Ulster University

Faculty of Computing, Engineering and the Built Environment

School of Engineering

Research & Innovation Annual Report
01 August 2022 – 31 July 2023

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1 Foreword

Foreword: Research Director
Professor John Anthony (Tony) Byrne

In presenting the Annual Report for Engineering for the academic year 2022-2023, it is encouraging to report yet another successful year for our research activities. This last year was particularly challenging with the move of our main research base at Jordanstown to the new Belfast Campus. The research laboratories in Belfast campus are now fully operational and the new state-of-the-art space is an excellent environment for us undertake World leading research. Engineering Research involves a multi-disciplinary group of over 150 researchers. Our work is broadly conducted in two overarching themes relating to the Healthcare and Wellbeing Technology and Advanced Future Materials and Manufacturing. Within these themes we have clusters of research in healthcare sensor systems, biomaterials and tissue engineering, water research, composites, advanced manufacturing, plasmas, and nanomaterials that involve cross-cutting activities. Most recently, we now have a growing cluster in RF communications engineering.

We aim to sustain our excellent performance in REF2021 in which Engineering research at Ulster continued to grow both in terms of scale and quality. We have more than doubled the number of our staff submitted to REF since 2014 and the percentage of our research deemed to be world-leading has more than tripled. Conducting impactful research in line with the Sustainable Development Goals has always been a key component of our strategy and we are recognised as being amongst the top tier of UK Universities delivering exclusively 3* and 4* research impact in engineering. We continue to strive to create an environment that supports all our researchers in their ambition to realise the highest quality research and are delighted to also have the entirety of our research environment recognised as 3*/4*. The school has a strong EDI ethos as evidenced by our Athena Swan Silver Award.

The 2022-23 academic year was another successful period for Engineering Research with research income awarded of just over £2 million, 11 PhD Researcher graduations, and the publication of 113 peer reviewed journal articles in the reporting period. Of note was the award of £780k for the Multi-User Vector Network Analysis (VNA) Facility Core Equipment grant from EPSRC (EP/X03478X/1), an EPSRC New Investigator Award (EP/X038408/1) and a MRC Award (MR/W029561/1).

Engineering research at Ulster aligns with two major innovation funding developments under the Belfast Region City Deals as outlined below.

The £43M **Centre for Digital Healthcare Technology (CDHT)** led by Ulster will provide a world-class space for academia, industry and clinicians to come together to innovate and boost the productivity of the Life and Health Sciences sector, as well as medical device and related sector activity in Northern Ireland. It will bring together internationally leading Computing-SERG (AI to IOT), Engineering-NIBEC (Digital Health Technology to diagnostic devices) and Biotechnology strengths (Molecular Diagnostics) from three Schools at Ulster leading to multidisciplinary research focused on many of the world's key challenges including rising healthcare costs and healthy ageing. Currently this initiative is operating in virtual mode with space

allocated for hosting companies, which currently include Dell, BT and PWC and has a newly set-up Integrated Diagnostics Laboratory and the commissioning of a new Digital Twin, IOT and Robotics Laboratory. The construction of a 5-storey building based at a site adjacent to the Belfast Campus is currently being tendered for and the design of a Clinical Living-Lab is underway at the Belfast Health and Social Care Trust (BHSCT) facilities.

The £96M **Advanced Manufacturing Innovation Centre (AMIC)** is aimed at securing Northern Ireland's manufacturing future and will be a springboard for innovation in the sector in Northern Ireland. AMIC will operate at the interface between academia and industry, by creating new opportunities for innovative manufacturing in the Belfast City Region. The involvement of both Queen's University Belfast and Ulster University will ensure that real-world industrial challenges based on market need are solved through cutting-edge research. AMIC builds on 50 years of sustained innovation and industry support through the Northern Ireland Technology Centre (NITC), the Polymers Processing Research Centre (PPRC) and the more recent university-industry partnership, NI Advanced Composites and Engineering (NIACE), and will consolidate and enhance these existing facilities.

