



*Shaping  
future  
societies*

RESEARCH AND INNOVATION  
ANNUAL REPORT

2022/23

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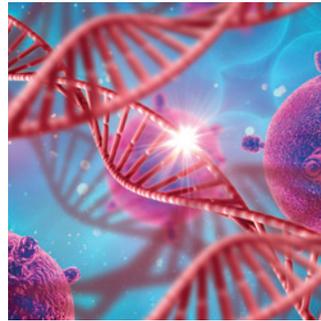
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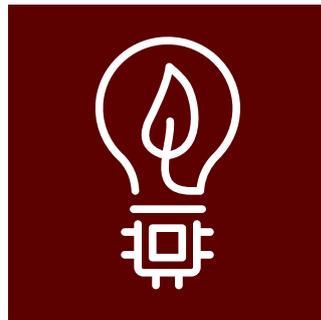
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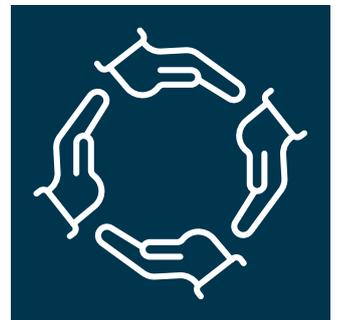
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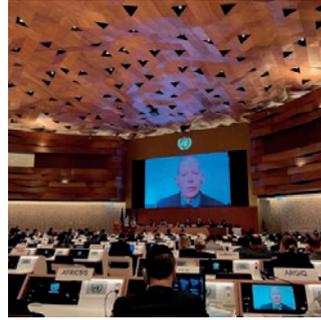
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Professor Harris Beider, Pro Vice-Chancellor, Research, Innovation and Engagement

## *Foreword by* Professor Harris Beider, Pro Vice- Chancellor, Research, Innovation and Engagement

I am delighted to join the University of Bradford as we publish our first annual report reflecting on the difference we make through the outstanding work we do to advance knowledge, and share this with the world to encourage positive and impactful change.

Our research encompasses many fields of applied and vocational scholarship, and we contribute across themes of health and care, the engineered environment together with sustainable societies.

This report highlights some of our world-leading centres for research and innovation, both long-established groups and new investments in people and programmes, all pursuing our strategic mission to shape future societies.

It also tells some of the stories of the change we drive through research – sometimes profound, sometimes more personal – leading to benefits for people locally and globally.

As I take up the role of PVC, let me extend my thanks to my immediate predecessors, especially Professor Chris Gaffney, for their own leadership in defining and implementing our current research and innovation strategy.

Let me close by extending an invitation to you to join us on our journey of change-making through research and innovation with the goal of shaping future societies. Collaboration and co-production are core in the delivery of impactful, high-quality applied and vocational research. Whoever you are - whether student, resident industry expert, politician, civil servant, or researcher at Bradford or elsewhere - we are committed to working with you in the work we do.

I hope you enjoy this report and find the intersections with your own interests. Please let us know how our mission aligns with yours, and how we might work together to make a difference now and in the future.



## *Research theme:* Health and Care

Our academic vision seeks to develop new models of health care delivery, health promotion and technology-enabled treatment models. This focus will reduce the burden of avoidable illness, reduce health inequalities and enhance the effectiveness of health and care interventions.

Our strong track record in health research is demonstrated through successful partnerships with healthcare organisations and across the pharmaceutical and beauty industries. We are also a major provider of expert practitioners to the UK and global healthcare sector.

### RESEARCH AREAS:

Inclusion and Diversity

Healthy Ageing and Dementia Studies

Health Technologies for Quality and Safety

Healthy Childhood

The Life Course - Cells to Systems in Health and Disease

The Interface of Chemistry, Biology and Materials

Computational and Data-Driven Science

Health, Society, People and Place

Archaeological and Forensic Sciences

Medical Engineering

Psychology

On the following pages are examples of notable **health and care** research projects in the last year.

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Director of the Institute of Cancer Therapeutics Professor Sherif El-Khamisy

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## DNA breakthrough contributing to new ways of beating cancer

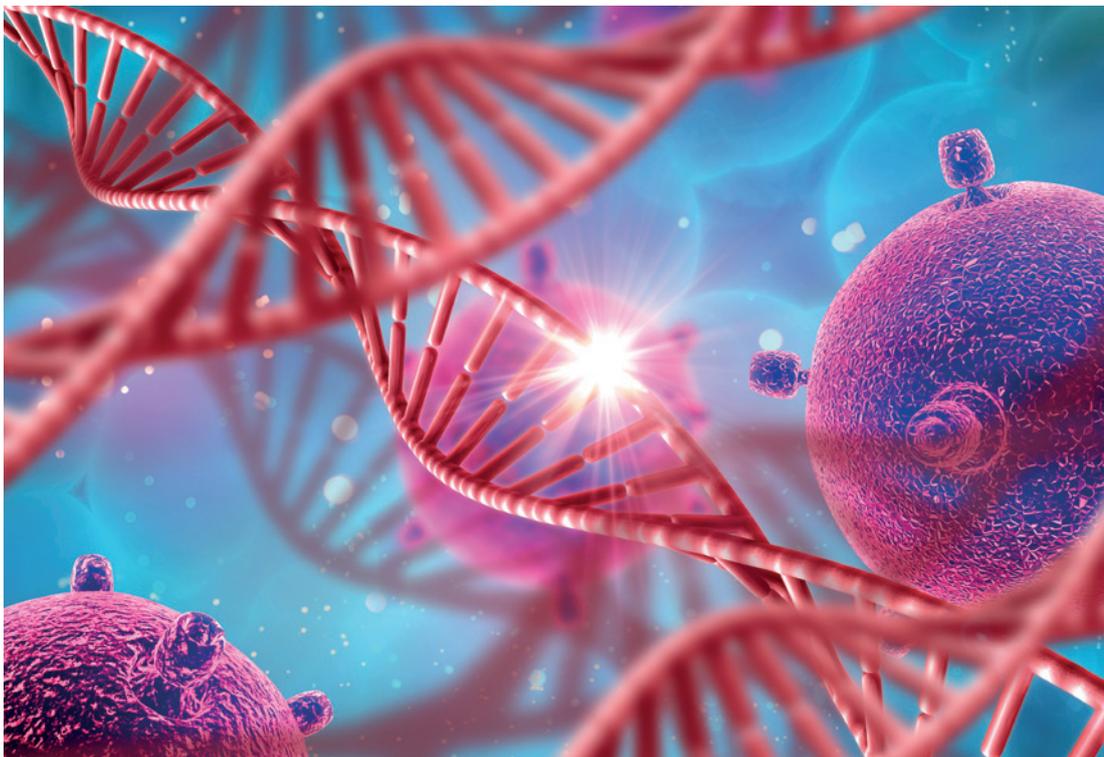
We are constantly innovating and exploring new techniques in the battle against cancer with a collaborative approach to research in our purpose-built Institute of Cancer Therapeutics (ICT) facility.

