

Institution: University of Lincoln
Unit of Assessment: 12 Engineering
1. Unit context and structure, research and impact strategy 1.1 Unit context and structure This Unit of Assessment (UoA) sits within the School of Engineering (SoE) at the University of Lincoln. Founded initially in 2010, the SoE has developed substantial collaborative research activities at both national and international levels. The SoE has successfully steered its research growth explicitly in the Energy and Industrial Digitalisation sectors. It spans broad technological themes of power systems, robotics and automation, smart grid, vehicle technology, communications, industrial prognostics and diagnostics, materials research and thermodynamics. Starting from a baseline in 2013/2014, the portfolio of successful research grants has more than doubled, on average, between 2014 and 2020. Research contracts were funded directly by industry and other funding bodies including EPSRC, H2020 and IUK; research outputs are demonstrable and highly impactful (see below). The SoE's research has had a significant reach, at an international level, due to its increasing links with Africa, India, the EU, and China. A very notable example of recognition of research achievements since the 2014 REF is the elite Siemens Global Principal Partner Status. It was awarded 'in recognition of the valued contribution that the University makes to Research and Development through the School of Engineering'. The University of Lincoln is one of only 5 UK Universities and one of 17 globally to possess this privileged status. Further, the strategic recruitment of outstanding academic staff has also strengthened, with more than 47% of the SoE's research staff now being non-UK. Since the previous 2014 census, the number of PGR students has increased by 67% from 2014 to 2020. 1.2 Achievement of Strategic Research Aims Since its inception in 2010, the SoE has successfully established well-sustained research activities with a strong emphasis on industrial relevance and aggressively pursues opportunities to facilitate market penetration stemming from its research outputs. For the 2014 REF, the SoE described its strategic aims as: 1. <i>To be a key facilitator in ensuring research outputs are disseminated in a timely manner with due consideration for IP protection.</i> Evidence of Achievement: The achievement of this aim can be seen from 41% of our outputs (>65 total per annum (mean) being in the top 10 percentile of journals throughout the census period, with a Field Weighted Citation Impact of 2.3, underpinning the SoE's commitment to high quality peer-reviewed research. Moreover, research has translated into industrial collaborator (Siemens) patent applications eg. Invention Disclosures 'Sensing and Analysis of Fuel Composition using Remote laser Induced Breakdown Spectroscopy', and 'Articulated Laser Delivery System for Ignition purposes of combustible fuels', 2017. Also, see point 3 below for examples of impactful research outcomes. 2. <i>To act as a research conduit so that multi-disciplinary and cross-sector research opportunities can be identified and exploited.</i> Evidence of Achievement: During the REF2021 census period, it is notable that ~50% of all successful research grants to which the SoE has contributed involved disciplines in addition to Engineering. For instance, the SoE took a pivotal role in successfully establishing the Lincoln Institute for Agri-food Technology created in 2016. SoE academics also contributed towards more than £6m of research projects, most notably with the SoE leading an Innovate UK/EPSRC Demand Side Response project with JMS/Tesco. For this project, the SoE developed the Lincoln Refrigeration Research Centre at the Riseholme campus (Lincoln). 3. <i>To facilitate step-changes in technology to improve productivity, growth and market leadership.</i> Evidence of Achievement: Mitsubishi Electric (Japan) adopted the SoE's thermodynamic research for developing a new type of air

conditioning unit that is now in production. It has led to the submitted Impact Case Study on 'Improving performance in air source heat pumps through computational fluid dynamics. Further, the outcomes from a PhD research programme are now being used by Napier Turbochargers Ltd. for optimising marine turbocharger designs and reducing material waste.

4. *To provide an integrated environment for wider intellectual inter-disciplinary debate and academic enquiry.*

Evidence of Achievement: The SoE has been instrumental in organising industry-based research seminars and knowledge transfer programmes. For example, a Siemens workshop on Laser Ignition ultimately led to direct funded research support and the submission of multiple patent applications (decisions pending). The SoE has provided support and access to facilities for external and industrial visiting research fellows and Chairs e.g. Adam Taylor (formerly of Teledyne e2v, and visiting Professor of Embedded Systems); Lei Shu (Honorary visiting Professor and the director of NAU-Lincoln Joint Research Center of Intelligent Engineering, Nanjing, China) and Festus Agbonzikilo (industrial Research Fellow in combustion dynamics from Siemens Industrial Turbomachinery (Lincoln)), among others (see below).

5. *To foster strategic research collaborations with regional, national and international organisations and the respective UKRI, EU Horizon2020, and other funders and programmes.*

Evidence of Achievement: This has been a particular success for the SoE during the census period due to the strong international research links coalescing in Asia, Europe and South America. To list a few, in China, CRRC is collaborating with [Gordon](#) on road and rail transport research; research organisations in India and Columbia are collaborating with [Srivistava](#) and [Nurellari](#) to investigate field monitoring using IoT and smart energy, agricultural waste reduction, and digitising cacao production (funded by Innovate-UK/Newton Bhabha funding totalling >£1.6m); EU Interreg ICAre4Farms project, led by [Bingham](#), is researching new methods of optimised solar-based water preheating for agricultural applications across the EU and brings together more than 16 partners and stakeholders.

