CARDIFF UNIVERSITY
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Digital Transformation Innovation Institute

A safe and sustainable digital age

Image:
Will Scott

Introduction

Leading the transformation to a secure, fair, and resilient digital age for all

We focus on real-world, applicable solutions that are driven by collaboration and partnership, to ensure that we deliver research with impact so that new digital processes are designed, deployed, and adopted in ways that are transparent and inclusive, with security at their core.

In our ever-changing modern world, we are seeing the rapid development of innovative digital processes that are transforming industry, government and civil society.

Developments in digital realms provide exciting opportunities, but present new challenges, including cybersecurity and privacy threats, as well as influences on social processes, employment, and democracy.

We have the vision of delivering co-designed solutions that enable new and disruptive capabilities by converging technologies, people, and digital infrastructures. We are committed to the delivery of solutions that are responsibly developed and implemented, co-created with those that are most likely to be affected by these developments.

Professor Pete Burnap
Co-Director

Who we are

A multidisciplinary coalition of experts harnessing the power of technology for a prosperous, secure, and inclusive digital society.

Cardiff University's Digital Transformation Innovation Institute is a collective of ground-breaking thinkers working to drive effective and responsible digital progress for all.

We're all about relationships — between people and technology, society and economy, skills and infrastructure, and cyber and physical spaces. Our uniquely open and cooperative approach allows us to work across disciplines and at the forefront of these interactions, harnessing the best ideas and opportunities that emerging technology has to offer.

Our institute puts people at the heart of our research, working alongside communities to fuel safe, ethical and responsible innovation and address concerns around artificial intelligence, psychology, cyber security, economy, and organisational change.

As a welcoming convening point between industry, policy-makers and leading academics, we provide cutting-edge expertise and dynamic solutions to aid our society's transition to a thriving digital economy.

Our team

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Key research themes

We are challenge-led, and are currently prioritising challenges in these areas:

Healthcare

From mapping the genetic makeup of infectious diseases, cancers and mental health conditions to empowering patients with apps and wearables, digital transformation is revolutionising the way clinical insights and treatments are developed.

Supply chain & logistics

Data driven technologies can transform how we source, manufacture, transport and store goods.

Transport

Creating a transport future that is smart, safe, connected, accessible and low carbon.

Finance & the economy

Digital transformation can overhaul financial technologies, currencies, and tax systems.

Circular economy

Using digital technologies to extend the life of products and materials, and enable reuse and repurposing.

Uncertainty & the future

Tools to model uncertain futures, supporting better policy decisions for a sustainable future.

Technical expertise

Our world leading research expertise lies in the following areas:

- **Artificial Intelligence (AI) and Large Language Models (LLMs)**
- **Cyber security**
- **Operational research**
- **Internet of Things (IoT)**
- **Human Factors and Applied Cognitive Science**
- **Human centric computing**
- **Organisational research**

This supports the full digital transformation process, from safe, secure and trustworthy technology to user experience, accessibility and inclusivity as well as the change management needed to implement transformation.

Key research theme

Healthcare

Precision and personalised medicine
We work in precision medicine, personalised medicine, and advanced therapies, underpinned by bioinformatics and big data approaches and in collaboration with the university's Systems Immunity Research Institute (SIURI) and Neuroscience and Mental Health Innovation Institute (NMHII). We're beginning to explore the use of artificial intelligence (AI) in this space, and have submitted a number of large bids in this area recently, including the LEAP Digital Health Hub, the Mental Health Platform Hub with NMHII, a Lipid Maps Database with SIURI, and a Virtual Centre for Rare Disease.

Data standards, integration and linkage
Data collection is multi-modal, and our consultations highlighted key challenges in integrating data from different sources and linking data via national platforms. Furthermore, research data standards and NHS data standards differ significantly. The power of data sharing was recognised, however, as a means of driving innovation, reducing the time to market for new treatments, and reducing duplication and redundancy in preclinical studies and clinical trials.

Data governance and ownership
We need to empower patients to access their own data. However, it's important to consider the ethics around uncoupling medical information from the context provided by healthcare providers.

