



horizon

DIGITAL ECONOMY RESEARCH

Impact Highlights

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Foreword

Established in 2009 and centred at the University of Nottingham, the RCUK-funded Horizon Digital Economy Research Hub and Centre for Doctoral Training brought together a team with expertise spanning a wide variety of disciplines to address challenges in the Digital Economy. In partnership with academic colleagues from the Universities of Cambridge, Exeter and Strathclyde, and the Royal College of Art, we research 'in the wild', embedding our research in the practices of our external partners spread across a wide range of business sectors.

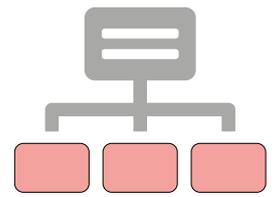
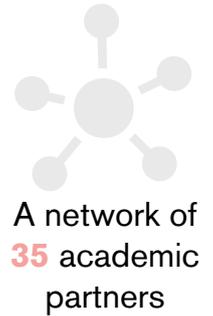
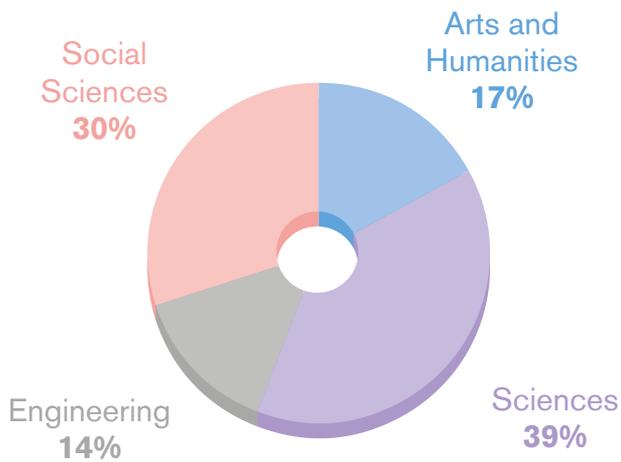
Our focus on ubiquitous computing technology and the 'lifelong contextual footprint' of personal data addresses the challenge of how to promote deep personalisation whilst providing control and privacy to citizens.

Building privacy and trust into the next generation of digital experiences and products is essential to ensure public acceptance and the continued economic and social benefits of upcoming technology innovations. Thanks to follow-on RCUK funding awarded in 2015, Horizon is now focussed on delivering impact from our first phase of work by exploring the private and ethical interpretation of 'human data', to understand and enable the transition 'from human data to personal experience' at scale.

Professor Derek McAuley

Impacts from the start of Horizon

Research Disciplines in Horizon



Over **200** industry, public and third-sector partners

Over **3800** visits to our Twitter profile and a **13.5%** increase in followers over a six month period

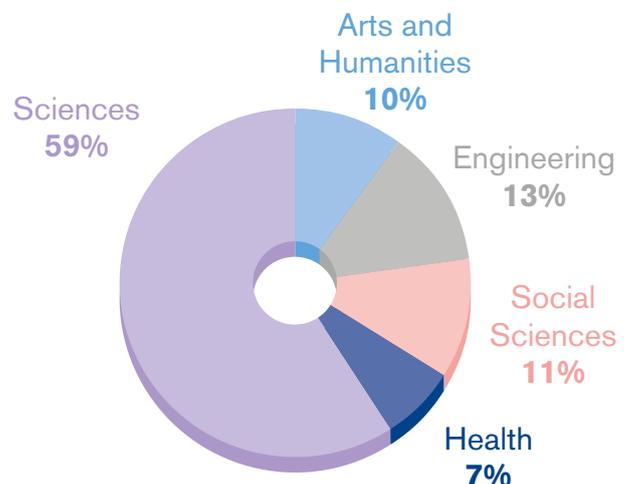


£46 million grant income resulting in **67 internal** and **46 external** research projects

700 Public Engagement activities attracting over **46,000** visitors

700 publications with a variety of disciplines

Publication Discipline



Awards and Recognition – **43%** international, **37%** national and **19%** regional

100 PhD studentships & **47** alumni

Our Approach



We collaborate with a wide variety of users across multiple sectors of the digital economy in order to drive our research and ensure successful knowledge exchange and long term cultural, technology, economic, societal and policy impact. Working with partners in a variety of ways, we involve them in the development of our projects, and enable different levels of engagement with Horizon and the projects to allow for a dynamic relationship over time.

During this second phase of Horizon our Partners have encouraged us to adopt a wider thematic, cross-sectoral approach to impact. We have introduced a delivery programme structured and managed through a translational programme of short, highly responsive agile projects, sitting alongside an Impact Campaign consisting of three themes – Media, Services and Products.

Our translational programme allows our multidisciplinary research team to respond to requests from our partners and address their needs in line with the fast-paced nature of the digital economy.

© Translational projects by their very nature, are varied in structure and diverse in form, ranging from developing technologies to writing policy briefings.

Our Media, Services and Products Campaigns each represent different starting points for approaching the design of future personal experiences and involve broad clusters of partners and associated contexts:

- © Our Media Campaign has addressed digital media assets as they take on aspects of everyday services or become embedded into physical products and how we transform today's mass media platforms into personalised experiences. Aiming to drive relationships among the creative industries, the campaign has highlighted the social and economic importance of talented professionals and amateurs in the creative landscape.
- © Our Services Campaign will address digital services that we rely on and that increasingly exploit our human data (e.g. financial, social media and healthcare), or control physical infrastructures (e.g. energy and transportation networks). This campaign will investigate how these services can be highly personalised and take on experiential properties, but implemented to minimise personal data sharing and hence privacy impact.
- © The focus of our Products Campaign will be business sectors that traditionally revolve around different kinds of physical products and how these will be transformed through emerging Internet of Things technologies coupled to human data. A key subsector here will be the world of Fast Moving Consumer Goods (FMCG), the packaged commodities that pass through our lives in great volumes. This campaign will highlight the ever-deepening connections between the physical and the digital and investigate the development and transformation of traditional products into 'experiences'.