6. *To be receptive to timely opportunities in high-technology commercial market sectors that the School's research outputs can penetrate.*

Evidence of Achievement: Research on vehicle road dynamics as a consequence of loss of driver control, based on original results from a PhD programme supervised by [Gordon](#), is now being trialled by Volvo Trucks in Sweden, and led by the PGR (now a Volvo employee) who originally researched at Lincoln.

1.3 Research Impact Strategy

Impact is underpinned by the creation of an environment for cross-disciplinary and multi-disciplinary research activities that are aligned with the University's strategic plan. It states, "We will create purposeful research on the key challenges facing the world, working collaboratively with partners to meet the needs of the 21st Century, promoting communication, freedom of thought, and personal and team achievement whilst recognizing the benefits of contributing to the solution of current and future environmental challenges."

The pursuit of internationally leading impactful research with continual and sustainable growth is fundamental to the SoE. Therefore, pursuing "Research with Impact" is a primary component of our strategic plan and staff development. Impact forms a key criterion for academic appraisal and progression and it is embedded at all career levels. We recognise the value of professional practice by academic staff and 'blended professionals' in generating impact; the SoE has a range of role profiles recognising this contribution. The University of Lincoln is a signatory of the National Coordinating Centre for Public Engagement Manifesto and has one of the first Professorial Chairs for Public Understanding of Research. Impact champions, an annual conference, and internal grants help researchers actively engage with the public.

The SoE emphasises industrially relevant research and aggressively pursues opportunities to facilitate market penetration stemming from its research outputs. To maximize the efficacy of its

research impact, the SoE is organized around two highly integrated multidisciplinary research groups with strong industrial and multinational links:

i. *Sustainable Energy and Power (SEP) research group*

Led by [Bingham](#), the SEP group conducts fundamental and applied research in all aspects of power and energy production, sustainability, distribution and control. The research group provides a strategic focus of research activity within the SoE and encompasses two sub-groups viz. Power Systems, and Sustainable Systems. Since its rebranding in 2019, the Group has attracted an average research income of >£51k/annum per FTE, with a current bid success rate of 78%.

ii. *Industrial Digitalisation and System Intelligence (IDSI) research group*

Led by [Saa](#), IDSI group focuses on use-inspired cross-sector research steered by three sub-groups, viz. Industrial AI; Robotics and Automated Systems; Communications, Networks and Embedded Systems. The IDSI group conducts application-driven theoretical and applied research. It covers topics on dynamics, systems and control, high-tech industry technology, fault tolerance, artificial intelligence, healthcare technologies and advanced multi-objective optimisation systems for a broad portfolio of real-life engineering problems. Organisations spanning the automotive, aerospace and other industry sectors are primary funders of collaborative research for IDSI members who have an overarching driver for the rapid transfer of its research into the field or marketplace. Since its rebranding in 2019, the IDSI Group has attracted an average research income of approximately £59k/annum per FTE, with a current bid success rate of 75%.

The Impact strategy is underpinned by a Research Action Plan aligned with the SoE's strategic plan, which includes:

- Full-day workshops for staff to engage with industry facilitate ideas generation and dissemination of highly impactful research.
- The establishment of School-level pump-priming opportunities for internal funding of high-risk/high benefit research and/or market exploitation of its impact.
- The establishment of internally funded PGR studentships for growing the PGR cohort. During the census period, the SoE has contributed £60k each year to support internally funded PGR studentships, including high-calibre international students.
- Bid-writing workshops to aid ECRs in developing research bids that integrate impact consideration at the inception stage.

1.4 Five-Year Plan for Enhancing Impact Generation

With University support, the SoE has committed to a 5-year plan for further developing research activities and raising its international profile by creating societal and economic impact. A unique feature of this critical planning exercise is the substantial expansion of Engineering research capability through **Strategic Academic Appointments**. The SoE will submit a business case for increasing Engineering academic FTEs from 19 (in 2020) to 46 (by 2025). The prospects for impact generation will be a crucial criterion for a successful appointment. As part of this expansion, a **Professorial Lead for Impact Generation** will be recruited by 2025. Encouraging and promoting the value of impact by academic staff is vital for success. Therefore, future **workload models** will incorporate evidence-based impact.