ICT Director Professor Sherif El-Khamisy describes the Institute's progress in the last year:

*"We've been making headway with two major issues of cancer treatment: Firstly, we've been able to make some very good progress in tackling relapse and recurrences of cancer by targeting new pathways and using smart chemistries so that cancer is less likely to return following successful treatment by chemotherapy or radiotherapy.*

*The other issue is the detrimental side effects of chemotherapy including depression, hair loss and nausea. Using our technologies, we've been able to develop treatments which reduce or minimise those side effects, and our expectation is that these drugs will undergo clinical trials soon."*

The ICT approach their research in three ways, as Prof El-Khamisy explains: "the first is identifying new targets, which includes finding new ways to break up the DNA of the cancer cells to induce cell death; the second is developing chemistry - producing prodrugs that are toxic to cancer cells but harmless to normal cells; and the third is DMPK (drug metabolism and pharmacokinetics) where we analyse the concentration and other properties of drugs to ensure they are at their most effective."



And it was within the first field of research, identifying new targets, that a discovery was made by Prof El-Khamisy leading to a new understanding of how DNA repairs itself, which has many potential applications in both cancer therapeutics and other medical treatments.

Historically there are many anti-cancer treatments that are based on inducing DNA damage, and the majority of chemotherapeutics kill cancer cells by breaking down the potentially cancerous DNA. Typically, these treatments target the bits of DNA that encode proteins, which is only 2% of the DNA. That means that the remaining 98% of DNA has largely been ignored, because as scientists weren't clear on its role, they dismissed it as unimportant (it was previously known as 'junk DNA'). However, it has since been discovered that the 98% remaining DNA has a vital role in whether disease is caused by controlling how many proteins are produced.

Prof El-Khamisy's new research discovered how the process of repair in the non-coding 98% of DNA works and how it affects the production of proteins. The findings were published in the leading scientific journal Nature and are significant in opening up a whole new area of studies and research in developing new drugs that induce DNA damage in the non-coding DNA. This could result in improved diagnosis and treatment for a variety of degenerative conditions, including dementia and motor neurone disease as well as cancer.

The ICT is embracing technology and in the last year has bought four pieces of equipment that can precisely determine drug concentration in biological fluids, meaning drugs can be modified to increase their effectiveness in treatment. Looking ahead, they are in the process of acquiring a radiation source for the first time to carry out more research into radiotherapy.



Dr Beth Fylan, Assistant Director of the PSRC



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## Transforming home care for patients

**We are playing a leading role in a new £5.8 million, five-year collaboration to improve the safety of health and care.**

Launched in April 2023 as a partnership between Bradford Institute for Health Research, University of Leeds and the University of Bradford, the National Institute of Health and Care Research (NIHR) Yorkshire and Humber Patient Safety Research Collaboration (PSRC) is the largest of six new national PSRCs funded by the NIHR to bring patient safety discoveries to frontline health and care services.

Dr Beth Fylan, Associate Professor in Patient Safety in the School of Pharmacy, is also Assistant Director of the PSRC, and is leading the research theme 'Supporting safe care in the home'.

Dr Fylan explains the context for the research:

*"The healthcare system is increasingly moving towards delivering care away from hospital settings, but if you're taking care into the home, you're also exporting risk into that environment. We're looking at the safety risks and benefits of healthcare delivered at home and the technical and clinical tasks that need to be performed there by patients, their family members, carers and healthcare professionals."*

The first stages of the programme of work are to assess the roles of different people performing care in the home, the tasks undertaken, their level of training and the background reasons for care being delivered at home. The research theme also includes work to support safely self-managing polypharmacy (taking five or more medications) and understanding the safety risks and benefits of remote and virtual care.

The PSRC's team of researchers is based at the Wolfson Centre for Applied Health Research, located at Bradford Royal Infirmary, and Dr Fylan sees this as an important factor in the team's success:

*"It's a hub for people from different research organisations in the PSRC to meet and work together. It's an important place where people feel like they're not part of a particular university, they're the PSRC, so we can concentrate on our collaborative goals of developing, testing and ultimately implementing patient safety solutions within health and social care systems."*

Also representing the University in the PSRC, Professor Udy Archibong is equality, diversity and inclusion champion, and Professor Rebecca Randell is co-lead in the 'Rethinking Safety Intelligence for Improvement' research themes. Dr Mohammed Faisal supports the PSRC with statistical expertise.



Children at The Academy at St James in Bradford in an active lesson

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## Getting children moving at school

**Researchers are working with schools and healthcare organisations across the region to improve the health and wellbeing of children by concentrating on motor skills and physical activity.**

The Creating Active Schools (CAS) programme encourages teachers to put physical activity at the heart of school life, and the FUNMOVES project helps to find and assist children with movement skills issues.

CAS, led by the University of Bradford and Yorkshire Sport, is now being used in more than 200 schools across the UK, including more than 50 in Bradford. Activities include a 'wet play' policy where children are given weatherproof clothing, and pioneering 'active classroom' teaching sessions, where children are encouraged to move around to complete tasks. Dr Andrew Daly-Smith, Reader in Healthy Childhood in the Faculty of Health Studies who is leading the initiative describes recent progress:

*“The highlight of the last year is the significant impact on the health and wellbeing of children within Bradford through the different projects. Central to the success of those projects is the thread of co-production. We’re working really closely with the schools, teachers, head teachers, pupils and parents to help design things that work for them within their settings, and that’s why they are being embraced.”*

Co-production is also a key factor in the FUNMOVES project - Project Lead Dr Lucy Eddy has worked with teachers, occupational therapists at St Luke's Hospital and placement students, and sees the connections between the NHS and schools as essential to improve outcomes for children.

Influencing policy is key to expanding the reach of these initiatives, and CAS has been cited in England's Active School Guidance and the International Society of Physical Activity and Health as a good example of a whole school approach and Dr Eddy has presented her work to Parliament and the Department for Education.

Healthy Childhood projects at the University of Bradford have received funding of around £300,000 in the last year, and around £850,000 in total in the last three years.



Dr Samina Karim arriving for the UNICEF project at Sukkur airport in Sindh province, Pakistan

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## Addressing social work challenges in the UK and Pakistan

Researchers are carrying out a four-year study into the abuse of children from Pakistani backgrounds, both within the UK and in Pakistan. The project aims to create data which will help bring about positive changes in both countries.

In 2022, Dr Samina Karim, Associate Professor in the School of Social Sciences and Department of Social Work was awarded a prestigious UK Research and Innovation (UKRI) Future Leaders Fellowship to conduct a four-year study into child sex abuse.