We continue to enhance our research environment with the School hosting a Seminar Series with lectures from visiting researchers, academic staff, research staff and PhD researchers. We have hosted visiting researchers from countries including India, Brazil, and Israel. The School has also hosted external events including the UK Society for Biomaterials conference in June 2023 and a Health Technologies ECO event in November 2022. We also actively engage in outreach and participate annually in the Northern Ireland Science Festival with Engineering Futures showcasing our research to primary school pupils.

Further details of our research, facilities, staff profiles and research expertise can be found at School of Engineering - Ulster University Departments or by contacting Charly Mifsud (Academic Excellence Executive Assistant) at Email: c.mifsud@ulster.ac.uk; Ph: +44 28 9536 7635.

Professor John Anthony Byrne
Research Director, School of Engineering.

Unit of Assessment 12. Engineering

REF2021 Research Excellence Framework

12. Engineering (ulster.ac.uk)

“Engineering research at Ulster has continued to grow both in terms of scale and quality. We have more than doubled the number of our staff submitted to REF since 2014 and our percentage of research deemed to be world-leading has more than tripled.

Conducting impactful research has always been key to our strategy and we are delighted to be recognised amongst the top tier of Universities delivering exclusively 3* and 4* research impact in engineering.

In addition, we have strived to create an environment that supports all out researchers in their ambition to realise the highest quality research and are delighted to also have the entirety of our research environment recognised as 3*/4*.” Professor Dewar Finlay, Research Director

2 Research Students

The following research students were registered on research degree programmes during 2022-23.

Name	Project Title
Abdullah, -	Artificial intelligence enabled rapid low-cost in-situ fluorescence sensor platform and excitation-emission matrices for faecal contamination detection in water.
Akram, Muhammad Shakeel	Cardio-AI-ReAccel: Reconfigurable Accelerators for Artificial Intelligence in Cardiology.
Alkharabsheh, Salem	Development of novel mechanisms based on photo and electrodisinfection and decontamination of wastewater and drinking water.
Antony Samy, Anto	Development of simulation models for additive manufacturing of polymers.
Aston, Will	Industrialised manufacturing processes for 3D printable biomedical sensor devices.
Bradley, Zoe	Enabling low-cost multiplexing for rapid point of care diagnosis of sepsis.
Cameron, Sarah	Chronic Wounds in the Community: A Smart Device Approach to Detecting the Early Onset of Infection.
Daha, Muhammad Yunis	Edge Intelligence for 5G Networks and Beyond.
Davidson, Scot	Advancements in Biomedical Signals Using Artificial Intelligence for Real-Time Detection and Classification of Epileptic Seizures.
Duffy, Sean	Development of multifunctional Polyether Ether Ketone (PEEK) Composites.
Fairooz, Towfeeq	Assessing the role of deep-learning in image-analysis of biosensing colour changing elements.
Gallagher, Courtney	Development of Image Analysis Algorithms for In-Situ and Ex-Situ Characterisation in Materials Science and Engineering Applications.
Hasson, Frances	3D printed Polymer/ Bioceramic Composites for Medical Devices.
Islam, Kd M Raziul	Intelligent Electromagnetic Surface-Based Microwave Beamformers.
Kambley, Ankur	Metal quantum dots and clusters for energy applications.
Kashyap, Apoorva	Low energy plasma radiotherapy – could this be a route to gentle and effective treatment of cancer or antibiotic resistant microbes?.
Khalid, Hessan	Plasma driven exsolution from perovskite oxide for catalytic application.
Khalil, Sameh	Novel nanostructures for high efficiency solar energy harvesting.
Lionadi, Indrianita	Visualization, characterization and treatment of cancer cells using nanoparticles.
Macartney, Robyn	Electrospun Polymer Biomaterials for Periodontal Regeneration in Type 1 Diabetes.
McCallan, Niamh	Advancements in detection and classification of anomalies in multidimensional biomedical signals using data-driven techniques.
McCartney, Ben	An investigation into paediatric out of hospital cardiac arrest and resuscitation; role and optimisation of PADs.