The Story to Date

2015

Data Journeys
Archway Project



August

EPSRC funding "From Human
Data to Personal Experience"

December

Media Campaign Launch
Data Journeys Archway Project
Digitopia Project

2017

January

5rights Youth Juries Report
Launch, House of Lords

February

Collaboration with Nottingham Theatre
Royal 'This Beautiful Edifice'

March

Services Campaign Launch
TalentLab showcase, London



TalentLab showcase



rights at Nottingham in Parliament Day



Cartography Project

2016

February

Artcodes Project
Wander the Workhouse Project

March

CTech launch e-Genie at Digital Catapult, London

June

Artcodes designs 'interactive wallpaper'
Artcodes exhibit at CREATE Festival, London

July

DHA Praxis Interrogating Interdisciplinarity
Project launches 'Good Practice Guide'



August

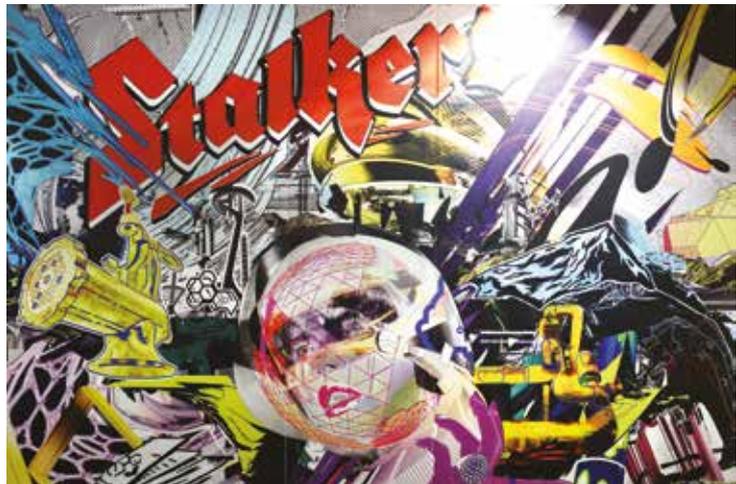
Wander the Workhouse events at Southwell
Workhouse, more than 3000 visitors
Foundation and launch of N-Lab

September

VR Playground Project
Cartography Project

October

iRights at Nottingham in Parliament Day
UnBias Project launch
Horizon Director presents 'Youth
Juries' at House of Lords
Databox Launch, London
Databox and Artcodes exhibits at MozFest, London
VR Playground installation at V&A, London



Artcodes Project



Cultural Impact

It's very important to argue for why Horizon and people working with digital technologies need to engage with the cultural and creative sectors. Two obvious reasons spring to mind:

One is that they are important sectors in their own right so just as any other sector of the economy and society, they deserve attention through digital technologies. There's an economic argument there also – the cultural and creative sectors account for roughly 10% of GDP, and are the fastest growing employment sectors in the UK. They are also culturally important to enrich people's lives, delivering value over and above just money to society. They reflect our identities and allow us to have discourse about who we are which, in troubled times, is really important.

Secondly, from a digital economy researcher's point of view, people who work in the creative and cultural sectors are creative innovators.

They have radical new ideas about what might be achieved with technologies, and that pushes the envelope in ways that go beyond the more conservative use of technologies by other sectors. So we benefit from a huge feed through of new ideas and new techniques into technology that we can build on, so it's a dual relationship.

The **Horizon Media Campaign** has been about scaling up this activity in a number of ways. We have increased the volume of interesting projects that are delivered, and expanded the reach to our audiences. By sharing platforms we have developed such as 'Artcodes' and 'Wander Anywhere' beyond targeted professional artists to everyday amateurs or pro-ams, we have enabled them to make and design their own experiences.

Professor Steve Benford

Full versions of Cultural Impact articles can be found at:
www.horizon.ac.uk/cultural-impact



Steve Benford talks to us about engaging with the creative economy

How have you engaged with the creative and cultural sectors?

Cultural creative industries tend to be characterised by very fast moving, ad hoc networks of relatively small organisations, right the way down to the individual practitioner. So you've got a very networked world, but not one in which you've got very many large companies (with the exception of organisations like the BBC and Tate who we work with). They often don't have their own well-funded research labs, or the resources to engage with universities in a significant way.

They work on very short project time scales of a few months to deliver things, and the amounts of money which they are dealing with tend to be quite a lot smaller than the research monies we hold. They are relatively ad hoc in how they organise and deliver projects and how they network with each other in a flexible way. Intellectual Property issues are different in terms of where the value lies - obviously lots of value in copyright but much less so in the traditional patenting of things.

All of that means you have to engage with them in a different way. The kind of waterfall pipeline

model of technical research doesn't really work. The idea that you invent something, you lock it down, you then figure out who wants to use it and you try to license it - that's not the business model. Our model is much more engaging, being able to be very responsive to a number of small projects, engaging quickly, helping deliver them, to some extent then figuring out what it is you delivered and what value it had afterwards.

We've established a research culture here in Horizon and the Mixed Reality Lab, where there are essentially three things going on in parallel. There's always a set of practice-led projects bubbling up - creative-led or artist-led - and our role is to help people achieve their vision. We respond quickly and we don't ask too many questions if that vision suddenly changes in the middle of the creative process - that's just how the creative process is!

At the same time we as researchers study what they're doing and build an understanding of why they're designing things the way they are. Then hopefully these learnings are reflected across a series of projects and developed into more general toolkits, frameworks or theories that can be applied elsewhere. All of these things are happening in parallel - it's very much a creative churn of activity.

The particular mechanisms we use to achieve this are really important. We've found it is key to follow a model of light-weight residencies and bursaries

- so artists can come into our environment, find their way around, network with researchers, all without even having to make a commitment to a particular project at that stage. We have now run a number of these residencies and we have found them really powerful for getting the dialogue going. And then we are prepared and able to make a quick response to a project idea going live, usually involving us working with the artists when they are securing funding from various venues such as the Arts Council.

What about plans to broaden activity?

There has been a greater focus on touring to more places - getting in front of a wider range of public audiences, potential funders and influential people in the creative sector. We are broadening the group of people we are working with by bringing more creative practitioners into the network, and encouraging interaction with individuals we may not have traditionally worked with.

One example is the B3 Media TalentLab Programme which specifically seeks out artistic talent within the Black, Asian and Minority Ethnic communities. This is a group who don't usually engage with the University research base, and we are reaching out to this group through their training programme.



Younger audiences who use mobile technologies for nearly everything appreciate interactive digital experiences when relating to heritage and culture.

But many organisations in this sector do not have the resources to develop engaging digital visitor experiences or the skills to maintain them.

Ben Bedwell and Laura Carletti, Research Fellows in Horizon, tell us about their research in the cultural and creative sectors.

What are the main issues for your heritage and cultural partners when interacting with technologies?

Cultural institutions want to attract a wide range of visitors, so they have to appeal to traditional audiences as well as younger people who might be considered to be more comfortable with digital technologies. However, smaller organisations have low staff numbers and budgets, and do not necessarily have the skills, confidence or resources to deal with complex technologies, purchasing hardware, or hiring or outsourcing developers. They feel digital experiences can be outside their reach.

While in the past websites were just a window to view content, now people have an expectation of interacting, having their say, and exchanging information. This is participatory heritage – where the public is no longer just a spectating audience, but a community of participants actively involved in managing cultural heritage. This is impacting on the cultural organisations who have to respond to this – for example, by building a social media audience.