The award means around £1m in funding and in-kind contributions to undertake innovative research on the abuse of children from Pakistani backgrounds, both within the UK and in Pakistan. The project aims to support positive change nationally and internationally, as the research will yield knowledge on the cross-cutting issue of child sexual abuse in both countries in a novel way. Dr Karim explains:

*“The idea is to learn about the barriers in terms of reporting and responding to the sexual abuse of children from migrant communities, by first undertaking research in the country of origin and then apply this learning to the UK. Back in Bradford there will be lots of community engagement events as part of a very interactive process.”*

Dr Karim's research in the UK and Pakistan led to a role as a consultant in early 2023 working with UNICEF to put in place enough fully trained social workers in Southern Pakistan to ensure children's safety following the devastating floods of summer 2022. She describes the role:

*“I was responsible for training around 80 people from diverse backgrounds and levels of experience, who are now out to work as part of the UNICEF flood response in quite remote regions of Pakistan. I was also involved in training the trainers (managers and district coordinators), to make sure the training could be replicated and was sustainable.”*

The UKRI project is now underway with a team of researchers employed in Pakistan, and Dr Karim has also published a paper titled 'Power-informed practice in social work' examining how we define and understand the exercise of power and empowerment.



## *Research theme:* The engineered environment

Our innovative engineering research advances the fundamental understanding of engineering and applied science to create technological solutions to real world problems in a range of sectors and industries that include healthcare, construction, manufacturing and more.

Our unique set of experimental facilities provides an environment in which ground-breaking research can take place, students gain expertise in engineering design, management and problem solving, and where we can work with industry and commerce to provide specialist solutions to complex problems.

### RESEARCH AREAS:

Advanced Materials

AI and Visual Computing

Healthcare Technology Innovation

Sustainable Environments

Smart Industrial Systems

On the following pages we have highlighted a selection of recent projects under **the engineered environment** research theme.

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## AI technology saving lives and solving mysteries

The University of Bradford are pioneering the use of AI in a range of applications, most notably a revolutionary method to assess the quality of organs for transplantation which has the potential to save lives and tens of millions of pounds.

The OrQA (Organ Quality Assessment) project, which has received over £1 million in funding from the National Institute for Health and Care Research (NIHR), uses Artificial Intelligence-based facial recognition technology created by Prof Hassan Ugail in our Centre for Visual Computing and Intelligent Systems to assess the quality of livers and kidneys for transplantation.

The project was launched in March 2023 as a collaboration with NHS Blood and Transplant Unit, Newcastle University, Oxford University and the University of Bradford. Prof Ugail is leading the process of refining the algorithm at the heart of the technology and is supported by two postdoctoral researchers.

The machine learning algorithm is trained by feeding in images of organs which have been given a score based on their quality and suitability for transplantation. This assessment is led by Colin Wilson, transplant surgeon

at Newcastle upon Tyne Hospitals NHS Foundation Trust and co-lead of the project alongside a network of surgeons, meaning that the software is based on high-quality expert data. Prof Ugail explains:

*“We train the machine asking it to examine colour, texture, etc., and then test its accuracy against new images that it hasn’t seen before. At the moment we are getting around 85-90% accuracy, but the more images that we get the better the algorithm will be, so we’re working with NHS Blood and Transplant to get as many images as possible.”*

The ultimate goal of the technology is not to replace the expertise of surgeons, but to provide an initial assessment stage that will mean valuable time and resources of medical staff when an organ isn’t suitable



Prof Hassan Ugail, Director of the Centre for Visual Computing and Intelligent Systems with the de Brécy Tondo, attributed to Raphael, at Cartwright Hall, Bradford

for transplantation isn't wasted. An organ can only survive out of the body for a limited time and in most cases, only one journey from the donor hospital to the recipient hospital is possible, meaning it is essential that the right decision is made quickly. A key part of the OrQA assessment is to look for damage, pre-existing conditions and blood clots that would make transplant success much less likely.

The aim is that the technology will enable up to 200 more patients to receive kidney transplants and 100 more liver transplants a year in the UK, and with each liver transplant costing an estimated £300,000 - £400,000 it means that resources and money can potentially be allocated more effectively. The technology is also being developed as a commercial product so it can be rolled out in healthcare settings across the world when available.

The underlying face recognition technology behind OrQA is remarkably versatile. The algorithm to identify facial features with more accuracy than the human eye has been used to identify the Russian suspects involved in the Salisbury poisonings, a Serbian drug smuggler, an alleged Nazi war criminal living in the UK

and rogue police involved in torture in the Middle East and South Asia.

But beyond its initial use, there is a project underway funded by the UK Defence and Security Accelerator programme to look at fingermarks on a chemical level to get far more accuracy than standard fingerprinting, and Prof Ugail has even turned his attention to Raphael paintings, with the remarkable result of attributing an artwork to the Renaissance artist.

The de Brécy Tondo has been the subject of speculation for many years due to its similarity to another of Raphael's paintings, the Sistine Madonna, but the AI analysis of visual elements down to microscopic level, in addition to chemical analysis of the paint also done at the University of Bradford, has led Prof Ugail to conclude that it is 'undoubtedly' the work of the Old Master. Fittingly, the painting was displayed at Bradford's Cartwright Hall in July 2023 alongside the story of Prof Ugail's research, and due to public demand the initial two-month exhibition was extended to six months.



Professor Mostafa Mohamed, Head of the School of Built Environment, Architecture and Creative Industries (BEACI)

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## Capturing thermal energy to heat our homes

Research at the University is exploring how we can tap into thermal energy in the ground, including in our sewers, to heat our homes efficiently and reduce harmful emissions.

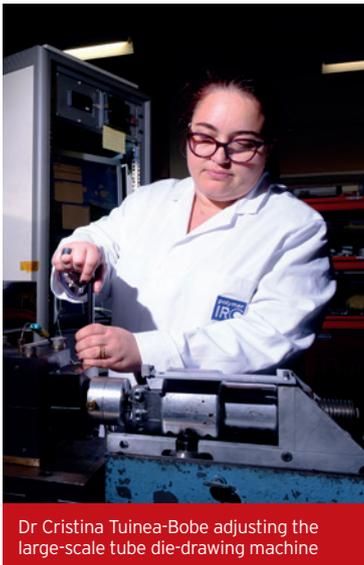
Professor Mostafa Mohamed, Head of the School of Built Environment, Architecture and Creative Industries (BEACI) is conducting research into technology that would dramatically improve the efficiency of heat pumps and says heat trapped in sewers could be harnessed efficiently. Prof Mohamed is currently focusing his research on investigating ways of improving the storage of excess heat in the ground. He explains:

*“We can recover heat from the soil, from tunnels and even sewers. But the technology needs to become more efficient and competitive to increase its adoption. It’s not something the UK is doing enough of at the moment, but it certainly has potential. This heat exchanger technology could be incorporated into the materials used to build houses, including the foundations of a building, we could even use it to recover energy from sewers and tunnels.”*

Prof Mohamed’s work on ground source heat recovery found that pipes encapsulated in a new aggregate material he has developed were 75% more efficient at transferring heat compared with those standard heat exchangers, and experiments are ongoing to improve the performance of the material even further and make sure it’s ecologically sound.