The SoE has seen the benefits of attracting **Visiting Research Fellows** and **Visiting Research Chairs** to support the generation of impact, e.g. [Dr. Vili Panov](#) joined the University of Lincoln in 2016 as a RAEng Visiting Professor in Gas Turbine Performance Diagnostics and Health Management. His research is now being used in Siemens for combustion dynamics modelling to predict and diagnose operational combustion abnormalities. Building on this success, the SoE has further extended its Visiting Chair appointments. For example, in 2020, [Prof Duncan Botting](#) was appointed to enhance the industrial collaborative scope for impact in short/medium term. By further growing its pool of visiting scholars, the SoE will generate new impact case studies in the future.

Through continued support for **Internal PGR Scholarships** and joint funding opportunities with stakeholders, the SoE will continue to expand its PGR provision towards its goal of 4 x PGR per FTE by 2025. A significant aspect of this growth model will be to encourage **part-time PGR** registrations from industry for dovetailing research outcomes rapidly into an industrial environment.

International collaborations are pivotal for extending the future reach of impactful research carried out in the SoE. Accordingly, the SoE has recently appointed a Lead for International Development ([O'Grady](#)) and a further academic staff member as the Director of Enterprise ([Elseragy](#)). The target is to secure 50% of successful research funding through collaborating with non-UK organisations by 2025.

1.5 REF Submission

The SoE is submitting a single unit of assessment that encompasses the combined outputs and impact of the two strategic research groups, to UoA (B) 12: Engineering.

2. People

2.1 Staffing Strategy and Development

Currently, there are 19 research-active academic staff in the SoE; an increase of 58% in research staff submitted to the UoA since the previous submission in 2014. Academic staff are recruited strategically according to the alignment of their profiles with the SoE's research strategy and associated research groups (SEP and IDSI). The SoE's recruitment criteria is primarily academic pedigree in terms of quality of outputs, income generation, and impact. The recruitment of academic staff helped to grow critical mass in key areas of strength for the SoE, thereby supporting intra-disciplinary working. It also led to an increase in the value of research bids submitted and a corresponding rise in research income (£51k per FTE for SEP and £59k per FTE for IDSI); this growth is from a baseline of £12k per FTE at the start of this census period. Recruitment of staff has taken place at all levels since 2014, including the recent appointment of a Global Chair in Robotic Engineering, but has predominately focused on Early Career Researchers (ECRs) to reflect the SoE's strategy of developing staff from early stages in their careers. This approach has proven to be a very effective recruitment strategy, with 100% of research staff appointed at Lecturer grade being promoted to Senior Lecturer within two years, and two members of staff being promoted to Associate Professor ([Tucker](#) and [Gallimore](#)).

The research imperative is well understood by all members of the SoE, as is its Research Strategy. An environment for cultivating academic research creativity is a priority for the SoE to significantly increase the number of research students, Research Assistants and Fellows, and promote wider external income generation opportunities. The SoE's Director of Research along with the Head of SoE are responsible for overseeing and monitoring academic staff research attainment to ensure the strategic aims of the SoE are achieved. Measures are in place to ensure transparency of the expectations and offer support mechanisms for research. In addition to the SoE's Research Committee, weekly staff meetings and annual all-staff research away days are platforms for effective communication with staff.

Researchers receive comprehensive support from within the SoE, the College of Science, and the wider university. The following mechanisms are in place to ensure timeliness of support:

1. An annual appraisal meeting, with the Head of School, discusses progress against objectives and identifies individual needs in relation to SoE's strategic direction and career planning.
2. An annual Individual Research Planning (IRP) meeting, with a senior member of staff (either the Head of School, Director of Research or Global Chair), discusses all aspects of research development. This includes outputs, income generation, enterprise

activities, impact, public engagement and support needs. The on-line IRP system draws data automatically from centrally managed facilities viz. an output repository and REF databases, providing staff members with an individual summary of key achievements. The College of Science Research Committee further reviews the outcomes of IRP meetings in the SoE. Accordingly, the Committee makes recommendations on continuing professional development for research, PhD studentships, the release of pump-priming funds and support for new equipment and facilities as needed.

3. A SoE pump-priming scheme is available to all staff, allowing staff to apply for up to £5k in funding each year to promote and support innovative research and provide a foundation for further grant applications.
4. Provision of facilities and support for ECR academics, including access to external collaborators' facilities in industry and academia.
5. Institution-wide training and support for Continuing Personal and Professional Development (CPPD) framework.
6. ECRs are provided with an experienced research mentor from within the SoE or College of Science to give individual support for bid writing, generating outputs, enterprise and impact activity.
7. ECRs are allocated a lower teaching/admin load in their first year in post to allow more time for research.
8. A SoE travel and conference budget of £20k is ring-fenced each year to promote the dissemination of research and provide networking opportunities for staff. The SoE also provides funding for laboratory consumables.
9. New staff are supported with start-up funds to establish a robust platform needed for developing their research within the SoE, including the purchase of new equipment and recruitment of PGRs and Post-Doctoral Research Associates. For instance, [Chalashkanov](#) (appointed 2020) was recently supported with the purchase of a high-voltage power supply costing ~£15k for his research in the area of di-electric breakdown. Samson was supported with funds to develop a dedicated biofuels laboratory to facilitate research on biomass gasification (>£60k).
10. A research leave scheme is available to all SoE staff which allows up to two members, each year, to have a full semester free of teaching duties to focus exclusively on research. Annually, SoE invites applications from interested staff who must demonstrate how they intend to avail this scheme. Successful applications may involve writing a specific large grant application, learning new skills or developing new tools likely to be of use for interdisciplinary research in the future, or extended research visits to other laboratories worldwide to facilitate collaborations.
11. SoE offers research leadership opportunities to staff for enhancing their overall profiles and supporting career development. For example, [Yao](#) has taken over the Postgraduate Research Lead's role in response to career planning discussions during the annual appraisal process.
12. Staff at all levels are encouraged to attend courses that enhance their research skills. Moreover, staff are encouraged to improve their research exposure and work on intra-disciplinary research topics facilitated by SoE's monthly research seminar series.
13. Expansion of facilities (see section 3).

