at Cranfield and Liverpool.

All academic staff are encouraged to undertake research and scholarly activity (University Plan, 2012, Staffordshire University). The members of staff associated with this UoA take this statement passionately. For example one of our part-time PhD students is one of our technical staff. The research activity of this ARC includes 19 academics (17.4 FTE), 3 Visiting Professors, 1 Emeritus Professor, 2 Enterprise Readers and 7 technical staff. Not all are "active" researchers, but all contribute to research activity as a whole.

Our research staff and students (as was this REF exercise) fall under the University's Equality and Diversity programme (http://www.staffs.ac.uk/support_depts/equality/).

ii. Research students

11.5 research students have successfully completed their programmes of research under our primary or secondary supervision, and were awarded PhDs (Table 2). At this moment in time this UoA is supervising 20 PhD registered students and the School is aiming to grow this activity (20 new scholarships are being offered this year). A new Postgraduate Centre has opened in the Engineering Building. All PhD students are supported with their own, fully serviced, dedicated desk space. In addition, and where appropriate, research students are able to secure dedicated laboratory space for their experiments.

Table 2: Completed PhDs

	2008-9	2009-10	2010-11	2011-12	2012-13	Total
PhD completions	3	3	2	1.5	0	9.5

All new postgraduate students must have either completed an appropriate Research Methods programme or must take the University's PGC in Research Methods. On enrolment students will

have been associated with a Principal Supervisor and supervisory team. Working together they develop their plan of study (RDC1) and identify any training requirements. If any training cannot be met by undertaking existing MSc (or other level 7) modules or by directed study, students may apply for support for external experiences. In addition research students may apply for funding to attend conferences and learned meetings. On completion all students are required to submit a thesis and are expected to defend this in a viva-voce examination. An independent chair, an external examiner and an internal examiner conduct the examination. The whole process is managed and coordinated by the University's Research Degrees Committee.

In addition to the existing engineering PhD students, the Faculty have submitted plans for a further 30 partial scholarships for the period 2013-2017. The move of Engineering to a purposely fitted building in the Stoke on Trent campus is focusing attention on research and research led teaching. We use our existing pool of full time and work-based MSc students to obtain high quality researchers. Our collaboration with industry and our work-based MSc programme is an excellent vehicle for attracting research projects.

Thus our networks within the academic and industrial fields enable us to draw quality postgraduate students from a variety of sources. For example our links with Indian universities draws students to study our MScs and we are able to select the best from the cohorts; many of our PhD students have come via the MSc route.

d. Income, infrastructure and facilities

D:1 Income

For the period 2008-9 to 2010-11 our research income was not coded correctly (in particular KTPs). This was identified and corrected in 2011. Thus there are discrepancies between the HESA return and the actual activity; this is illustrated in Table 2. Furthermore our unit's research income is attracted from a variety of sources – including those that are not commonplace and do not sit well within the University's financial coding system. Much, for example, is Government funding specifically targeted at providing R&D support for industry, (often classified under 'enterprise'). Thus our actual research income exceeds that given in the HESA return (Table 2). We calculate our research related income to be £2.4million (£42k/FTE/annum). This research income compares favourably with the activity presented in the 2008 return.

Table 2: Research Income (x £1000s)

	2008-9	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**TOTAL**
HESA data	68	17	43	213	245	**586**

ACTUAL income

KTP	105	133	230	46	45	**559**
Industry	22	44	11	22	26	**125**
EU/UK Govt	524	434	87	129	99	**1,273**
Other				36	60*	**96**
University		66	141	168 (500)	15 (400)	**390**
TOTAL	**651**	**677**	**469**	**401**	**245**	**2,443**

*unconfirmed reconciliation

The numbers in brackets refer to capital investment for the postgraduate thin-film and telecoms laboratories in the new STEM building, and the new engineering equipment in Stoke (that relate to postgraduate work). They are for information only, in order to demonstrate the Universities commitment to engineering research; they have not been included in the totals.

D:2 Infrastructure

The University's Research Degrees Committee oversees all MPhil and PhD student registrations, progression and ultimate examination of the postgraduate degree. All procedures are accredited follow the HEFCE accord. The University's Ethical Committee oversees all ethical procedures; it too is accredited and follows relevant accords and guidelines.

The University manages its research through Applied Research Centres (ARCs). All research activity is promoted and monitored via the individual ARC directors. This management structure enables the University to oversee research and scholarship activity. They also act as the vehicle through which the University is focussing its research activity into key, strategic, areas. All research staff and research students are associated with, at least, one ARC. University funding is available, through the ARCs, for postgraduate scholarships, staff training, secondments, research equipment and travel.

The University supports external funding applications through its central Enterprise and Commercial Development (ECD) unit. This unit promotes and supports all applications to research bodies, government bodies, charities and the EU. The unit also provides a liaison officer to enable industry to access R&D funding. Industrial relationships are managed through the ECD *For Business* group who, specifically, identify and attract new industrial partners. Furthermore it is this unit that supports, promotes and facilitates exploitation of IP through consultancy, patents, licenses, sales or spinouts. Furthermore they support our links with industry (such as Alstom) and the MoD (over the next few years the whole of the combined medical services is moving to Staffordshire).