He and his team also looked at ways to further enhance the efficiency of heat recovery using rainwater, such as funneling roof run-off into soakaway areas, as initial experiments found that rainwater enhanced the recovery of energy from the soil by up to five times compared to when it was dry.

Looking ahead, Prof Mohamed is looking to build on the technology through partnerships with a company currently working on heat exchange infrastructure in Bradford, and a project to retrofit historical buildings with innovative thermal storage methods to make them much more energy efficient.



Dr Cristina Tuinea-Bobe adjusting the large-scale tube die-drawing machine



An example of the strong and light pipes created by the die-drawing process

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# Plastics expertise creating more sustainable water pipes

A method of making lighter, stronger, more durable plastic water pipes which are better for the environment has been pioneered by the University of Bradford and global materials company SABIC.

Using technology invented at the University by Professor Phil Coates, the pipes are made by drawing plastic through a die and then over a mandrel (a cone which further shapes and stretches the pipe to size as it rotates) which means that it has been stretched in two directions, or biaxially oriented. This process changes the properties of the plastic at the molecular level, making the pipes far stronger and more durable than traditional plastic pipes.

Dr Fin Caton-Rose, who runs the research laboratory in the university's globally-recognised Polymer IRC, explains further:

*“Pulling plastic through a die forces the molecules in the plastic to realign, so they are all facing the same direction, which makes it much stronger. In our biaxial pipes, the combination of a die and a mandrel gives us a balanced molecular alignment down the length of the pipe and through its thickness. These biaxially oriented pipes are*

*lighter and much stronger than traditional polyolefin pipes. They are easy to make, easy to transport and they last longer which means they are better for the environment.”*

Polyolefins are a versatile group of plastics that are widely used in manufacturing, featuring in around 50% of all the plastic used in Europe. But with sustainability in mind, this new process means the pipes are less prone to cracking and collapse so need to be replaced less often than pipes used today.

SABIC aims to capture 20 percent of the market with the new pressure pipes, and their ability to withstand high pressures and a range of chemicals means there are many other potential applications.

The project is part of a longstanding partnership with SABIC, a petrochemicals company with operations in around 50 countries, where we have collaborated on a number of projects including work with their healthcare division on microneedles.

The same die-drawing technology used in the plastic pipes is a versatile process that can be used in a number of ways; it has been used to create 'memory fibres', polymers for use in the building industry to exploit the fibres' ability to return to their original shape and close cracks effectively, and another project is using woven die-drawn fibres to create an extremely strong material.



Professor Anant Paradkar, Professor of Pharmaceutical Engineering, demonstrating the crystal engineering technology

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# Innovative crystal engineering technology a huge win for the environment

Award-winning 'crystal engineering' technology invented at the University of Bradford - marketed under the registered trademarks EfferShield® and EfferShine® - has had a massive impact on the manufacturing process of effervescent products, including a range of positive benefits for the environment.

The citric acid and sodium bicarbonate in traditional effervescent products causes them to fizz in humid conditions, requiring humidity-free manufacturing and packaging. EfferShield® and EfferShine® eliminate this issue, which opens up a range of benefits, including huge CO2 savings during manufacturing, vast reduction in transport costs and a reduction in the salt content of things like vitamin tablets and other supplements.

There are also significant environmental benefits in that tablets can be sold in environmentally friendly compostable packaging, this has a particular impact in the eco-cleaning market as every tablet used means one less plastic bottle in the environment, potentially translating to millions fewer bottles every year.

Professor of Pharmaceutical Engineering Anant Paradkar, director of the University's Centre for Pharmaceutical Engineering Science (CPES), on the breakthrough's significance:

*"This is a major achievement for our University that has global significance in terms of turning the tide on the use of single-use plastics, and reducing the carbon footprint of products, both during manufacturing and transportation. It also enables manufacturers to drastically reduce the salt content of certain products."*

The technology, which won Project of the Year at the BioNow awards, has been exclusively licensed to Octopoda Innovations Ltd, based in Liversedge. Octopoda Innovations will formulate, develop, and manufacture cleaning products using the EfferShine® technology. Health Innovations Group, based in Skipton, is the licensed partner to manufacture, formulate and develop effervescent products in the food and pharmaceutical sector utilising the EfferShield® technology.

A range of EfferShine® and EfferShield® products are available in stores across the UK and will be available in Europe soon.



## *Research theme:* Sustainable societies

The growing need to develop truly sustainable societies has arisen from global issues which affect us all; countries which are riven by war and conflict; the depletion of energy, food, water and other resources, and weak governance and economic models leading to corruption and stark inequalities.

The academic theme of Sustainable Societies includes innovation and expertise in fields such as sociology, business and economics, archaeology and heritage and peace and development. Our research supports growth in economic, political and relational well-being for current and future generations through globally relevant resources and initiatives.

### RESEARCH AREAS:

Accounting, Finance and Economics

Business Analytics, Circular Economy & Entrepreneurship (BACE)

International Business, Marketing & Strategy (IBMS)

Archaeological and Forensic Sciences

Archaeomagnetism

Peace Studies & International Development

Psychology

Social Work and Social Care

Sociology and Criminology

Inclusion and Diversity

We've selected four interesting case studies from the last year on the following pages that have **sustainable societies** as a key theme.

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Surveying in progress in the Adriatic Sea on the straight between the Island of Brač and mainland Croatia



Dr Simon Fitch, Future Leaders Fellow

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## Ancient undersea landscapes informing our past and future

The Submerged Landscapes team at the University of Bradford are considered global leaders in deep sea ancient landscapes, or palaeolandscapes, as a result of their pioneering research work which includes the first ever direct prospection of an artefact from the sea, and the mapping of more than 180,000 square kilometres of prehistoric landscape beneath the North Sea.

And recent research by the Submerged Landscapes team led by Dr Simon Fitch to look at the geography and archaeology of the seabed off the coastlines of Croatia, Belgium and Florida has revealed information about our paleolithic ancestors and provided data that gives us more accurate models of rising sea levels and tsunamis.