2.2 PGR Students

Developing a vibrant postgraduate research experience is a priority for the SoE. It helps to guarantee the continued growth of the SoE's research activity and promote a culture of innovation and produce a pipeline of research talent to help build the next generation of SoE academic staff. PGR students in this UoA are predominantly PhD (90%) with a lower number of MSc by Research (10%). The majority of students are either self-funded (the case for most MSc by Research) or funded through external grants and industry funding. Further, three PhD studentships funded by the SoE are made available to staff on a rolling basis;

this equates to £60k of investment per annum on PhD studentships. The number of PGRs has grown by 67% between REF periods, with 41% being female and 50% identifying as BAME. Attracting the highest quality PGRs from across the globe is considered fundamental to the SoE's longer term research success, with 65% of PGRs being non-UK.

The success in recruiting PGRs is mainly attributed to the following strategies:

1. The SoE has accelerated its research engagement to increase the number of high-potential international partners worldwide, particularly in China. This has led to two significant joint research initiatives with the [Guangdong University of Petrochemical Technology](#) and [Zhaoqing University](#), including joint PhD arrangements of 10 per institute over five years.
2. Industry engagement has increased significantly during the census period, both nationally and internationally. Since 2013/14, the number of successful collaborative industrial research projects, per annum, has more than doubled. The recently appointed Director of Enterprise within the SoE supports SoE staff in all enterprise activities; the staff also receive further support from the central Research and Enterprise office.
3. A £37m investment in new facilities and equipment has made the University much more attractive to prospective students, including those who self-fund. This increase in facilities has also provided all students with their own desk space in a dedicated PGR Office, creating a sense of community amongst fellow students.
4. A boost in the SoE's external profile due to growth in overall research, development of critical mass in key areas of strength, and the appointment of internationally renowned staff (see Staffing Strategy and Development section). This has broadened the research specialities that students can engage in.

PGR support is overseen by the School Postgraduate Research Lead, who reports to the School Director of Research and Head of School. It is governed through the School Research Committee, which reports to the School Leadership Team. PGR support focuses on two key areas, namely, research experience and achievement, and career development.

1. PGRs get support for gaining teaching experience through paid teaching activity, subject to undertaking mandatory training, and with the help of experienced teaching mentors. Carrying out teaching accelerates their future career progression (e.g. [O'Grady](#) who was an Associate Lecturer alongside her PhD studies and progressed directly to Lecturer upon completion) and ensures that they have the skills needed to convey their research to peers.
2. All PGR students complete a Research Training Needs Analysis that establishes an individual Research Development Plan. This process helps to identify future support needs, such as attendance on training programmes, mentoring requirements and broader research and technical skills development.
3. Students have access to SoE funds to support attendance at conferences and for networking opportunities (e.g. De Barrie (supervised by [Goher](#)), who presented at the international ICRA2020 conference and followed with a related [publication](#) in the international journal - IEEE Robotic and Automation Letters). Students are also encouraged to develop their research dissemination skills through engagement with the SoE's research seminar series.
4. All students have a minimum of two academic supervisors. Monthly meetings are held in order to monitor and record progress and to discuss ongoing training and support needs. All students are subject to an annual review of progress and PhD Confirmation viva when transferring from MPhil to PhD.
5. Where appropriate, students are allocated an industry supervisor/mentor in order to provide additional support and to maximise the impact of their research (e.g. [Borman](#) with Teledyne-e2v, [Gallimore](#) with Siemens, Rahman with Volvo Trucks).

Further expansion of PGR support can be evidenced by the SoE recently attracting KA107 Erasmus funding (165k Euros over 3 years) to facilitate international research, recruit prospective PGR/PhD students and aid their mobility between Lincoln and three Jordanian HEIs. The SoE is the principal coordinator of this initiative which supports the three collaborative thematic areas of Engineering, IT/Computer Science and Pharmaceutical Studies.