McCausland, Christopher	Automatic detection of sleep arousals using deep learning and a visual representation of time-frequecny analysis of EEG signals.
McFerran, Aoife	Multi-Functional Layered Nanocomposite Coatings for Bioactive Tissue Scaffold Development.
McGreeghan, Aine	Understanding the influences on the self-efficacy of female engineering students in Northern Ireland.
McLarnon, Liam	Development of optically transparent nanofibrous biomaterial scaffolds for ophthalmic tissue engineering.
McMullan, Reshma	Studying the 3D printing on PEKK with respect to different grades and suppliers.
Montgomery, Callum	Advancing composite preforming technologies for complex loaded maritime structures.
Moore, Michael	Printing of Biological Cells: 3D Printing of Biological Cells for Tissue Engineering Applications.
Muldoon, Kirsty	High Precision 3D Printing for Novel Biomedical Applications.
Nasr, Sara	Advanced techniques for detection and removal of biofilm in marine vessels using electric sensors.
Nguyen, Chi	Deep Learning Models for Channel Estimation and Modelling in Wireless Networks.
O'Boyle, Adam	Development of an autonomous tufting machine for carbon laminate reinforcement.
O'Donnell, Eimear	3D printing for manufacturing medical devices.
Patterson, Trudy	An investigation into the implementation of Project Based Learning for teaching Engineering within the Higher Education Sector.
Rioja Cabanillas, Adriana	Investigation and development of electrocatalysts and electrochemical cells for the production of hydrogen from wastewater.
Rooney, Karyn	Analysis of Materials, Processes and Design of Continuous Multilayer Composite Pipe.
Scott, Cameron	Water Security and Ecosystem Surveillance: Design of Sensors for Remote Drone Systems within Marine and Freshwater Environments.
Spence, Cody	Development of advanced preforming technologies for use in complex marine structures.
Stinson, Harley	Additive Manufacture via Cold Metal Transfer.
Ward, Richard	Design and development of additive manufacturing process machinery for production of larger structures.
Wucherer, Stefanie	Developing a hybrid model and supervised learning approach for automated handling tasks using tactile feedback.
Zhang, Xushuo	Point-of-Care Lateral Flow Analysis for Cystatin C Based Kidney Function Diagnostics.

Graduated December 2022

Name	Thesis Title
Dahale, Monali	Fundamental characterisation of 3D woven composites for aerospace and automotive industry applications
Manzoor, Faisal	3D-printing and characterization of PEEK bioactive composites for craniofacial applications
Saeed, Khalid	Development of novel materials and techniques for additive manufacturing
Ullah, Jawad	The Influence of additives (pigments) on the processing and properties of polymers for medical device applications

Graduated July 2023

Name	Thesis Title
Afkhami, Arsalan	Design, modelling and development of filtration processes for household water treatment systems
Dsouza, Slavia Deeksha	Novel nanomaterials for next-generation solar cells
Harkin, Ryan	An Investigation into the Laser-based Powder Bed Fusion Process for Ti6Al4V Components
Li, Shiyao	Using multiwalled carbon nanotubes to impart electrical conductivity, particularly in the electrostatic dissipation (ESD) range, to injection moulded polyether ether ketone (PEEK) components
McAlister, Olibhear	Analysis and characterisation of biosignals for the optimisation of cardiopulmonary resuscitation
Meenagh, Aiden	Conductive PCL-Graphene 3D scaffolds for functional cardiac tissue models
Shah Mansouri, Tahereh	Machine learning and patterning recognition in a new sensor systems for chemical-biological detection and biomedical applications
Singhal, Amit	An evaluation of g-C3N4 and BiVO4 for photocatalytic water treatment and disinfection

3 Publications

Details of all Publications by the School of Engineering are on the Ulster University's Institutional Repository-PURE https://pure.ulster.ac.uk/. This section reports those outputs published over the period of this report and classified as either journal articles, books/chapters in books and published conference papers.