Research led enterprise activity is an important income stream for this UoA. In addition to the services described above we enjoy two Enterprise Readers whose sole aim is to facilitate the transition from project concept, to fully funded project. To this end one is concerned, solely, with supporting KTP projects, and the second to support non-KTP activity. The success in KTP provision and outcome is, in no small part, due to their efforts.

Through ECD the researchers have access to good practice and advisory bodies such as UKRO, VITAE, AURIL, Enterprise Educators UK, ARMA, NSCCI, UK Council for Graduate Education, Modern University Research Group, and PRAXIS Unico. They also fund access to standard research and business innovation sources such as Research Fortnight, and Frost & Sullivan. Through our central Library subscription our postgraduates have access to the standard selection of electronic research search engines and electronic journals. Equally, through membership of external bodies, such as the IMechE, IET, Royal Society of Medicine and CIBSE, staff and students benefit from their specialist libraries.

D:3 Facilities

We have laboratory and extraneous facilities that cover our breadth of research activity. In our new building(s) we will have laboratories specialising in thermo-fluids, mechanical systems, electronics, control, cad/cam, thin film deposition, electrical power and telecommunications. The university has invested £1million solely for new equipment for these laboratories. Furthermore our move to Stoke gives this group access to Atomic Force Microscopy, Electron Microscopy, Mass Spectrometry and Biomechanics facilities within the new STEM building.

We have three specialist research laboratories, the thin-film deposition laboratory, the EU centre of excellence in Biomass, and the telecomms laboratory; also we have a dedicated Postgraduate centre. All other research activity takes place in dedicated space within one of the general laboratories. In addition to hardware, the University Library subscribes to Athens, OVID and other on-line bodies that enable research students to access research literature. Research students are also encouraged to use the larger libraries, such as the British Library for their literature searches.

In addition we have collaborative links with other universities and industrial partners that provide further facilities for the postgraduate student. Examples are: the donation of an industrial biomass boiler and fuel from Agripellets ltd; donation of exhibition space and facilities for MEDTEC UK and MEDICA DE; donation of equipment and use of facilities by ALSTOM; and access to the Bionics Laboratory, and a weekly research clinic at the University Hospital of North Staffordshire.

e. Collaboration and contribution to the discipline or research base

Despite being a relatively small group our collaborations are significant (as illustrated by Table 4). In terms of countries we have collaborative partnerships in the EU, the USA, Middle East, Asia and Southern America. Much of our work is with high quality universities including Keele, Kiel, Delft and Harvard. We also collaborate with hospitals on a World stage including those in the UK, Germany and the USA.

All of our research staff act as referees for high quality journals, for example Proc. IMechE, Proc. IET, and Proc. IEEE. They also contribute to the national and international Engineering debate through membership of panels. For example Ogrodnik is the Founding Chair of the IED's new Special Interest Group Design in Healthcare and Wellbeing; he is founding chair of the IED-MEDTEC Innovation in Medical Devices conference. Over the REF period Al-Shemmeri and Ogrodnik supported the regional agenda by acting as chairs and deputy chairs of AWM cluster panels and thematic networks. Prof. Davis (VP) has chaired numerous panels and, recently, was invited to join the Steering Group of the UK Government's Parliamentary Inquiry instigated by the Associate Parliamentary Manufacturing Group. He has authored and been a major contributor to many reports aimed at steering government policy in manufacturing, medical devices and renewables. Ogrodnik and Prof. Davis led Medical Interchange, a collaboration of all of the 13 West Midland's universities and took them to unique medical devices exhibitions in the UK and the World's largest in Germany. Al-Shemmeri and Oberweis lead a 13 member consortium whose whole aim is to influence EU policy on biomass utilisation and biomass supply chain. Ogrodnik and Prof. Thomas (VP) are both directors of a medical devices company and are in the process of creating at least one new venture. Ogrodnik was elected to Fellow of the Royal Society of Medicine in this period. Our REF names have been an invited speaker, a chair, or an organising committee member of a learned event - such as a conference. One of the patents of Ogrodnik, Moorcroft and Thomas has been sold to a European company for exploitation.
Equally, our collaborations persist with our alumni. One of our recent PhD students is now a Professor at Imperial College, a second has also obtained a chair and a third is, now, President of his University in China. In the latter case, several, recent, publications are joint-authored.

Table 4 attempts to illustrate the variety of collaborations we enjoy (an average of 20 per FTE). As with most universities, where there is a mix of active researchers and supporting staff, the variety is broad. However, Table 4 demonstrates that General Engineering at Staffordshire has a national and, more importantly, an international visibility; and that others want to work with us.

Table 4: Collaborations

	UK Universities	Int. Universities	UK Industry	Int. Industry	UK Govt. Bodies	Int. Govt. Bodies	TOTAL
TOTALS	37	44	42	17	25	9	**174**