2.3 Equality, Diversity and Inclusion

The UoA has 19 T&R (Teaching and Research contract) staff members, with 21% female and 47% of staff identifying as BAME; the latter being significantly higher than the Lincolnshire average of <5% and the UK national population average of 14%. BAME academics constitute 62% of Grade 7-8 staff submitted to the UoA. Investment and support of young, high quality academics also features strongly in the School's ethos, as evidenced by 36% of staff being 34 years or under.

Equality, diversity and inclusion within the SoE is overseen by the School's Equality, Diversity and Inclusion (EDI) Committee. The EDI Committee consists of academic and support staff and students from all levels (UG to Head of School). Members are selected ensuring diversity in background and experiences (i.e. those with caring responsibilities, ethnicity, gender, disabilities etc.). The committee is co-chaired by the Head of School (male) and the Lead for International Development (female) to ensure equal gender balance. Further, this arrangement assures that matters concerning both staff and students are fully considered in all committee meetings and SoE activities. The SoE EDI Committee reports to the College of Science EDI Committee.

The SoE EDI Committee continues to ensure that EDI considerations underpin all SoE activities. For example, all whole staff SoE meetings run no later than 3pm to better support staff with childcare responsibilities to attend. One of the primary roles of the Lead for International Development is to ensure the international student voice is at the forefront of any SoE decisions and to ensure maximum integration and promote a sense of belonging. Another paramount focus is raising the cultural awareness of all students (born within or outside the UK) and includes a SoE 'Global Award' to promote students' opportunities to engage in cultural awareness activities, e.g. summer schools, peer mentoring etc.

3. Income, infrastructure and facilities

3.1 Research Income

Research income has become a priority during this census period to facilitate our rapidly growing research profile. During this period 2014-2018/2019, SoE academics have secured more than £3.8m in external funding as PI and contributing to more than 30 individual projects in total. The current proposal submission-to-success ratio is over 75% (new research group structure), with a mean submission-to-success ratio over the total census period of 50%. Funding secured has increased substantially over the period 2019/20 with the inclusion of two internationally funded projects worth more than £1.3m alone with China and India, for instance. This also reflects the increased diversity of research partnerships during the census period, of which 38% has been national and international industrial collaborative research. This has led to a rapid growth seen in our income generation profile of 168% (mean) over the past 5 years.

The SoE was formed in 2010 in partnership with Siemens Industrial Turbomachinery (Lincoln). Our early research focus was on industrial gas turbine technology and the majority of research income came directly from Siemens. During the census period, direct funding from Siemens has amounted to over £700k. Subsequently, the SoE has substantially broadened its portfolio of funded research, gaining support from a range of new industrial sponsors, including Tesco, Teledyne e2v, CRRC (Chinese National Railways), Huawei Internet of Vehicles

(IoV), and Mitsubishi Electric. For example, the collaboration with Mitsubishi has brought in more than £140k of funding during the census period, while the two vehicle projects with Chinese industry has generated over £300k during 2019-20.

While over half of our funded research is in direct collaboration with industrial partners, there have been notable successes with grant awarding agencies. Research Councils have funded projects such as novel robotic automation of food manufacturing (£139k), optimal ground transportation (airport operational engineering, TRANSIT, £316k) and evolutionary digital expert systems (£96k), among others (total £1.3m). The SoE also received funding for research in air transportation via the EU FP7 programme. In addition, the Royal Academy of Engineering has supported several research activities, including international collaborations and an industrial Visiting Chair.

The overall scope of SoE funded research covers a wide spectrum of applications and industrial sectors. Focus areas include smart energy and renewables, packaging from waste and laser induced breakdown spectroscopy for real-time emissions monitoring, automation in the agri-food sector, and the intelligent control of mobile robots and ground vehicles – including autonomous safety of road vehicles, inspection robots for space applications, aircraft ground movement optimization (IDSI research group).

A particular highlight, mainly from the SEP research group, has been its collaboration with the Lincoln Institute of Agri-food Technology, with SoE academics contributing, both as PI's and Co-I's towards more than £6m of research

funding. Most notably, researchers and academics from the SoE participated in a £5.5m (total) project on dynamic energy control for food retailing refrigeration systems (IUK). Led by Intelligent Maintenance Systems Limited, the SoE took the research lead in the University's £1.03m of attributed funding.

A special highlight from the IDSI group has been its long-standing collaboration with Siemens in the area of Industrial Digitalization with the STARMS project (Siemens Turbomachinery Applications – Remote Monitoring System). This project is focused on remote diagnostics and health monitoring of the global network of gas turbines used in the field. SoE research has led to a new generation of validated algorithms, based on signal processing and machine intelligence, to improve the reliability and scope of this service that Siemens offers to its worldwide network of customers. Funding has further expanded into Siemens of Germany, as the work has become widely known and respected within the company. Impact of this research is detailed in the submitted impact case study 'STARMS: Online Diagnostics for Improved Operational Behaviour of Industrial Gas Turbines'.