Many visitors bring their own digital devices with them, so it makes sense to develop experiences that use these devices. Our aims have been to provide a framework for the museums to harness simple web-based platforms and technologies that are already available or that we have built for them, and for them to be able to take these over once our project has finished.

Give examples of where you have introduced technologies to cultural partners

Tate wanted to visualise their digitised artworks on a map, and recognised that the general public had a large amount of information about the places, people or things in the paintings that was not being captured. We developed the ArtMaps crowdsourcing platform that allowed people to contribute their knowledge about locations associated with artworks. This included people who do not habitually visit museums by extending the gallery experience outside the museum and allowing for encounters with items not ordinarily on display.

We also developed Wander Anywhere, an active online platform which enables rapid prototyping of locative media. Authors create web content and associate it to geographic areas. Then, with the aid of a smart phone, mobile users can explore the outdoors to track down and reveal this content, experiencing it 'on location'. We developed experiences for various partners, including Southwell Workhouse, the Theatre Royal in Nottingham, and the State Tactile Museum Omero in Ancona, Italy.

How have these tools helped the organisations?

We have found that it is not just about providing tools, but about exchanging knowledge and co-designing experiences with them. We help them identify which content works effectively



with the technology, building their confidence in curating their own experiences so they can be implemented with the general public.

Besides one-to-one sessions co-designing experiences in their own venue and context, another way of working with these organisations is to run training sessions for a group of them at the same time. Lack of familiarity in using technologies is one of the main issues that cultural organisations might have. We run the sessions with participants, making them practical and fun, and they have proved very popular for two reasons.

Firstly they are about showing it is possible for a non-technical person to use the tools - by letting them play they realise it is not that hard.

Secondly, by working together using the tools and building things, they recognise that all the individuals in the room have the same issues and they are not alone. This helps them build enough confidence to take the skills and their creations back into their own organisations and, by virtue of attending the workshop, they act as the “digital champions” who push the technology to their colleagues. They also make new connections in different organisations to exchange ideas.

Have you any examples of organisations changing the way they work as a result of collaborating with you?

Qatar National Library, staff from private companies as well as public administrations

(e.g. Qatar Airways; the Qatar Ministry of Transport, the US Embassy in Qatar) are re-thinking and re-purposing their websites and their relations with the public following workshops we ran on digital heritage and engaging with audiences in new ways.

Dance 4 is an international centre for the development of extraordinary 21st century dance based in Nottingham who attended our training sessions. We scoped out the requirements for a new visitor experience for them, and they are starting to put the ideas into practice - building a modern, responsive website and developing ways of pulling in user-generated content.

Derbyshire County Council and Buxton Museum and Art Gallery have received Heritage Lottery Funding to refit the museum. We are developing mobile visitor experiences to run alongside their collections and events. These will be launched at the end of 2017 when the museum re-opens - the visitors will be able to physically visit the collections but also walk out into the surrounding landscape and find locations and objects that inspired the collections.

The ArtMaps and Wander Anywhere platforms are freely available

“Horizon skilfully guided us through focus groups and piloting inventive digital schemes that enable people to access our archive in wholly original ways, such as the Wander Anywhere project. All this has shaped our own thinking about how we want to present our archive in a bold, innovative and non-traditional manner and certainly contributed to our recent success in being awarded funding from HLF to explore this work even further.”

David Longford, Creative Learning Manager, Theatre Royal & Royal Concert Hall, Nottingham





When design meets technology, interesting things can happen.

Boriana Koleva and Emily-Clare Thorn tell us the story of Artcodes, and how technology fulfilling a particular function can be beautiful at the same time.

Tell us about Artcodes and how they came about?

QR codes are a type of two-dimensional barcode containing information about an item to which they are attached. We were interested in developing an alternative way of using computer vision where the markers would actually add to the aesthetics of the product rather than be a necessary evil. Collaborating with designers, we were able to create beautiful and complex imagery- now known as the Artcode.

An Artcode is made up of regions, a boundary and blobs, which together represent a code – and this simple set of rules gives a lot of power to designers to be creative. The technology uses an app which can be downloaded on to a smart device and can then be used to scan the Artcode – the app does not recognise the image but scans the topography of the image. By making such decorative patterns interactive, all manner of everyday objects can become part of the 'Internet of Things' simply by decorating their surfaces. Pointing a camera at a thing might then enable people to learn about what it is, how it was made, and how to use it; to access personal

memories or review their history of use; or to trigger other contextually relevant services.

Where have Artcodes been deployed?

We worked with the London restaurant chain, Busaba Eathai, to provide ideas for an enhanced digital dining experience, allowing customers to scan decorative pattern designs on tableware, menus and placemats. The intention was to allow the diners to access information such as specials of the day, a view into the kitchen to see the food being prepared, and to learn about each dish, its ingredients and any possible allergens. Busaba was one of the first restaurants to sell Thai street food so they were also very keen on communicating the stories about the culture that inspired the food, and the history and social context of the dishes.

We created three big wall murals with embedded Artcodes that were deployed at The Nottingham Writers Studio, Mozfest, and one is decorating the wall in Horizon for visitors to play with. We worked with ceramic designers and Johnson Tiles to explore the creation of beautiful tiles decorated with Artcodes. We also commissioned designers



to produce digitally interactive wallpaper and we are aiming for these to be installed in public places and in homes. One will be installed in a private home where it will be used as a virtual guest book in the spare room.

How has the technology developed?

We explored embedding multiple codes into a single illustration, and making the Artcodes more robust for working in environments where variables such as reflections, shadows and curved surfaces need to be considered.

We played with the orientation of the code so reading the pattern from different angles would be like reading different codes, and hence linking to different content. Colour filtering was another big development, enabling layering of Artcodes - depending on the colour filter you would see a different code.

What other new creations have been developed using Artcodes?

We commissioned an artist, Alice Angus, to design a beautifully illustrated, freestanding Advent calendar - traditional and handcrafted

in style, and featuring scannable Artcodes on stickers for under the doors. We developed the Christmas with Artcodes app, and instructions on how to customise the stickers and associated content to share with family and friends. It was very well received, and we are set up to sell the product on Etsy and through various Nottingham retail outlets in the lead up to Christmas.

And the future?