A key challenge is offering data accessibility for all patients, including those with reduced capacity. Giving patients autonomy over their data is a key route to allowing patients to stay out of hospital and manage complex conditions at home, increasingly important in an ageing society.

We also face additional challenges around security of data, ownership, and the role of private industry and commercialisation of anonymised and pseudonymised patient data. Accessing NHS patient data in the future might be more difficult for future researchers, and significant upskilling is needed across the sector, including educating patients in the management of their data and systemic culture change in the NHS to fully support the implementation of digital transformation.

People

Antonio Pardiñas
Robert Andrews
Liz Merrifield
Barbara Coles
Emiliano Spezi
Paul Harper

Key partners

LEAP
A DIGITAL HEALTH HUB FOR THE SOUTH WEST AND WALES

GIG CYMRU NHS WALES
Iechyd a Gofal Digidol Cymru
Digital Health and Care Wales

Key research theme

Supply chain & logistics

We can help you become more efficient through better modelling and digital transformation of your supply chains and logistics. Our researchers have developed new forecasting, inventory control, and production planning policies that help companies to revolutionise their supply chain and logistic models in a way that promotes economic and environmental sustainability.

We collaborate with industry to supply core expertise in supply chain forecasting, inventory control, transportation science, supply chain modelling, logistics business modelling, and freight economics. We can help you to explore the effects of additive manufacturing (3D printing) solutions on supply chain decision-making, closed-loop supply chains, digital passports, forecasting, and inventory and production optimisation.

The RemakerSpace Centre supports the move toward a circular economy, extending product life cycle, ending planned obsolescence, and protecting the world's resources for the future.

People

Aris Syntetos
Jane Lynch
Jonathan Gillard
Omer Rana

Key partners

DSV

Resilience
Cyber resilience and the implications for security and safety, both physical and cyber, is a significant challenge for this sector. We work to help the sector understand dependencies and how to manage and protect critical systems and services, especially once there is greater connectivity and data sharing across sectors. Alongside the National Cybersecurity Centre, we're doing crucial work into the modelling of supply chain resilience.

Rural vs Urban
Across all of the challenges faced by supply chain, and logistics sectors, a key consideration and recurring thread is the separate and specific needs of rural and urban communities. Different solutions may be needed to achieve the same objectives across these communities. Humanitarian logistics and supply chains also forms an important aspect of our work.

Key research theme

Transport

We are addressing decarbonisation and sustainability in road, rail, and aerospace in a whole system approach to realise net zero goals. Our other key focus within this theme is on the development of future transport solutions – including connected and autonomous vehicles.

Smarter transport
The digital transformation of the transportation sector through the use of real-time data and AI solutions supports the efficient use of limited resources. We are working with partners such as National Highways and the Global Centre for Rail Excellence to:

- boost efficiency and enhance quality
- decrease costs
- open up new revenue streams
- improve customer experience and loyalty
- explore new areas of research to accelerate these changes.

Decarbonising transport
Introducing electrical vehicles requires an integrated whole-system approach to address challenges in electricity supply systems and charging infrastructure. Working internally with colleagues from the Net Zero Innovation Institute, alongside partners including the National Grid, BAE Systems, and Rolls Royce, we bring together expertise to transform current practices and research in the decarbonisation of transport. We can help you with electricity networks, electric vehicle charging infrastructure, electric and hybrid aircraft, and the electrification of the rail network, facing challenges such as driving behaviour change and meeting the differing transport needs of rural and urban communities.

Connected and autonomous vehicles
We have a 10-year+ history of funded cutting edge research on human-centric aspects of connected and autonomous vehicles. Themes and projects have included: development and measurement of trust; design and testing of human-machine interfaces; examining blame and implications for legislation; responsible design and usage; and human-centric cyber security. In our showcase laboratories based within the School of Psychology we have a cutting edge driving simulator with best in class SCANeR software, a traffic networking centre, immersive 360 Igloo cave and VR/AR capabilities.