Our strategy for building research income and associated industrial impact encompasses four significant areas:-

1. Supporting individual researchers by providing time, mentoring and expertise to help with grant applications.
2. Expanding the proportion of collaborative bids through extended networking opportunities and researcher training.
3. Improving the quality of research proposals through internal peer review and strategic research planning.
4. Developing the track record of each academic by increasing the number of their top-rated outputs, including small-scale feasibility studies and the generation of pilot data.

The SoE has incorporated time spent on writing research proposals within an annual workload model to ensure that researchers have time to work on them. All ECRs are assigned a senior academic as a research mentor to ensure they have one-to-one support from someone experienced in successful bid writing. The College of Science also provides grant writing workshops and seminars. Identification of appropriate funding schemes, interpretation of scheme rules and requirements, and support for costings and budgets, are provided by [dedicated research officers](#) at both the College and University levels (the latter through the division of Research & Enterprise—a central professional support department).

The SoE promotes collaborative bids through structures that support interdisciplinary research both within and beyond higher education. In particular, funding is available at School, College and University level, for facilitating collaborative bids. Networking (through conference

and collaborator visits) is also supported financially through the SoE research fund and via the College of Science research fund.

A formal peer review scheme has been established within the College of Science to improve the quality of research proposals submitted. Drafts of grant applications are to be made available six weeks ahead of the submission deadline and sent for peer review by one expert and one lay reviewer (minimum). This provides time for researchers to make appropriate improvements in good time. All submitted bids are further reviewed by Research & Enterprise for correct costings and compliance with scheme rules before being signed off. As required for peer review, the individual research planning process ensures that funding bids are planned well in advance and fit with the individual researcher's overall profile. Peer review is also conducted at the SoE level to provide earlier feedback and more subject-specialist support for research proposals. Typically, bids are reviewed by a senior colleague with a successful track record of relevant funding. Where no subject specialist is available, the scheme allows for external reviewers to be hired.

To ensure that bids are supported by an appropriate foundation work and track record, the College of Science research fund supports small studies to demonstrate the feasibility and produce pilot data. The SoE has successfully won several small 'pump-priming' funds via the European Structural Investment Fund (ESIF) supported Innovation Programme and Productivity Programme which provide Innovation Vouchers, each with budget up to £5k. Although the income is small, the diversity is essential, and local companies have benefitted from several start-up projects with the SoE. A recent example ([Margetts](#)) has collaborated with a local company, Mibrid (formed in 2016 to supply low cost EVs), to design and develop a low-cost electric vehicle chassis. The project focussed on handling stability and early results have been encouraging. Contact with Mibrid remains active, and several additional collaborations have built upon this initial project, including three MSc projects funded by ERASMUS+ from SIGMA-Clermont (France). A further travel grant came from this partnership, leading to an ongoing collaboration with UC Davis (USA) to explore advanced vehicle modelling with Hyundai Research Centre (South Korea). This is a notable example where pump-priming via a small project has created new opportunities for future funding, creating a research cluster between the UK, France, USA and South Korea in this instance.

3.2 Infrastructure and Facilities

The University of Lincoln has made a step-change investment in Science and Engineering facilities during the census period. Following the Phase 1 construction of the Engineering Hub (EHub) in 2011, the University made a further £6m investment for Phase 2 extension in 2016 which created a 50% expansion in office and laboratory space compared to the original EHub. The expanded EHub also hosts extensive Siemens Global Product Training facilities, including gas turbine engines and peripheral technologies valued at more than £10m. These facilities provide a foundation for several research collaborations with Siemens.

After the completion of Phase 2, the Engineering Hub was further expanded to create the Isaac Newton Building. The overall project costs were £30m (including Phase 2) and included £500k for Engineering facilities and equipment. As a result, the SoE has access to a wide range of laboratory and technical facilities, including: biofuels research laboratory with new equipment for gasification and gas analysis; high power electrical systems including a Faraday cage structure enclosing the whole laboratory; renewable energy research laboratory; robotics and automation laboratories which are shared with Computer Science and host a wide range of industrial robots; the Laser Systems Laboratory used for research with Siemens and with food industry collaborators; a full-size vehicle simulation laboratory with 360° visualization and hardware-in-the-loop vehicle control simulation; a semi-anechoic chamber used in conjunction with machine fault diagnostics; an EMC pre-compliance testing chamber with associated high gain antennas and data acquisition; a dedicated vibration testing laboratory with seismic slab and isolated vibration measurement tables. Multiple teaching laboratories include

space for PhD research, and all of these facilities are supported by a new 100 m² electrical/mechanical workshop.