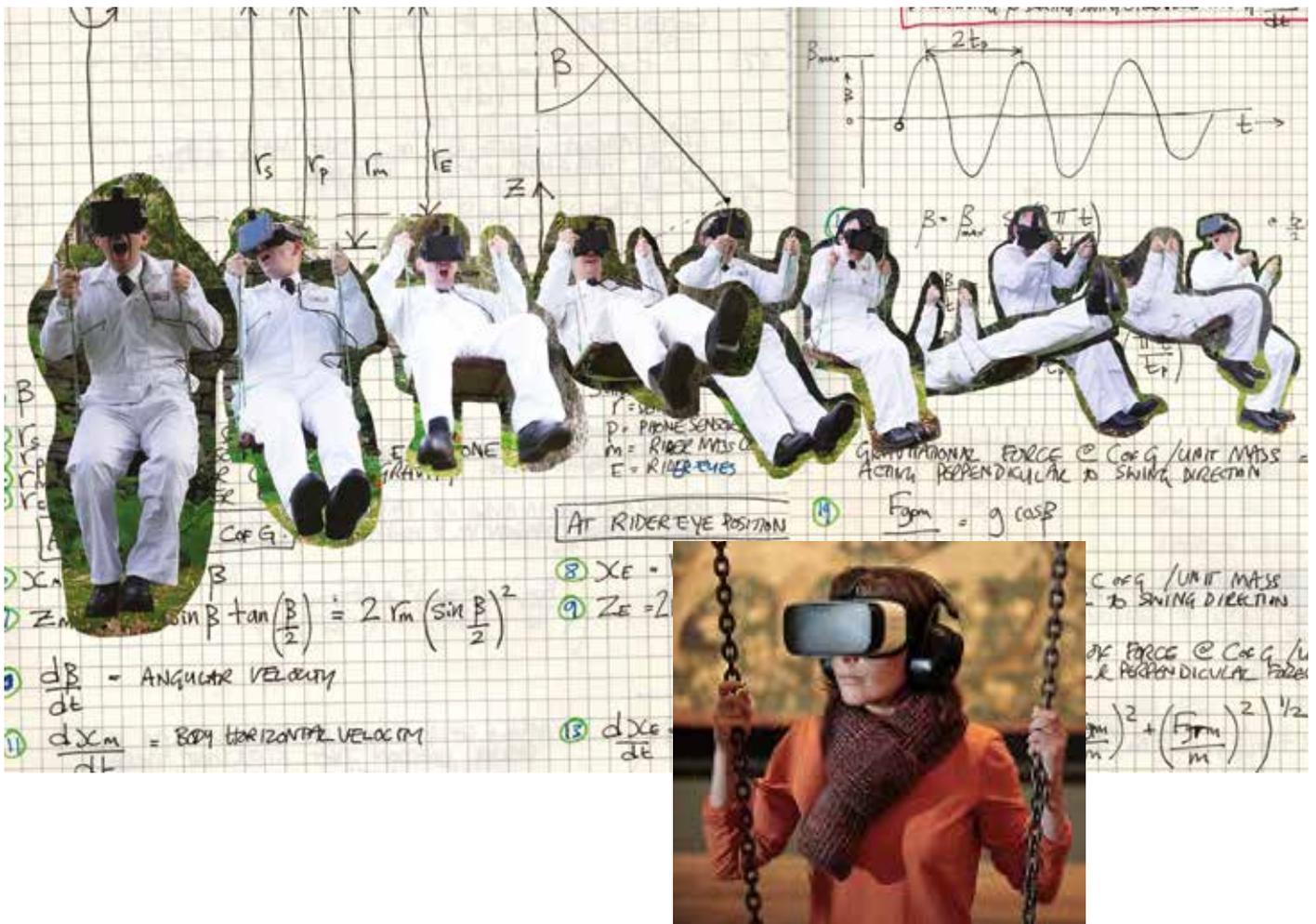
One of the projects funded by Horizon was looking at hybrid gifting (digital and physical combined), working with the BBC to find innovative ways to release their content in a personalised way. We ran a workshop with the Advent calendars, and also looked at different ways of utilising Artcodes with children. Scanning Artcodes on murals for story-telling at bedtime, or using them in backstage tours for linking to content, are ideas we may pursue.

We are also working with Nenescape, a Heritage Lottery funded Landscape Partnership Scheme (www.nenescape.org) using Artcodes to re-connect local people to, and attract new visitors to, the river Nene and its surroundings.

The objects we have used to deploy Artcodes up to now have been 2-D - wallpaper, murals, placemats - and we have the opportunity to work with 3-D objects and materials on this project, such as shoes! It will also provide us with a long-term Artcodes deployment in a heritage environment, where the organisations themselves have the capability to maintain and update the interactive experience.

We have deployed Artcodes in various settings - City Arts Nottingham window display at the Festival of Light, artCHI brochure, Design Carousel in London, Create Festival, London Design Festival - Tent, Tate Britain, Tate Exchange, Lakeside Gallery.

<http://www.artcodes.co.uk/>



Entertainment and the creative industries are one of Britain's greatest exports.

Brendan Walker tells us about his work with Horizon on developing interactive experiences for entertainment.

Brendan, tell us about your work with Horizon.

My interest in developing interactive installations to elicit increasingly thrilling experiences has earned me the title of the world's-only 'Thrill Engineer'. Thrill Laboratory evolved from my work backdating to 2003.

Historically Thrill Laboratory has worked on a number of research projects involving the development of digital technology in collaboration with the University of Nottingham (Horizon and the Mixed Reality Lab (MRL) and external partners including designers, artists, engineers, technologists, and cultural historians - indeed anyone who has an interest in the manufacture of 'thrill' and how it appears in our cultural world.

I also run my own design practice Aerial, consulting on rides and entertainment TV shows, which often involves physiological monitoring of participants and design of dynamic data graphics for factual entertainment. Much of the work of Thrill Laboratory (which is a product of Aerial) has been monitoring people's

physiology to help them understand their emotional responses to different types of thrill-related entertainment. Another facet has been to create new experiences, and I started using virtual reality (VR) in a simple way. I realised that there was something very interesting in the relationship between what the rider was seeing, the motion they were sensing, and their relationship between the real and virtual worlds.

Tell us about the VR Playground

Early versions of the VR Playground concentrated on the relationship between the rider and their physical experience, using a playground swing and creating a very simple room for the virtual world, replicating the gallery space they were in. Experimenting with this technology allowed me to explore the relationship between the virtual world and the real experienced world, and to start amplifying aspects of the virtual world, for example how far people felt they were swinging in the room. Dropping away the virtual floor was also very successful to the extent that we were able to make people scream! Exploring these visual, psychological techniques - similar to those



used on the Victorian ride called 'The Haunted Swing' - made me realise I was able to replicate what they had managed to do mechanically 100 years ago but using virtual reality. Surely there must be more we could do? Hence the development of the VR Playground.

What ideas are you exploring?

Interesting areas we are exploring are around motions that currently exist in the real world and looking at ways to add a VR narrative over the top. By doing this we are immersing people in a completely 'other' world, appropriating existing experiences that aren't intended or understood as being thrill rides to start with – for example the playground swing, but also things like lifts and escalators.