Dr Fitch was awarded a prestigious Future Leaders Fellowship in 2022 which has enabled the development of his work in the University of Bradford's Faculty of Life Sciences, the Life on the Edge project:

*"It's allowed us to move further back in time and study periods of time which haven't been studied before - we're looking at the Late Palaeolithic, which has never been looked at before in any detail. It's allowed us to test out new techniques, look at new study areas and reach out to wider audiences."*

This builds on previous work which helped tsunami researchers to better understand how landscape affects waves and provided data which allows researchers to better understand past catastrophic events and use the information to plan for the future, as Dr Fitch explains:

*"Our work on Doggerland has revealed new information on a huge tsunami in Britain around 8000 years ago, by collecting and analysing sedaDNA (sedimentary ancient DNA) from under the sea to establish the extent of the waves' devastating impact for the first time."*

The understanding of these underwater landscapes means that researchers can also improve how we model the impact of rising sea levels. Current models largely rely on sea level index points around the modern coastline, but these can be substantially refined by adding index points from positions further out to sea using data collected from the expeditions.



3D image which uses seismic data to show the Palaeo-Cetina river which is buried beneath the modern seabed off the coast of Croatia

The work of the team is also transforming the story of how our ancestors interacted with the once habitable regions now underwater, as described by Prof Vince Gaffney, Anniversary Chair in Landscape Archaeology:

*“Historians have known about land bridges and human dispersal for around 100 years, but without the technology to examine the landscapes there was no way of obtaining evidence to find out more. We’re now learning more about global migration patterns, but also that these areas, as big as modern countries, were desirable places for hunter gatherer populations to live with access to water and plentiful food sources, so not just places to pass through from A to B.”*

A further element to the research is the use of Magnetometry to examine submerged landscapes, an innovative use of technology and data collected by companies looking to extract oil, gas and minerals from the seabed and install windfarms. Ben Urmston, the Harding PhD Scholar in Marine Palaeolandscapes (funded

through a donation of £50,000 from The David and Claudia Harding Foundation) has been leading the project examining anomalies in magnetic fields by analysing magnetometry data, which could indicate the presence of archaeological features without the need for excavation.

He has already had significant results, including a map compiling all the Mesolithic sites in Britain and surrounding seas for the first time.

Looking to the future, the Submerged Landscapes team have an important role in ensuring that wind farms can be built without areas of special interest becoming inaccessible, as Prof Gaffney explains:

*“Britain is the leader in windfarm development in Europe, concentrated in the North Sea. We accept this as a necessity to get to net zero emissions, but there is potentially valuable archaeology in these areas, so we are designing strategies that allow developers to reduce the impact of potential damage by accurately mapping the landscapes which is beneficial for both parties.”*



'BD25', the first Boston Dynamics Dog in the UK with a colour vision camera, recently acquired by the School of Archaeological and Forensic Sciences

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## Exploring Bradford through its virtual twin

Since the launch of Bradford's digital twin last year, our archaeologists have developed their capabilities and knowledge even further around capturing the built environment (human-made structures) digitally, and Bradford Council has benefitted from having a resource that is useful in many ways.

The Bradford digital twin, a collaboration between the University and Bradford Council, is a 3D model incorporating more than 10,000 aerial images and street-level mobile mapping collected with cutting edge technology and combined to create an immersive virtual environment. The model can allow people to explore virtual replicas of buildings before they are built, take a tour of Victorian Bradford, check live pollution counts and many other applications.

Bradford Council have used the virtual model in urban planning, showcasing the planned development of Bradford city centre at a national infrastructure expo. They have also used it to understand and predict energy consumption and emissions, and to manage public engagement at Saltaire, a UNESCO World Heritage Site.

Further development of the digital twin and other digital heritage projects has been made possible through a massive £6 million investment the University has received from CapCo, the Capability for Collections fund, part of the Arts and Humanities Research Council's (AHRC) allocation of world-class laboratories funding, UKRI World Class Labs. The AHRC recognised the University's long-established reputation as one of

the key centres for archaeological research in the UK, including the prestigious Queen's Anniversary Prize in 2021 for world-leading work and innovation in developing archaeological technology and techniques and its influence on practice, policy, and society.

The funding has meant the University of Bradford is leading the way in the use of this technology, as Professor Andrew Wilson, Chair of Archeological and Forensic Science explains:

*"There are lots of UK firsts in that investment, ranging from the first cone beam CT scanner in any setting, the first TRK700 Evoke mobile mapping system that's vehicle mounted, the first Mosaic Viking Camera, which is the highest resolution 360 degree mobile mapping camera anywhere in the world and the first Boston Dynamics Dog in the UK that's got a colour vision camera. This means we can interrogate everything from tiny human remains up to cities and landscapes in unprecedented detail."*



Dr Michael Crowley addressing the global Biological and Toxin Weapons Convention Conference in Geneva



Dr Michael Crowley (left) and Emeritus Professor Malcolm Dando

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# A warning against the weaponisation of science research

**University of Bradford experts have been sharing their concerns about the potential misuse of chemical and biological research to create weapons which can affect the nervous system and brain chemistry and even cause death.**

Dr Michael Crowley and Emeritus Professor Malcolm Dando who produced a book published in November 2022, 'Toxin and Bioregulator Weapons: Preventing the Misuse of the Chemical and Life Sciences', attended conferences and gave briefings across the globe throughout the last year, encouraging action around the control of bioregulators and toxins to make sure they are not misused or weaponised. Dr Crowley describes the background to the issue:

*“Both the Biological and Toxin Weapons Convention (BTWC) and Chemical Weapons Convention (CWC) prohibit weaponisation of naturally occurring and synthetic toxins and bioregulators. However, in reality, there is a dangerous regulatory gap that risks the control regimes failing to effectively prevent development and use of toxin or bioregulator weapons.”*

The book contains case studies from China, India, Iran, Russia, Syria and the USA, including the exploration of poisons derived from plants and agents that affect the nervous system. The idea was that these real-world examples would provoke action, and the book contains comprehensive recommendations for the international governmental and science communities to ensure that rapid scientific and technological advances are safeguarded from hostile use and are instead employed for the benefit of all.

Promotion of the book and its messages involved articles in relevant media outlets and presentations at a range of conferences, and Prof Dando describes some of the response to their talks:

*“At the CWC 5th Review Conference in April 2023 there were lots of delegates who were interested in talking to us about the book, so we did two days of quite intensive briefings to diplomats and scientific advisors who are interested in these areas.”*

As well as direct contact with conference delegates, Prof Dando and Dr Crowley's work has been cited in a number of reports, and has led to an invitation to produce a new book on neurological weapons by the UK Royal Society of Chemistry.



Students uncovering the remnants of the streets within the campus grounds



The Victorian streets shortly before demolition, with the University's Richmond building in the background. Copyright Special Collections, University of Bradford UNI X325/5/1/9

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# The surprising history of a Bradford community uncovered on campus

**Lockdown restrictions in 2021 meant that University of Bradford Archeology students had to forgo their usual field trips and look closer to home for practical experience of an excavation. Digging trenches in the car parks and green spaces of campus, students uncovered the remnants of Victorian streets.**

This inspired Dr Carole Binns, Assistant Professor in the School of Social Sciences, to look into the social history of the communities that lived here in the late 19th and early 20th Century, and she unearthed some surprising insights.