SoE also has access to multiple research facilities outside of the Isaac Newton Building. This includes materials and thermo-fluids testing labs situated at other sites within Siemens Energy (Lincoln). For example, Siemens has given SoE staff access to its large-scale atmospheric and high-pressure testing chambers to support our advanced combustion research, including laser ignition systems research and development. Other facilities include materials and chemical test facilities in the Joseph Banks Laboratories (main University campus), and laboratories for agri-robotics at the Riseholme campus.

4. Collaboration and contribution to the research base, economy and society

The SoE believes that a vital part of its professional duty includes contributing to the wider academic and professional research base, collaborating with key stakeholder groups and engaging with the public. The SoE has had an important and active contribution to society. SoE research staff continue to explore new ways of creating scientific, societal and economic impact.

4.1 UoA Collaboration and Contribution

Wider Academic and Professional Contribution

In terms of wider engagement during the census period, Engineering has hosted events for the Royal Academy of Engineering East Midlands Regional Lecture (2018); The Ogden Trust's Young Physicist of the Year Ceremony; and regularly exhibits its research in the renowned Lincoln SPARK! Engineering festival. The SoE is also a longstanding organiser and regular contributor to Lincoln regional industry breakfast events that have led to further collaboration and projects. For example, the Breakfast Club catalysed the formation of [The Bridge](#) – an Advanced Engineering R&D Centre. It was a critical mechanism for attracting multiple engineering companies with diverse business needs, into the initiative.

The HEIF-funded IP Commercialisation Fund and Impact Accelerator programme allow researchers to engage with industry via Knowledge Exchange Secondments, Innovation Fellowships and Mobility Awards. We have built long-term strategic partnerships with key collaborators – for example, we are one of Siemens 17 Global Principal Partner Universities, and have contributed to the success of the [Lincoln Science and Innovation Park](#) with the Lincolnshire Cooperative, which now hosts 15 companies.

Researchers within the UoA regularly peer-review articles for internationally recognised journals, and others also review grant applications for major awarding bodies both in the UK (e.g. [Gordon](#) is a reviewer for the EPSRC, [Saaj](#) is a panel interviewer for the UKRI FLF, and [Yao](#) for the British Council (UK National Commission for UNESCO) UK Researcher Links Newton Fund) and internationally (e.g. [Bingham](#) for the Qatar National Research Fund (2014), and [Yao](#) for The National Fund for Scientific and Technological Development (FONDECYT) of the Chilean National Commission for Scientific and Technological Research (CONICYT)). Samson is a Member of the Committee for the Clean Energy Special Interest Group for the Institution of Chemical Engineers (CE SIG, IChemE), and a Member of the Royal Society of Chemistry. Additionally, [Gordon](#) has acted as a reviewer for academic promotions at several international universities such as Politecnico de Milano and the University of Cambridge, and [Griffiths](#) is a Visiting Professor to the National Institute for laser, plasma and radiation Physics, Romania. Many members continue to offer keynote/invited talks (e.g. [Gordon](#) for the Royal Academy of Engineering's annual regional lecture at Nottingham and Samson to the Flame and Energy Research Forum) and are involved in event organisation such as leading the Greater Lincolnshire Manufacturing Network hosted by the University (SoE) and funded by the Greater Lincolnshire Local Enterprise Partnership and Greater Lincolnshire County Council, as well as coordinating the organisation of annual International

Engineering Summer School ([Elseragy](#)). Members of this UoA are also involved in editorial duties, such as [Bingham](#) acting as special issue editor for *Energies* and guest editor for MDPI (books) *Electrical Power and Energy Systems for Transport Applications*; [Yao](#) as a board member for the Journal of Applied Research and Smart Technology (ARSTech); [Tucker](#) as a Guest Editor for the Journal of Bioengineering (special issue: Electrospinning for Tissue Engineering) and [Calashkanov](#) as a board member of the IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP).

Members of the SoE are actively involved in national and international professional bodies beyond Higher Education (IMechE, IChemE, IET, IEEE, AIAA, BCS, RSC etc.).

SoE regards these wider contributions as highly critical and valuable, and supports them through financial, developmental and organisational means. Individuals contributing to this UoA are encouraged to take up opportunities where they exist and asked to identify areas where they would like to participate as part of their annual development and appraisals. Any wider academic and professional activities are accounted for in the workload model and funds to support travel to relevant events is departmentally provided. Additionally, further support is also available from the Lincoln Institute of Advanced Studies for international opportunities. Research mentorship offered by the SoE provides early career staff with advice and knowledge of professional opportunities. Further, useful contacts and networking opportunities are also made visible to faculty and researchers.

The SoE has a mission to increase regional investment and employability in high technology research and development. With SMEs and OEMs coalescing around the Engineering Hub, knowledge transfer between academic-industry became more effective. For instance, e2v (Teledyne) has [quoted](#) closer links with the SoE as a motivator for part-relocation of their business.

The SoE also recognises the value of timely knowledge dissemination. It uses the University of Lincoln's ePrints open-access data repository, facilitating external access to both outputs and underpinning data.