The most unique thing is that we are deconstructing the physical experience, and this draws on my original training and career as a military aeronautical engineer at British Aerospace. Rather than studying the G-Forces exerted on a pilot in a fighter jet, in the VR Playground we're studying the forces exerted on the body and the physical actions of the body

during the action of swinging. Even though it may appear to be just a simple pendulum, these forces can be just as complex as with a pilot albeit a little subtler. We've started to be able to isolate different forces that are felt by the body and use visual and audio techniques to amplify these in the virtual world. For instance, while you may feel like you're on a pendulum swing in the real world you may, in our virtual world, believe you're bouncing up and down on a spring. The narratives you can create, and the rides themselves, start to become quite fantastical.

Where are you at with the project?

We are now taking the VR Playground on tour. This has been funded by Horizon and the MRL, the Arts Council England, Norfolk and Norwich Festival, Greenwich and Dockland Festival, and (thanks to winning a competition) supported by Without Walls - a consortium of most of the major outdoor arts festivals in the UK, which also provides exposure to their touring network. The first year sees the VR Playground attending four UK venues, and in the second year we will be promoted to international festivals looking to source work for 2018.

Visitors coming to experience the VR Playground will firstly see a series of sculptural cubes with swinging riders inside. Riders will have chosen to ride one of five different themed worlds to explore. They'll hopefully be screaming and laughing disproportionately as they swing in their cubes, wearing VR headsets and earphones. What are they experiencing? Well, you'll just have to join the queue to find out.

Once the VR Playground goes live, we hope it will attract a lot of interest, resulting in bookings to present the work at different venues. The University of Nottingham is providing the underlying technology and developing the support package required to train staff at each venue. This model of technology hire and production support is generating income for the University. It is exciting new territory for me as this is a financially sustainable model, which means our work can now reach a much larger audience, over a greater period of time, across wider geographic locations, hopefully internationally.

We talk to Professor **Steve Benford** about the TalentLab project

Our relationship with B3 Media takes a particular form which is known as 'TalentLab'. This involves a structured training programme that B3 Media have run for a number of years with funding from Arts Council England, Skillset and various other partners.

“Our partnership with the University of Nottingham Horizon/MRL has enabled us to establish B3 TalentLab into one of the UK’s leading creative arts development programmes. TalentLab supports artists and creative leaders on the margins by inspiring their confidence, and giving them access to the time and resources that enable them to develop their individual projects and artistry.

BAME workers only make up 11% of workers in the creative industries and we hope our partnership will result in the continued success of innovative projects and opportunities for UK’s BAME creative talent.”

Marc Boothe - Founder, Creative Director, B3 Media

Traditionally the focus of TalentLab has been on film making; each year a cohort of creative talent is competitively recruited and put through a training programme on how to make and pitch films, and how to take some of those projects on afterwards, presenting them to Film4, BBC Films, Tate, Wellcome Trust, Creative England and other potential funders.

We became involved in thinking about how to bring in a more interactive programme

- expanding film with supplementary experiences and building interactive works.

We're now in our third cohort of TalentLab: to date, over 60 artists have been directly supported through the programme, and another 500 indirectly through 'spin out' projects, productions and showcasing activities. It's definitely a learning process – how to involve us as researchers in the training programme, and how to follow on with the work.

The first TalentLab cohort involved a number of folks and was really exciting. One example is Richard Ramchurn who undertook a TalentLab residency programme at the Mixed Reality Lab (MRL) to develop an interactive brain controlled film '#Scanners: The Disadvantages of Time Travel'. The film premiered at FACT in Liverpool in July 2015, won Best Art Paper at CHI 2016 and is soon to tour. Richard continues his research into Brain Controlled Films and is studying towards a PhD at the Horizon Centre for Doctoral Training (CDT), exploring Brain Computer Interface (BCI) technology.

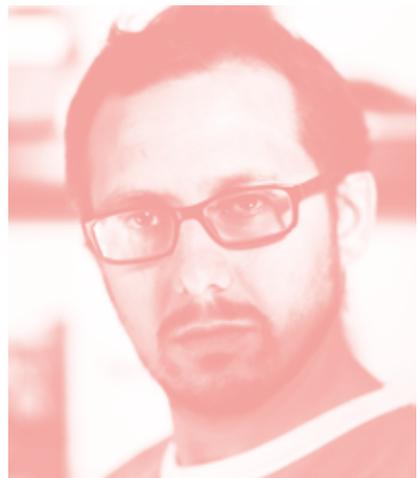
The second cohort focuses more around music technologies. We pair people with research mentors so they are connected into the lab more easily. Three proto-projects have come out of this so far.

For example, Ron Herrema is a Composer and App Developer working on Infinity, a graphically and sonically generative iPad application that uses touch interaction to modify the audio/visual elements generated, and create an interactive experience. The project, in collaboration with Horizon/MRL, explores the concept of user experience from multiple perspectives: as a piece of art, a tool for contemplation and also engagement. This may lead to further projects with other artists.

Grant Smith is a Digital Artist working in collaboration with us, SoundCamp and B3Media to develop DIY STREAMBO - an affordable, resilient, plug and play streambox that captures live environmental sounds and broadcasts them in high quality stereo over the Internet. This initiative has potential to dramatically increase participation in the emerging field of live audio streaming, and

contributes towards creating a varied open microphone network as a resource for artists.

The next cohort of TalentLab is being recruited - they will come to Nottingham with bursaries, engage with us and hopefully pitch a number of new projects as a result.



Richard Ramchurn

“The TalentLab programme of industry professionals and project development support came at just the right time, it inspired me to push my boundaries and is a significant landmark in my artistic career. The biggest inspiration and most impactful part of the training was to visit The University of Nottingham’s Mixed Reality Lab (MRL). From my time working with the MRL, I successfully applied to the Horizon PhD programme and secured a fully funded 4 year PhD. It is no exaggeration to say that the TalentLab programme has changed my life.”

Richard Ramchurn

Technology & Economic Impact

Our research considers what happens when technology starts to achieve wide scale adoption and hence impact on society and, in turn, how society then influences technical advances and drives change back into the innovation cycle.

Many technologies that we work with have existed in labs for years, and research on advancing the technology has been carried out for some considerable time. Take for instance mixed reality gaming - my colleagues at Nottingham in the Mixed Reality Lab have been working on such technology for over fifteen years. However, this recently came to the public attention through the release of Pokémon GO, a game that achieved rapid growth because of availability and ubiquity of smartphones – and that rapid and widespread deployment raised issues of social acceptance and safety. However, even fifteen years ago, the idea that smartphones would be so widely available was science fiction for most people,

so understanding back then how society at large would react was futurology, not science.

There are many technologies in the labs already that within the next ten years will be available at scale to society with the same scenario playing out – an apparently disruptive event that is underpinned by new uses of technology enabled through the gradual introduction and acceptance of our key platform technologies, like smartphones, into our everyday lives.