People

Phil Morgan
Carol Featherston
Liana Cipcigan
Dimitris Potoglou
Yasemin Sengul Tezel
Yulia Cherdantseva

Key partners

GCRE
AIRBUS PROTECT
national highways

Key research theme

Finance & the economy

Blockchain as a facilitator
We want to help leverage the power of distributed ledgers to promote digital accountability and transparency beyond finance, whilst also addressing the use of cryptocurrencies for illegal activities. Our researchers are working to track funds across the blockchain to identify the funders of terrorism, empower the public to use cryptocurrencies, and use blockchain to verify carbon offsetting.

Banking the unbanked
A section of the population has no bank account, which immediately bars them from accessing any transaction-based digital platforms, compounding digital exclusion. We address this by working with underrepresented groups and supporting teachers to deliver fintech education as part of the curriculum. The Cardiff-led UKFin+ Network Plus supports research into this type of wicked problem.

Fraud and trust
Digital financial fraud is expanding rapidly and becoming more sophisticated. The challenge of reliable authentication is central here, particularly in the rapidly growing circular economy. We use techniques such as behavioural finance to identify fraud and protect consumers.

People

Arman Eshraghi
Maggie Chen
Hossein Jahanshaloo
Carla Edgely
Tommaso Reggiani
Qingwei Wang

Key partners

UKFin+

Image:
Peter Wells

Key research theme

Circular economy

Minimising waste
The traditional "take-make-dispose" model of production and consumption is reaching its limits. The circular economy (CE) offers a compelling alternative, advocating for a closed-loop system that decouples economic growth from resource depletion and environmental degradation. As defined by European Institutions, CE prioritizes keeping "the value of products, materials and resources in the economy for as long as possible, while minimizing waste generation." Digital technologies play a crucial role in this transition. They empower businesses to redesign linear supply chains into circular networks that prioritize resource efficiency, waste reduction, and environmental responsibility.

Environmental, social and governance goals
To navigate the evolving landscape of CE, external partners and stakeholders need support. This includes aligning with existing and emerging public policies as well as organisations' own ESG (environment, social and governance) goals. Complying with the emerging legal environment focused on driving CE transitions and the increasing societal pressures on business actors to develop circular business models requires significant innovation related to extending product lifecycles, repair, and re-use, tracking of materials and components throughout the whole life cycle, capturing value from end-of-life stages, re-skilling to enable circularity activities, and much more.

Equitable and accountable circular economy
As part of DTII, the Circular and Digital Economy Research Group (CiDER) at Cardiff University offers expertise in these crucial areas. Led by Prof. Peter Wells and Prof. Yingli Wang, CiDER actively collaborates with private, public, and third-sector organizations. We work through various initiatives, from joint research projects to knowledge transfer and feasibility studies, all involving our postgraduate students under faculty supervision. Together, we can explore pathways towards a more equitable and accountable circular economy business model.

People

Yingli Wang
Peter Wells

Key research theme

Uncertainty & the future

Modelling and understanding future uncertainty
Developing and applying effective tools for understanding future uncertainty presents a significant challenge. These tools must integrate both qualitative and quantitative data to provide a holistic view of possible futures. The complexity lies in ensuring these tools—ranging from statistical models and expert opinion methods to advanced artificial intelligence (AI) algorithms and hybrid human-AI models—can effectively handle diverse data sources and generate reliable future scenarios while being adaptable to various application domains.

Communicating uncertainty effectively
Communicating uncertainty in a clear and impactful way to different audiences is a major challenge. It involves developing methods to convey complex and often abstract concepts to diverse audiences, including policymakers, the public, and stakeholders in various industries. Evaluating the effectiveness of these communication methods and ensuring they promote informed decision-making without causing unnecessary cognitive load remains a major challenge.

Decision-making and planning under uncertain futures
Planning for the future involves making decisions across short, medium, and long-term horizons that will significantly impact future generations. This challenge includes connecting possible future outcomes with decisions and assessing how decisions under uncertainty will affect future societies. Developing frameworks that acknowledge and incorporate uncertainty is critical to guiding these decisions and ensuring they are fair and equitable.