3.1 Journal Articles

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Bakaya, K, Paracha, W, Schievano, S & Bozkurt, S 2022, 'Assessment of cardiac dimensions in children diagnosed with hypertrophic cardiomyopathy', Echocardiography, vol. 39, no. 9, pp. 1233-1239. https://doi.org/10.1111/echo.15437

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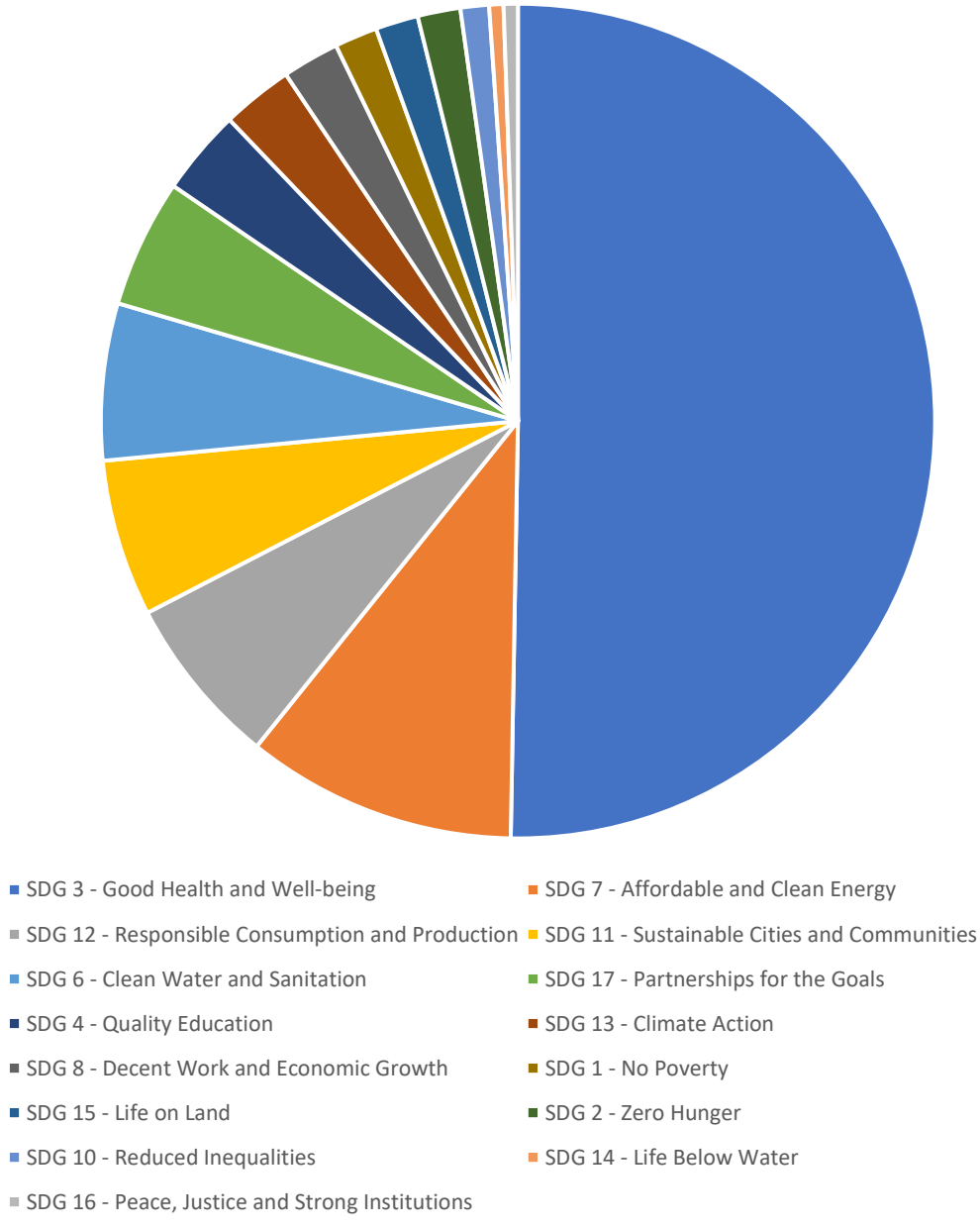
Universities and knowledge institutions globally have a critical role to play in the achievement of the United Nations Sustainable Development Goals (SDGs).