Our focus is on ongoing research to address the leading edge of this Digital Economy. We do this by working closely with a range of companies to investigate how the disruptions provide both opportunities and challenges to businesses. Such work is intended to assist in driving productivity and competitiveness through the appropriate use of digital technology, and in turn support economic growth and impact.

Professor Derek McAuley

Full version of Technology and Policy Impact articles can be found at:
www.horizon.ac.uk/technology-and-economic-impact



Professor Derek McAuley talks about the Databox project, the conclusion of a number of years' work in Horizon looking at how third parties may be allowed to process our data in a privacy-preserving way.

What are the issues around companies using the data they collect about us?

Living in a digital world, we all leave digital footprints – data about who we are, where we've been and what we've done. Our phones know where we've been and who we've been talking to. Our heating controllers know when we are at home and how warm or cold we like it to be.

This gives the organisations we interact with a large amount of information about us. We may be comfortable with a company knowing some things about us – such as how many cups of tea we drink in a day. However we should not be comfortable handing over information such as our second-by-second energy profiles from which others could determine when we are at home and when we are not.

Often we end up sharing a huge amount of our personal data with a company, when what they actually want, and what is of value to them, is only a very small statistic derived from that data. Current architectures promote this sharing of the raw data with the service provider so, in addition to relevant data being handed over, other information is also passed on. This is where privacy concerns

arise and people have become distrustful.

What is Databox, and how does it overcome these problems?

Databox is an open-source personal networked device that, rather than having to share personal data with a company, allows the company to run an application on our data on our own computer. By providing this different implementation and a measure of auditability, we are aiming to recover user trust and, in addition, unleash some of the creativity around the use of personal data.

With Databox you never have to give your data away. It stays in your Databox safe and secure, allowing control over exactly what data is shared and with whom. Databox enables you to use your data, and allows other people to use your data, without ever giving it away.

Search for 'What is Databox?' on YouTube for a simple explanation of how it works.

How will users benefit from Databox?

For companies, having to comply with data protection regulation in addition to other sectorial business legislation, Databox technology provides a valuable service in



minimising risk associated with accumulating personal data outside of what they actually require. Many companies do not want personal data for other purposes - their business model does not depend on selling the data to somebody else. They just want to provide their customers with a tailored service, to meet their needs and retain their good reputation.

From a societal point of view, companies may be able to offer insight encapsulated in software that enables them to run and process certain data that would be difficult for them to gain access to otherwise, whether due to regulation or issues of privacy. This could prove to be advantageous to the individual - for instance obtaining personalised recommendations provided in complete privacy.

Understanding how data can be exploited is important to both companies and the general public. It is very difficult to detect what an application is doing when connected to the mobile phone network, and so it could have one behaviour on the Wifi where it's monitored and could change its behaviour when it goes somewhere else, with the risk of data leakage. Databox monitors all activity - any information that gets shipped out of the Databox is logged. Part of our role will be to produce simple visualisations to help users understand this.

At what stage is the Databox project now?

We are looking at many of the so-called big data problems, where today people try to gather as much information together in one place so they can run their analytics on it. Instead we need to understand the classes of problem we can solve by leaving the data where it is and distributing the analysis over the wide area network - how to get bits of the analytics running in each home so we process the data there and only share the derived information once it's been compressed down to a small number of useful statistics. This is taking a very different approach to the current model that most people have about big data.

Databox has launched the open source software to start building a community who is interested in helping us build the platform - a generic infrastructure similar to the 'operating system' of Windows, an environment in which anyone can write applications to run on Databox. However, in the same way that when you buy a new device you expect it to come with certain built-in applications, for instance email and text messaging, Databox will come with standard setup applications, with others available to download, and possibly buy, through the familiar "app store" model.

<http://www.databoxproject.uk/>





Motivating people to save energy in the home has long been an area of research focus, but understanding how to translate these behaviours to the workplace is more difficult to justify.

Alexa Spence, Principal Investigator of C-Tech (Psychology), and **Murray Goulden**, Research Fellow in Sociology, tell us about their work with organisations around studying energy use in their premises, and developing novel ideas to effect behaviour change.

How has the energy research in Horizon evolved?

Much of the research into energy saving behaviours has been carried out in the home where there are easily quantified environmental and financial imperatives to motivate home owners to take an active interest. However in the workplace these imperatives are not clear - collective responsibility for usage, individuals not paying for the energy - and the question arises as to what would motivate staff to demonstrate energy saving behaviours when the immediate benefits may not be apparent to the individual.

With this in mind, we were funded for the C-Tech (Creating the Energy for Change) project in collaboration with the University of Southampton and the Centre for Sustainable Energy (CSE), a national charity focussed on supporting changes in energy behaviour.

What was the background to your work?

We soon realised that many attempts to engineer people out of energy management in the workplace had failed, and there was very little literature about research into people's behaviour in this setting - technical solutions, yes, but psychology and studies of user interaction with the interfaces, no.

The importance of incorporating staff in the process is shown by data from Innovate UK (from the non-domestic building performance projects they funded up to this point) suggesting that 65% of energy consumption can be controlled by occupants in a building, and that up to an incredible 50% of consumption occurs out of working hours. There is a team of stakeholders in most organisations, and each of them needs to be engaged and bought into the activities - from senior management, the Facility and Energy managers (who deal with energy management on a day to day basis, albeit from different perspectives), to of course the people that actually work in the buildings. The last group may be the most important, however mostly left out of the discussions, with the problem being isolated to a small part of the organisation.

In addition, most building management systems are quickly and badly installed without buy-in and understanding of the clients. It is difficult to see how these technologies can be expected to play a part in energy-saving activities, and there-in lies the problem.

What work did you carry out in C-Tech?

We have been successful in incorporating a number of test sites, including a mix of SMEs, corporates, councils and catapult centres. The

project activities undertaken have included accessing energy data for specific workplace buildings and analysing this data to identify patterns in usage and anomalies, where changes could be made. Further workshops, survey work and ethnography have provided insight into organisational energy policy, energy needs, and user perspectives and motivations for energy use and energy conservation.

What are the outputs and key learnings from the studies?

We found the major challenge for organisations, especially now with the introduction of smart meters, is that there is easy access to tons of data from overly clever systems, but with no resources to make use of it – as in the words of one of the Facilities Manager’s we spoke to, it is like using a Ferrari to deliver the mail! In addition to the technology problem, there is the organisational problem of lack of communication and stakeholder buy-in.

We provided a specific report to each of the test sites. These highlighted the potential for major savings through a reduction in wasteful energy usage (such as water heating being on during the night); better use of the Building Management System through simplification of functionality and good training and maintenance; and institution of cooperative measures to reduce consumption.

In addition, we have produced various tools in the course of our research. One is a scale to assess motivations to save energy at work as there was nothing currently available. We also developed and deployed IdleWars, a game that converts environmentally positive and negative behaviours into individual scores. It was shown to be effective in terms of generating discussion and behaviour change, and won the EnviroGame prize for best environmental game of the year in 2014.