Exploring the Kelly's Trades Directory, Dr Binns found a self-sufficient and thriving community where small back-to-back houses were next door to larger villas, and mill managers and mill workers went to the same church, schools and shops which catered for the needs of all in the local area:

*“There were all kinds of trades in the area, there were several drapers, a dentist, a doctor, a milliner and a shroud maker. The local school was very good and even the millworkers’ children were very well educated. There was a bowling green so leisure time was obviously part of their lives.”*

One mystery that Dr Binns uncovered is the fact that there is no existing war memorial for the area, despite military records showing that over 300 local men (and two women, one of whom was a nurse) served in the First World War, many of whom lost their lives. She found that the beautifully carved wooden memorial was housed in the boys’ school, which was damaged by fire in 1949, and one of the outcomes of this project she is working towards is the reinstatement of a memorial on the University grounds.

Meanwhile, the research has brought together descendants of the residents of these streets, and even former residents themselves, along with historians and archivists from across the region, culminating in an exhibition at the Bradford Mechanics Institute in September 2023.



# Research centres

Our research centres are a critical part of our research enterprise, playing a vital role in advancing knowledge, training the next generation of researchers, and translating research findings into practical applications that can benefit society.

The Centre for **Applied Dementia Studies**, the **Bradford-Renduchintala Centre for Space AI** and the **Centre for Skin Sciences** are featured in the three example case studies on the following pages, and the **Institute of Cancer Therapeutics** is featured on pages 4-5. Our other research centres are listed below.

- **Advanced Materials Engineering** - Focuses expertise in polymers into the growth areas of medical and biomedical products and advanced materials, and the developing area of sustainable materials.
- **The Automotive Research Centre** - Bringing together staff knowledge, expertise and experience from a broad range of mechanical and automotive engineering research areas and a unique set of facilities to focus on CO2 reduction in the road transport sector.
- **The Centre for Chemical and Biological Analysis (Analytical Centre)** - Offering specialist analytical equipment with experienced and highly skilled staff, it is the hub of analytical science at the University for both research and commercial projects.
- **The Centre for Pharmaceutical Engineering Science** - Offering expertise across the pharmaceutical sciences, chemistry and polymer engineering disciplines with a reputation for industry partnerships and contract research work.
- **The Centre for Sustainable Environments** - Leading on interdisciplinary approaches that integrate technological, organisational and societal solutions to meet contemporary environmental challenges.
- **The Centre for Visual Computing and Intelligent Systems** - Combining computational, physiological, and psychological expertise to make advances in visual media, biometrics, security, computer gaming and more applications.
- **The Computing Enterprise Centre** - Providing custom software solutions to industry clients using a combination of academic research and student expertise.
- **The Digital Health Enterprise Zone (DHEZ)** - Home to an ecosystem of businesses, health professionals, researchers, community members and students working on digital health solutions that put patients first.
- **Ethical Tissue** - Providing researchers from academia and industry with a wide range of ethically sourced, anonymised human tissue samples and biofluids to support medical research.
- **The John and Elnora Ferguson Centre for African Studies (JEFICAS)** - Supporting academic and applied research, teaching and knowledge transfer concerning Africa within the University academic theme of Sustainable Societies.
- **Polymer Micro and Nano Technology** - Combining high-quality expertise and cutting-edge equipment for a unique offer in the field of polymer micro and nano technology research.
- **Wolfson Centre for Applied Health Research** - Bringing together researchers from the Universities of Bradford and Leeds with clinicians from Bradford Institute for Health Research and the NHS to develop benefits for patients.



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## The Bradford-Renduchintala Centre for Space AI

The Bradford-Renduchintala Centre for Space AI, officially opened in October 2022 was made possible thanks to a multi-million-pound donation from Dr Murthy Renduchintala, who studied at the University in the 1980s and 1990s. It builds upon research in satellite and space dating back to the 1980s, when the research focus was on the satellite-earth propagation phenomena (how signal transmissions behave between earth and space) and antenna design. Since then, the research has expanded, covering:

- satellite antenna design,
- digital signal processing,
- integration and interoperability between satellite and terrestrial systems,
- network design and protocol architecture,
- satellite applications to transport systems and healthcare
- satellite imaging, space weather and solar flares.

The development of AI technologies at the University of Bradford has augmented traditional space engineering, as Prof Ifiok Otung, Director of the Centre explains:

*“AI will help us to process the huge amount of raw data collected in space, extract the intelligence from it and send down a very small*

*subset of the most relevant data. AI also helps you to look at historical patterns to predict what will happen. It’s important because you can take proactive measures to prevent data loss, which means we can use space more sustainably and intelligently as it greatly reduces the amount of power and signal bandwidth required.”*

One of the first major research projects of the Centre is to launch a miniature satellite, known as the PocketQube, into low earth orbit in 2024 that would include an array of instrumentation, from temperature and humidity sensors to miniature propulsion units and a hi-res camera.

The small size means that one or more PocketQube satellites can be piggybacked into orbit during the launch of a bigger satellite, and this process could cost as little as £25,000 (compared to millions of pounds to launch a big satellite), making space more affordable and achievable. But, as Prof Otung explains, there’s a challenge with the PocketQube’s small size:



Prof Ffiok Otung, Director of the Bradford-Renduchintala Centre for Space AI with a prototype PocketQube satellite

*“Because it’s so small, there isn’t a big surface area that can convert solar energy into electricity. Its power generation capability is very limited and there is very little power left for transmitting loads of data or doing intensive computations, so that’s where we want to try to develop new technology in the area of low cost, low power computing. That is the future, we believe.”*

Research at the Centre also deals with issues faced by the existing satellite network:

*“The satellites used for commercial services such as TV and video broadcasting, broadband Internet access, and Very Small Aperture Terminal (VSAT) networks have an issue in that the radio spectrum is becoming increasingly full at the lower radio frequencies where transmission conditions are more benign. There is bandwidth available at higher*

*frequencies, but the signal can be hugely impaired by rain and to a lesser extent by water vapour and oxygen in the atmosphere. We want to develop smart and cost-effective techniques that will enable satellite communication links to operate reliably at these higher frequencies even during intense rain events.”*

This and other projects are focused on the sustainable exploitation of space technologies to meet some of the big challenges faced by society, including measuring climate change and digital inequality.

Another goal of Prof Otung’s, and the Centre is to produce the next generation of researchers through its postgraduate programmes, with the MSc in Satellite Systems Engineering course the foundation for PhDs in the coming years, in collaboration with space agencies across the world with the aim of benefitting the space industry as a whole through world-class training, research and facilities.