4.2 Research Group Collaboration and Contribution

Sustainable Energy and Power (SEP) research group

Led by [Bingham](#) the SEP group has already established on-going research activity, with key application sectors currently including smart energy and renewables research (e.g. [Bingham/Bickerton](#)'s work on Demand Side Response of widely distributed retail refrigeration systems in [Tesco](#) stores; packaging from waste (e.g. [Tucker's CERES agri-tech knowledge exchange partnership](#), £245k (Lincoln income), part funded through Ceres Agri-tech partnership and partly through HEIF); novel biofuels research (e.g. Samson's time-on-stream impact on carbon deactivation, enabling the use of inexpensive char to mitigate tar problems); alternative fuel and low carbon-emissions engines (e.g. [Bickerton](#) demonstrating the use of domestically disposed fat for powering ICEs); gas turbines (e.g. [Bingham](#) leads a significant research activity for prognostics and diagnostics of industry systems, including a global fleet of gas turbines). Moreover, in collaboration with the [National Centre for Food Manufacturing](#) (part of the College of Science), [Dowding](#) has successfully developed a new low-cost laser technology for improved food packaging integrity, with demonstrable repeatability, process flexibility and energy usage benefits. Members are also pioneering new technologies for the control of debris from micro-ablation and laser activated selective bonding. The Group leads a direct industry-funded (e2v Ltd, backed by the Anglo-French MCMITP initiative) research activity to investigate explosive detonation by plasma-initiated shockwaves ([Dowding](#)). Group members also have a pedigree in the application of novel manufacturing technologies, such as electrospinning ([Tucker](#)) and in particular, the manufacture of arrays of electrospun nanofibres with controlled orientation and density of deposition. This novel technology has applications in composite reinforcement, biological and chemical reactor substrates, and cell growth scaffolds. Members have a longstanding track record for the

research and development of renewable and energy harvesting technologies for both built environment and transport sectors. Continuing strategic expansion of SEP academic expertise is planned to support increasing electrical and control based disciplines to complement the University's/College's core strategic [research themes](#) eg. agri-tech/robotics, energy harvesting, vision/image/health. In addition, members' academic recognition includes a Visiting Professorship at Tongji University, Shanghai ([Gordon](#)), Presidency of the International Association for Vehicle System Dynamics, IEEE — Co-chair, Technical Committee on Intelligent Vehicular Systems and Control, Fellowship of the Inst of Materials, Minerals, and Mining ([Tucker](#)), membership of the IChemE's Clean Energy Special Interest Group (Samson) and on the scientific committee of several conferences such as the 12th European Conference on Industrial Furnaces and Boilers.

Industrial Digitalisation and System Intelligence (IDSI) research group

The IDSI group, led by [Saaj](#), conducts both theoretical and industry-driven research to advance innovation beyond the horizon. For example, significant activity concerns industry-funded research investigating sensor-fusion techniques for sub-15 MW industrial gas turbines to maximize unit operational availability. The outputs of the research are now also being used for forecasting customer operational behaviour ([Maleki](#)). The intelligent ground vehicles research conducted in partnership with Chalmers University in Gothenburg, Sweden, and also with Volvo Cars and National Electric Vehicle of Sweden is another area of strength. Ongoing research includes developing autonomous and semi-autonomous safety systems for cars (£300k). Members of the IDSI group have international recognition in their respective fields that includes, but not limited to, the following areas: multivariable and applied robust control, multi-objective optimisation and fuzzy methods applied to health (e.g. [Gallimore](#)'s prizeworthy research into the automatic classification of human heart abnormalities from ECGs), energy efficiency and air transportation, advanced engineering optimisation (eg. [Bickerton](#)'s turbocharger multi-objective optimisation design tools to reduce the impact of engineering tolerances and minimise waste materials; now in use by Napier Turbochargers), high performance embedded systems design (eg [Srivastava](#)'s high performance FPGA systems for satellite and microwave systems), intelligent laser ignition systems (e.g. [Griffiths](#) demonstrating the first controlled liquid-fuel ignition of gas turbines). Moreover, academic recognition at both national and international level includes editorial positions at top-ranked journals in the area of Systems and Control (e.g. IEEE Transactions Control Systems Technology, IET Proceedings Control Theory and Application and Frontiers in Robotics and AI), active memberships on highly acknowledged research committees and national chapters (e.g. in IEEE, IFAC – the International Federation of Automatic Control) and positions on conference organisation and (research-related) external roles. Recognition of the robotics and automation expertise residing within the SoE is evidenced by the University of Lincoln being a member of an international consortium, led by the Queen Mary University of London, which won the bid for hosting IEEE's premier conference - the International Conference on Robotics and Automation ([ICRA 2023](#)). The SoE academic, [Saaj](#), is a programme committee member for IEEE's flagship conferences [IROS 2021](#), [ICRA 2023](#) and [IROS 2024](#).