4 Research Funding

Portfolio of Research Grants awarded during period 1 August 2022 - 31 July 2023

Unit of Assessment Member	Title of Award	Funding Body	Value	Date
Prof John Byrne Dr MS Gallagher Prof Mickey Keenan Dr Nigel Ternan Dr Ruth Price Prof Helene McNulty Prof James Dooley Prof Rory O'Connell Dr Michael Brennan Dr Alan Brown Dr D Guldenring Dr George Burke Dr Mark Ng Prof Pilar Fernandez-Ibanez Dr Patrick Dunlop Prof Dewar Finlay Prof J Davis Prof James AD McLaughlin	SAFEWATER Support (Support to 70203R)	EPSRC-Global Challenges Res Fund - RCUK	£22,404.00	01/07/2022
Prof Davide Mariotti	International Newton 2022	The Royal Society	£131,250.00	05/09/22
Professor Alistair McIlhagger Dr Edward Archer Dr Calvin Ralph Dr Atefeh Golbang Dr Patrick Porter Alison Gault	Reviving Northern Irelands Textile Heritage	DfE NI Department for the Economy	£80,000.00	11/11/22
Prof Margaret Morgan Dr Bogaraju Sharatchandra Varma Prof James McLaughlin	WE-Bridge-Program@UU: Women in Electronics Bridge Program @ Ulster University	Royal Academy of Engineering	£70,000.00	22/11/22
Prof Pagona Papakonstantinou Prof James Davis	Microneedle Array Patch for the continuous monitoring of multiple	British Council	£49,544.00	23/11/22

Dr Nikhil Bhalla Prof Finbarr O'Harte Dr Paula McClean	Chronic Kidney Disease biomarkers in transdermal biofluid			
Professor Alistair McIlhagger Dr Edward Archer Dr Calvin Ralph Dr Atefeh Golbang Dr Patrick Porter	A natural fibre supply chain in NI	DfE NI Department for the Economy	£80,000.00	30/11/22
Dr Edward Archer Prof Alistair McIlhagger Dr Calvin Ralph Dr Atefeh Golbang Dr Joanna Ward	A green carbon fibre opportunity Northern Ireland	DfE NI Department for the Economy	£74,000.00	05/12/22
Prof Christopher Nugent Prof Frank Lyons Prof James Mclaughlin	DELL Technologies PhD Funding: CDHT and SMIL	DELL Technologies	£204,088.00	07/12/22
Prof James McLaughlin	Collaborative Research Support Fund - Theme Leader Digital Health (NICP) (2022)	Department for the Economy	£72,828.00	01/01/23
Dr Nikhil Bhalla Prof Pagona Papakonstantinou	Design and Development of Bio/Chemical sensors to address antibiotics abuse in India	British Council	£39,934.00	05/01/23
Prof Brian Meenan Dr Adnan Ahmad Cheema Dr Muhammad Usman Hadi Dr Sunish Kumar Orappanpara Soman Dr Jonathan Acheson Dr Adrian Boyd Dr Patrick Dunlop Dr Patrick Lemoine Prof Dewar Finlay Prof James McLaughlin Prof John Byrne Prof Alistair McIlhagger Dr Kok Ng	Multi-User Vector Network Analysis (VNA) Facility Core Equipment.	EPSRC Engineering & Physical Sciences Research Council	£782,502.00	25/04/23

Dr Calvin Ralph Dr Ardavan Rahimian Dr Selim Bozkurt Dr Joseph Rafferty Prof Christopher Nugent Prof Jonathan Wallace Prof Liming Chen Dr Raymond Bond William McElholm Prof Jim Harkin				
Monali Dahale Anto Antony Samy	Manufacturing and modelling of variable thickness near-net-shaped 3D woven composites for complex aerospace structures	EPSRC Engineering & Physical Sciences Research Council	£7,500.00	04/05/23
Dr Jonathan Acheson	Multi-doped Calcium-Phosphate coatings for resorbable magnesium alloy implant applications	EPSRC Engineering & Physical Sciences Research Council	£409,270.00	15/06/23

Note from the Associate Dean

It is my pleasure to endorse the Research & Innovation Annual Report from School of Engineering (SENG) for the 2022-23 Academic Year. The report provides a concise account of the core research activities undertaken and the outputs achieved in the period.