Further to this, the Centre will be hosting a series of events, including the International Communications Satellite Systems Conference (coming to England for the first time in its history) to position it as a hub of excellence in space research.



Prof Karen Windle, Acting Director of the Centre for Applied Dementia Studies

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## The Centre for Applied Dementia Studies

The Centre for Applied Dementia Studies (CfADS) is one of the UK's leading centres for psychosocial research into living well with, and caring well for, people with dementia and their families. The pioneering work of the Centre dates back more than 30 years and includes the prestigious Queen's Anniversary Prize in 2015.

Working with stakeholders from across health, social and third sector care and other academics, its work is structured through four themes:

1. Living Well with Dementia
2. Improving the Quality of Care for People with Dementia
3. Addressing Health Inequalities and Healthy Ageing
4. Research Methods and Outcome Measurement

The CfADS works alongside other University academics in the Faculty of Health Studies and research partners at the Wolfson Centre for Applied Health Research, where members of the team lead and deliver the Healthy Ageing theme. There are also international collaborations, with the Universities of Florida, Maastricht and Raboud among others, and INTERDEM, a pan-European group of dementia researchers.

The CfADS is supported throughout by an active Experts by Experience group with over 150 members, who are all affected by dementia in their lives.

Professor Karen Windle, Acting Director of the CfADS, gives an overview of recent successes:

*‘It’s been an exciting year for the Centre for Applied Dementia Studies, and we’re growing in numbers which reflects how we’re developing. A hugely important recent success was winning the NIHR Policy Research Unit (PRU)*

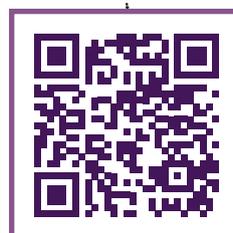
*in Dementia and Neurodegeneration in collaboration with the Universities of Exeter, Newcastle and the London School of Economics. We have also been accredited by Alzheimer’s Disease International, receiving wonderfully positive feedback from the Accreditation team on our post-graduate education and training provision. We’ve trained 380 members of staff based in Leeds and York Partnership NHS Foundation Trust and developed and delivered a range of bespoke training and consultancy contracts.*

*We’ve been successful in publishing over 30 peer-reviewed publications in a range of high impact journals and we are delivering the first ever co-produced dementia module in the UK in our MSc in Dementia Care, called ‘Understanding the ME in dementia’. It was co-designed by 22 experts by experience and went live in September 2023; we’re already having incredible feedback from it.*



Prof Julie Thornton, Director of the Centre for Skin Sciences

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# The Centre for Skin Sciences

The Centre for Skin Sciences (CSS) is an established academic research centre offering a blend of fundamental and applied skin and hair follicle science. It has a strong track record of successful partnerships with companies in the UK and internationally, developing new scientific understanding reflecting the themes of the Centre. A longstanding partnership with Aveda/ Estée Lauder has highlighted significant changes in scalp health with age; a commercial project funded by Innovate UK has successfully developed a pigmented human skin equivalent laboratory model, and there is also work with other partners on research into wound healing as well as alopecia areata, an autoimmune disease.

The Plastic Surgery and Burns Research Unit, which was instrumental in the early foundations of CSS, provides placements for trainee plastic surgeons to complete a MD or PhD in an area of wound healing or burns related research. The Unit was established in response to the Bradford City FC fire in 1985 and has deep connections with the community who raise funds to support it.

There is a new focus in CSS to understand the role of the skin microbiome. The Skin Microbiome in Healthy Ageing (SMiHA) network was one of eleven funded networks in ageing research set up in 2022 in response to the House of Lords Science and Technology select committee report. The networks are tasked with addressing gaps in our understanding of the biology of ageing and developing approaches to improve health across the life course and reduce health inequalities.

CSS Director Professor Julie Thornton highlights SMiHA as one of CSS's recent key successes:

*“Set up in 2022, the network has grown rapidly. Members range in expertise from academics and researchers, to clinicians and industry. Our inaugural conference in September 2023 had an amazing response. The network is already leading to international projects - we’ve just been awarded a global partnering award with Singapore and Australia, and we’re also involved with projects in Japan.*

*I’m proud of the diverse range of current research projects, including use of machine learning to extract relevant burn injury information from 2D photos; exploring changes in the skin microbiome in relation to menopause and HRT; the treatment of hair loss; and why workers in Ethiopia get lymphedema (fluid buildup) in their legs. This contributes to the great learning environment we provide for all our students, and we were delighted that three of our PhD students graduated in summer 2023.”*



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## Partnerships

Here are three examples of how we collaborate with partners in various ways to further our research, from long term projects with business, to consultations with members of the public that ensure our projects are relevant to the real world, suitable for their target audience and can really make a difference.

### AI helping to put tenants first

A Yorkshire-based housing association is using our artificial intelligence expertise to explore how they can help tenants avoid getting into debt and monitor their properties from a distance.

We are working with Incommunities, who manage more than 22,000 homes in Bradford and across Yorkshire, on a Knowledge Transfer Partnership (KTP) made possible with funding of £179,165 from UK Research and Innovation (UKRI) who oversee and fund all KTP projects. KTPs are two-year projects where a graduate with specific expertise, known as a KTP associate, works with a supervisor within an organisation, supported by an academic at a university.

This project is looking at how machine learning can 'predict' things like boiler checks, general maintenance, and housing repairs, and could also be used to help tenants who might fall into debt.

In the first year of the project the KTP associate has been getting to grips with the vast amounts of data in Incommunities' data warehouse, and has already come up with some potential uses, as Professor Sankar Sivarajah, Head of the School of Management and principal investigator on the project, explains:

*Working with Incommunities' Business Intelligence Team, the associate is looking to establish a correlation between postcodes and types of rent payment arrears, with a*

*similar study looking at age profiles. This helps preempt potential issues so that Incommunities can put in support measures early.*

The next stage is to come up with meaningful models that can help the business team to make informed data-driven decisions, and by the end of the project the machine learning tool will be able to create a range of predictive analytics to help Incommunities understand their customers on a deeper level and save on operation costs."

Speaking about the benefits of the partnership, Sarah Barnes, Head of Data and Insights at Incommunities said:

*"We are committed to ensuring customers are at the heart of our business and that the services we deliver reflect their needs. Using artificial intelligence and machine learning can help us predict and prioritise our services more effectively, reduce costs, and improve efficiencies across the business."*

The AI technology is also being put to use on another project, using the same principles for a marketing organisation to track online customer journeys to help with business decision making.



Dr Jae Hargan, Service User and Carer Involvement Lead



Group photo from a recent Experts by Experience meeting

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## Public involvement enriching research

Our partnership with members of the public, known as our 'experts by experience' group, allows our researchers to understand the behaviours and preferences of the people their research is designed to help. This engagement throughout the research process helps make our outcomes more effective by considering real world implications and how they affect the end user.