The key project output we have developed is e-Genie, an energy engagement tool that provides an energy consumption dashboard with data on workplace electricity use and heating and encourages people to take action. In conjunction with CSE, we are currently developing a toolkit around e-Genie, including advice and workshop plans for energy saving in the workplace which will be made available open source at the end of the project.

How have the results of your work been disseminated to different audiences?

We have published in top ranked academic journals such as Nature Climate Change and

Global Environmental Change. Our paper published in Energy Policy about the role of the facilities manager in organisational energy use won a prize from the British Sociological Association Climate Change group in 2015. We have also appeared in The New Yorker, The New Scientist, The Guardian, on the radio and Alexa recently gave a talk at the Carbon Journey event at Genting Arena in Birmingham to Birmingham city and Aston University students and a range of industry representatives.

And the future?

C-Tech findings will be presented along with the launch of our toolkit to engage office employees in energy conservation at the TEDDINET-C-Tech Non-Domestic Energy Symposium at the Digital Catapult in London, 2017.

“We can see clear benefits from having e-Genie installed in our office in that it provides us with concrete energy data which we can refer to when making operational decisions. It gives credibility to points being made and allows us to bring discussions to life by, for example, being able to illustrate exactly where the hottest bit of the building is.”

Peter Karney, Digital Catapult





Little is known about how doctors deliver out-of-hours care in hospitals, and yet studies have shown drops in healthcare quality at night and on weekends, and significant increases in patient mortality.

James Pinchin, Transitional Assistant Professor in Horizon, talks about his research to use and combine data about hospital doctors' tasks and locations to help the understanding of their workload and what can be done to support them.

What is the background to the Wayward project?

We know that the demands of out-of-hours working lower quality of life for hospital staff and impact the costs of care through absenteeism and over-reliance on locums. However, out-of-hours care remains under-studied, due in part to practicalities of large scale manual studies in the complex, geographically dispersed, and sensitive working environments of hospitals.

The Horizon Wayward Project was set up to measure the amount of work undertaken in the out-of-hours system and understand how the workload is managed by teams and individuals. New technologies such as indoor positioning and tracking were employed, alongside data from task management systems, to provide an insight into the system at scale.

Can you update us on what's happening in Wayward now?

In collaboration with Nottingham University Hospital, Aintree Hospital, Blackpool Victoria Hospital and Liverpool School of Tropical Medicine, we gained Health Foundation funding to expand research activities across multiple sites.

The different hospital sites have very different ways of working, and we are aiming to get every doctor on every shift carrying one of our location-tracking boxes and adding to our picture of out-of-hours work.

Interviews and focus groups with clinicians and patients are underway to increase our qualitative knowledge of these working environments and to explore the ethics of remotely monitoring activities out-of-hours. In addition structured observations will be carried out, involving shadowing doctors on their shifts and recording in detail what is going on in the hospital.

What outputs and impacts are expected to be achieved by Wayward and how will these be shared?

Data from our activity with NUH has been shared with the Royal College of Physicians (RCP) Future Hospitals Programme. This initiative is about the design and running of hospitals in the future. We're working in particular with the Safe Medical Staffing working group that looks at hospital staffing and staff/patient ratios.

Whilst there is work being done and toolkits available to identify the minimum safe

number of nurses in ratio to patients on a hospital ward, there is very little out there that's the equivalent for the doctor level. We are developing a toolkit with RCP to enable calculation of the number of clinical staff likely to be needed per patient.

We will also contribute to the training of junior doctors about to embark on out-of-hours shifts. By exposing them to some of the non-clinical problems and situations they will be exposed to in this type of work, and providing successful management strategies developed by experienced staff, we aim to make their early shifts less stressful and ultimately safer for patients.

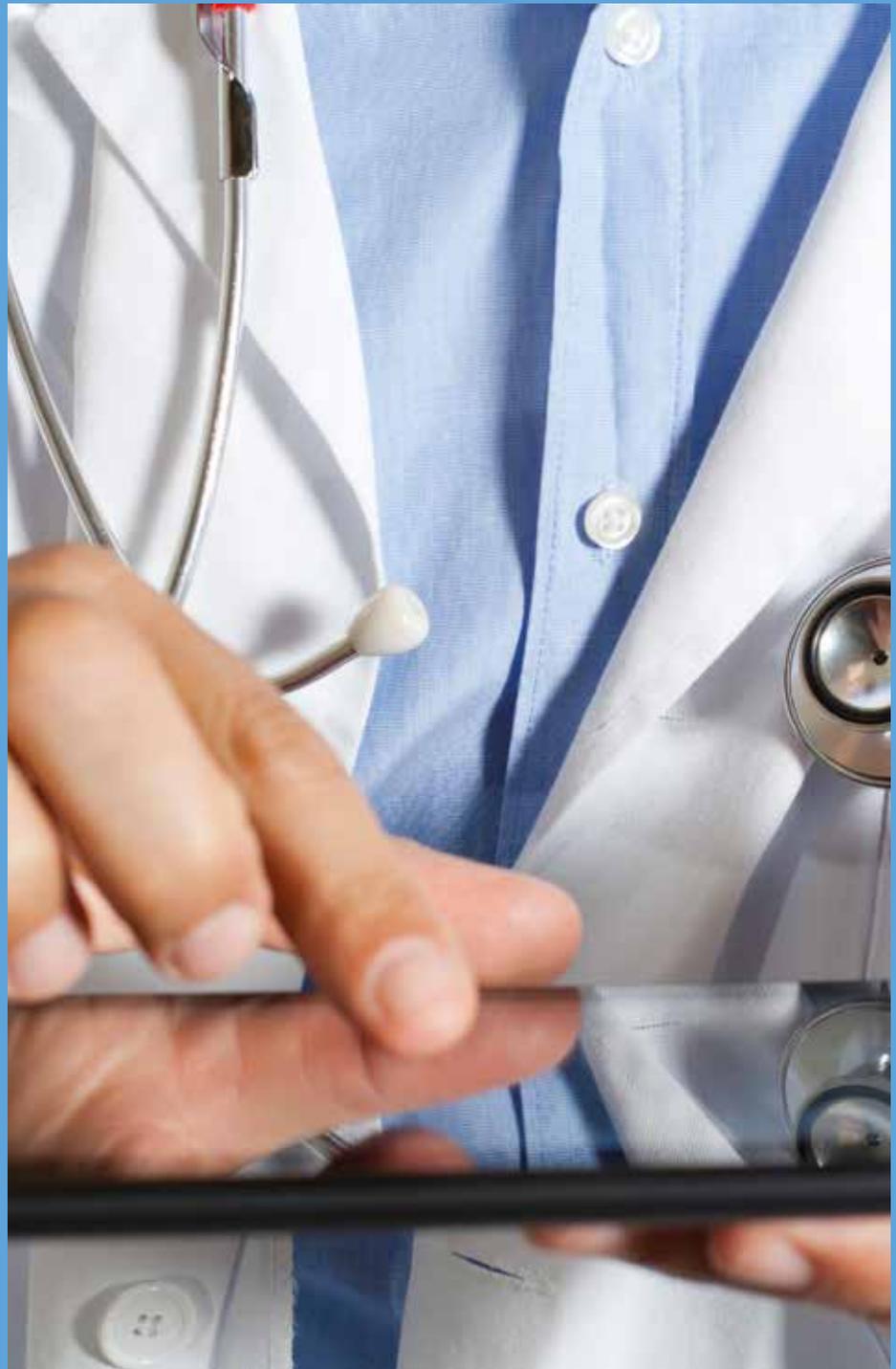
Any other observations?