The research and innovation activities reported here build on the excellent outcomes that colleagues in the School achieved in the 2021 Research Excellence Framework (REF 2021) and contribute to our ambition for an even better performance in the next REF exercise.

The achievements reported here are fully aligned with the Ulster University Strategy, People, Place & Partnerships: Delivering Sustainable Futures for All (Strategy - People, Place and Partnership (ulster.ac.uk)) and the Ulster University Research Strategy 2023-28 (Ulster University Research Strategy 2023-2028). As such, they contribute significantly to the Faculty of Computing, Engineering & the Built Environment Operational Plan in respect to the delivery our collective goal of research excellence, inclusion, and impact.

Professor Brian J. Meenan
Associate Dean, Research & Innovation
Faculty of Computing, Engineering & the Built Environment

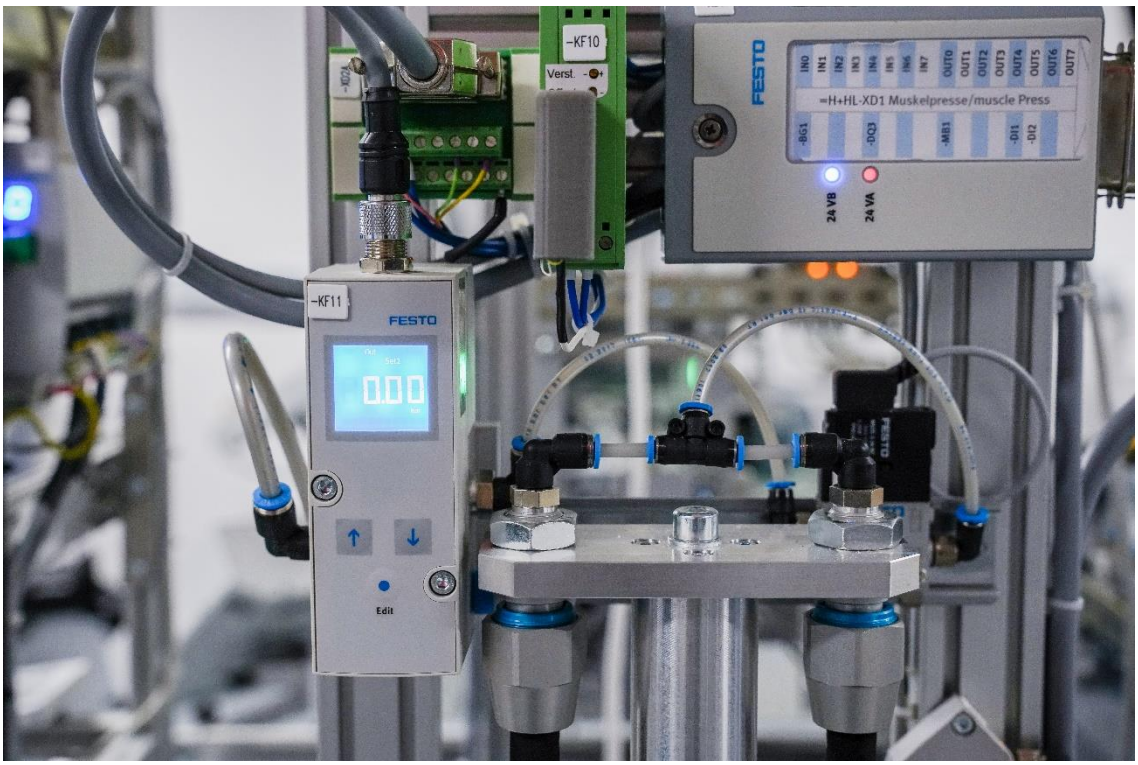
Ulster University

Faculty of Computing, Engineering and the Built Environment

Our research may be viewed in two main themes with sub-clusters of research activity;

Theme: Health and Wellbeing Technology
Clusters *– Healthcare Sensor Systems, SAFEWATER, Biomaterials and Tissue Engineering, with emerging cluster in wireless communications.*

Theme: Advanced Future Materials and Manufacturing (AFM2)
Clusters *– Composites research, Advanced Manufacturing, Plasmas and Nanotechnology*



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