Dr Jae Hargan, Service User and Carer Involvement Lead, gives an overview of the service:

*"We've got about 65 members of the public in our Patient and Public Involvement (PPI) group who are diverse in terms of ethnicity, sexuality, disability, mental health condition, addiction, etc., plus people whose lifestyle can give us valuable insights, such as an asylum seeker, a sex worker and somebody who identifies as transgender. They are involved in areas like teaching, student recruitment, governance, simulation activities, curriculum development and research."*

The group was initially formed in the Faculty of Health Studies, but the development of the programme led by Dr Hargan has seen the service become available across the whole University in 2023, and usage in research projects has tripled in a very short space of time. Dr Hargan identifies the value of the PPI input in research projects:

"For a project looking at potential new blood tests for cancer, the investigators were concerned with whether a skin test or blood test was preferable, but the feedback from the PPI group was the method of delivery was unimportant, it was the speed of the results that mattered most in that situation. This led to a change of focus of the project, which has since received £750,000 in funding. Other contributions have identified potential ethical concerns, unearthed unconscious biases and challenged generalisations. It's these nuances that you can only get if you've got that personal insight."

Gill Bowskill, one of the Experts by Experience, describes her involvement with research projects:

*"We bring more focus on people from a patient's perspective, so it is not all about facts and figures. We ask questions or challenge researchers and remind them that they are researching topics that benefit people."*

Dr Hargan is looking forward to further development of the group's involvement across the University, which includes a more positive democratic model where peoples' rights to be considered are respected and their experiences are valued from the outset of each project.



Dr Richard Telford inspects a NMR machine, one of the powerful pieces of equipment in the University used to analyse the properties of materials.

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## Chemistry experts making better products for companies

University of Bradford chemistry and bioscience experts are working with commercial partners to analyse the composite of their health products and make improvements, as they have done with stoma products for Trio Healthcare.

Assistant Professor Dr Tom Swift from the School of Chemistry and Bioscience and colleagues specialise in research into chemical and polymer analytical capabilities that can be used to benefit local businesses such as our collaboration with Trio Healthcare, manufacturers of stoma care solutions, as Dr Swift explains:

*“They wanted to change the properties to make the material fundamentally softer on one of their stoma products. That’s the specialism that the chemistry team and I can offer which complements what a company’s engineering team does - we can go back to the raw ingredients to make sure the chemistry of this product is as good as it can be.*

*We consulted and tested some additives, trialled four or five different ingredients and highlighted those that we thought were beneficial. They took*

*our advice, reformulated and patented their product and it’s since been trademarked and launched to market with positive reviews.”*

Since the work, a paper about the collaboration has been published in the British Journal of Nursing and Dr Swift presented his research at the UK Association of Stoma Care Nurses Annual Conference alongside Trio Healthcare. This is an example of the ongoing positive relationship between Trio Healthcare and the University, which is continuing through further testing of new products.

The success of this project was in part due to the expertise across the University, in this case calling upon the knowledge of the Centre for Skin Sciences, but the team also works closely with the Centre for Polymer Micro and Nano Technology and others to share knowledge and offer the best services to business partners.

This work took place in the University’s core facility the Analytical Centre, housing its high value analytical equipment which has recently successfully delivered Project CAYMAN (Chemistry Assets for Yorkshire Manufacturing), which up until June 2023 offered local businesses access to the Centre, with no upfront costs, through grants from the European Regional Development Fund. This is set to be superseded by Project SIBLING (Scientific Instrumentation for Business Leadership in Innovation and Growth), supported by the UK Shared Prosperity Fund with the same goals of training and development projects with regional businesses.



£9.9m

new awards



£7.6m

research income



201

academics engaged in research funding

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## Research at Bradford

The University of Bradford always aims to produce the highest quality research and outcomes for its partners and beneficiaries. We use measures for conduct, integrity, and performance to review the quality of our research. We undergo extensive external research assessments, implement internal policies, and design procedures and processes to ensure we are constantly improving our research standards.

### Research conduct and integrity

Our **Code of Good Practice in Research** promotes good research practice and aims to prevent misconduct. Everyone at the University has a responsibility to ensure that research is legal, meets funders' contractual terms and conditions, and is in accordance with best current practice on equality, diversity and inclusion.

We are signatories to the **Universities UK (UUK) concordat**, a national framework for good research conduct and its governance, committing to support and promote research integrity. This includes ensuring that our research is conducted according to appropriate ethical, legal and professional frameworks; supporting a culture of integrity and based on good governance; and using transparent, robust and fair processes to deal with allegations of research misconduct should they arise.

### Research performance

We are rigorously reviewed by Research England on our research quality and interactions. Every six years the University's research activity, publications and impacts are graded through an external process called the **Research Excellence Framework (REF)**. We are also annually reviewed on our interaction with businesses and the community through the **Higher Education Business and Community Interaction (HEB-CI) Survey**.

We are signatories to the **Declaration on Research assessment (DORA)**, which means we are improving the ways in which researchers and the outputs of research are evaluated to be more reflective of our values, especially inclusion. Our recently appointed Research Metrics Officer reports on research performance, develops responsible metrics and delivers DORA standard training to staff and students on peer review, output quality, bibliometrics (statistics around publications), and responsible research assessment.

We are an engaged signatory of the **Knowledge Exchange Concordat**. We are committed to improvement in the areas of the Concordat consistent with our priorities and expertise. Our most recent internal evaluation against the KE Concordat showed improvement in our processes for capacity development across the University and reaffirmed the strength of our institutional commitment to KE.

### Researcher development

We became a signatory of the **Researcher Development Concordat** in 2020 with the aim of fostering an even more supportive and inclusive research environment in our institution, and in line with this we have adopted a ten-step Action Plan and report annually on our progress to the public. Our activities align with three key areas of the Concordat - environment and culture, employment, and professional and career development.

In the last year, we have strengthened our commitment to the Researcher Development Concordat by investing in a researcher development team, supported by an existing Researcher Development Framework Manager who oversees the implementation of the Concordat. The team plan to expand further in the coming year.



The University of Bradford became the UK's fortieth University in 1966 and has continued to grow ever since. With a rich history of making knowledge work, our mission is simple: to drive sustainable social and economic development through outstanding teaching, research and innovation.

This report features case studies from the last year from across our four faculties that represent our research themes of Health and Care, Sustainable Societies and the Engineered Environment.

As you will see, our multidisciplinary approach means that there is a lot of crossover between the themes - we employ engineering techniques in healthcare solutions for example, and we strive to collaborate and share knowledge within the University and with external partners to achieve the best possible outcomes.

The pioneering city of Bradford inspires us to change the world for the better. And our peers, partners and regulators recognise the quality of what we do.



[www.bradford.ac.uk/research](http://www.bradford.ac.uk/research)



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