Designing adaptive systems that leverage uncertainty
A major challenge is creating systems that not only survive uncertain conditions but also thrive in them. This involves assessing the resilience and adaptability of future societies and designing adaptable and resilient structures. These systems must be capable of leveraging uncertainty to drive innovation and development, and identifying key factors that contribute to such systems is essential.

People

Bahman Rostami-Tabar

Cross-cutting challenges

Digital society

Policy as a driver for change
Positive digital transformation can be accelerated through legal framework and policy support, such as tax incentives and mandatory sector regulation/adoption. This is particularly important in relation to carbon reduction and climate-related innovation, as well as to drive behaviour change.

Inequalities in access to digital technologies
It is clear that digitisation can be transformative, including the potential to empower individuals in the management of key day-to-day activities including health and finance. However, access is not universal, both in terms of the skills people have to use technology, and access to the hardware needed. Our work and research aims to offer solutions to help rectify this and promote digital equality.

Digital for rural vs digital for urban
The needs of urban and rural communities are quite different across all of our key research sectors. In particular, digital transformation has the potential to be particularly impactful in rural communities.

Democratising data
There is a need to empower individuals with ownership of their own data across all sectors, and to involve stakeholders at all levels in decision making. In our work, we seek to help drive that democratisation.

Data management

Data integration and unified data platforms
Data is currently held in myriad repositories, and legacy systems have evolved in parallel which cannot share data between them. This means that data is difficult to access in order to improve services, and the data currently held is not used as efficiently as it could be. As more data is collected, the issue is amplified. We work towards enabling and developing unified, integrated systems across entire sectors, as well as encouraging distributed data storage.

Data governance
Appropriate and widespread governance structures are needed around digital transformation, to strike a balance between privacy and sharing. The public may be more positively disposed to data sharing than policymakers and service providers may recognise, but a need for greater transparency over how data is collected and used is a key step in empowering people in ownership of their data.

Cross-cutting challenges

Artificial Intelligence

A role for generative AI
Generative AI holds significant potential for positive impact, but a lack of trust in and transparency of some large language models (LLM) and generative AI models continue to be a concern.

Responsible AI
We work towards ensuring that the application of AI is transparent and accountable, and meets ethical AI standards.

Cyber resilience

Cyber resilience
A number of recent high-profile incidents highlighted a marked lack of resilience to failure in key digital systems, whether the failure is caused through accident or attack. Our work aims to help promote understanding of the dependencies in critical systems and build in resilience.

Automated cyber defence and security operations
We use data science and AI methods, combined with expertise in criminology, psychology and international relations, to better utilise and interpret the vast volumes of data being produced on a daily basis for prediction and real-time automated responses to emerging cyber threats. This includes robustness testing of AI algorithms, better visualisation and explainability of AI algorithmic decisions, and communication of threats between interdependent people and processes.

Future of secure critical national infrastructure
We aim to enable the secure digital transformation of critical national infrastructure using data-driven technologies while retaining security via the integration of our research on automatic monitoring and control in safety critical systems, and mapping to risk assessment and compliance. Human centric research in cybersecurity and the adoption of semi-automated defences is a key focus across our entire interdisciplinary team.

Key partners

In association with National Cyber Security Centre
Academic Centre of Excellence in **Cyber Security Research**

Engineering and Physical Sciences Research Council

Science and Technology Facilities Council
Hartree Centre | Canolfan Hartree
Cardiff Hub | Hwb Caerdydd

Our flagship institutes bring together brilliant and passionate people to provide answers to some of the world's most pressing areas of concern.

Our Institutes

Digital Transformation Innovation Institute

A multidisciplinary coalition of experts harnessing the power of technology for a prosperous, secure and inclusive digital society.

Net Zero Innovation Institute

Where world-leading researchers come together for the future of our planet.

Neuroscience and Mental Health Innovation Institute

Empowering a healthier, happier future through collaboration, creativity and clinically relevant research into neuroscience and mental health.

Security, Crime, and Intelligence Innovation Institute

Ground-breaking interdisciplinary research intelligence for a safe, secure world.

Systems Immunity Research Institute

Together, we harness the potential of the immune system towards global public health.

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