An interesting observation has been the variation in amount of interaction seen between the different staff roles across the hospitals. There is a good amount of inter-hospital networking at senior management level, a fair amount at senior consultant level, however not so much between senior nursing staff. It is important to help build and maintain these links, especially as the nursing staff are the ones that actually implement the out-of-hours programme on the wards.

Our work has enabled us to create links between all ward staff at Nottingham, Aintree and soon to be Blackpool hospitals, and we anticipate more useful links being established throughout the lifecycle of Wayward.

And the future?

I've started to think more about the patient focus and communicating the work of the hospital from a patient's point of view - for example, looking at ways to extract information and communicate it to and for patients (creating a bedside 'digital advocate'). There is scope for the Wayward team to develop support tools to ease the managerial work of members of the out-of-hours teams and allow them to focus on clinical tasks. I think that'd be a really interesting research proposal!



“Working with Horizon has facilitated strong working relationships between the Departments of Clinical Sciences, Engineering and Computer Science. It has enabled several projects to be developed including Wayward which uses an indoor navigation system, developed at Horizon, to allow us to study the movement of doctors within wards. The potential implications of using these new technologies to improve service delivery within the NHS are very exciting and have the ability to shape the way we provide future hospital care.”

**Dominick Shaw (MB ChB, FRCP, MD),
School of Medicine, University of Nottingham**

Societal & Policy Impact

Technology shapes society, but society by its pattern of adoption and appropriation of technology in turns shapes the technology. As examples, SnapChat and Instagram emerged as responses to social media technologies that many felt had been designed to share information too widely by default and were too complex to manage.

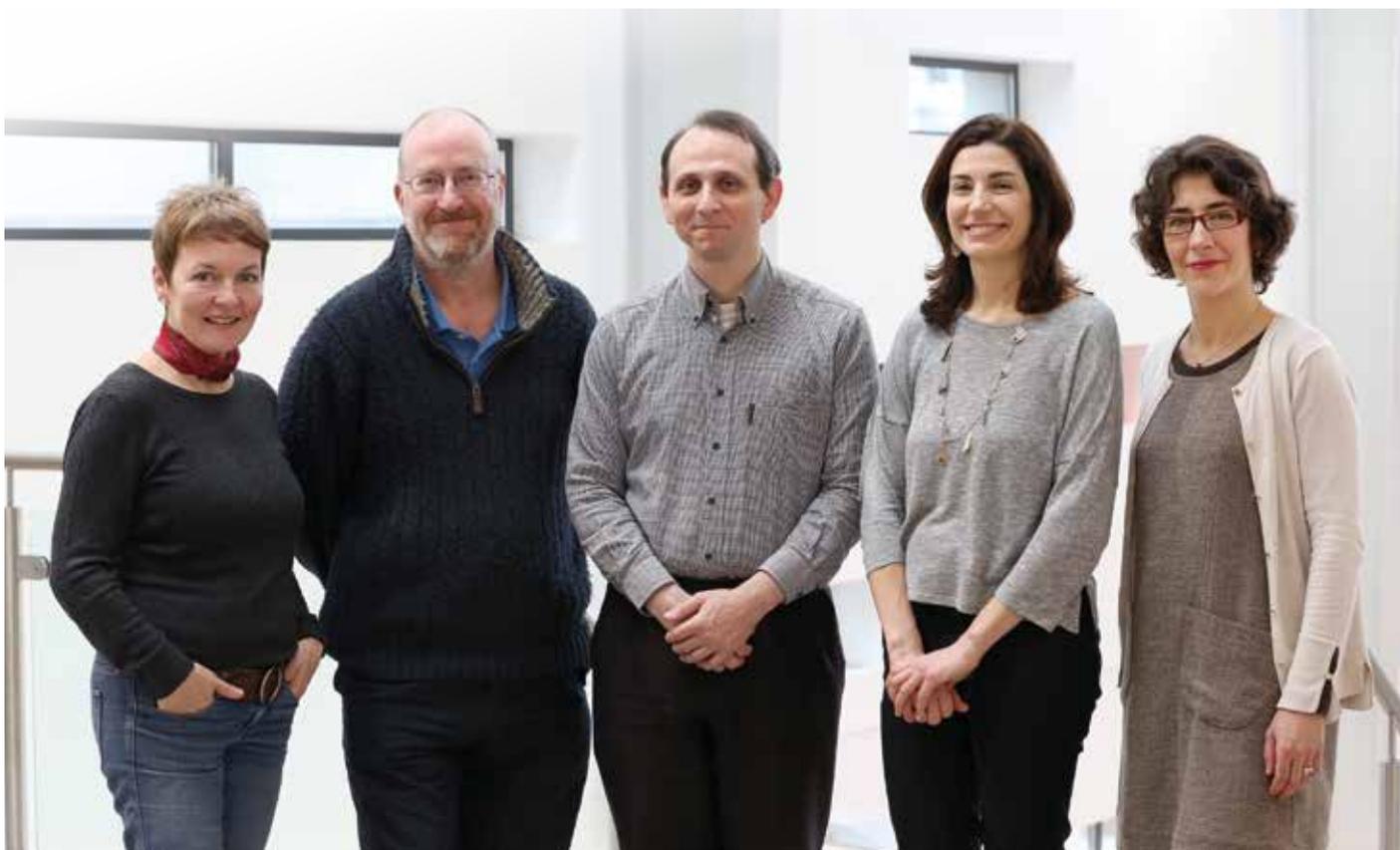
As societies react and impose their views on companies and citizens through regulation and policies, our research to support the interpretation of human data - in particular around privacy and data control - involves working within the policy arena as

independent experts, in order to encourage policy debate and inform regulation.

New technology leads to disrupted markets and the need for constant review of the relevant regulations within those markets - on one side to foster innovation, on another to protect consumers, and finally to encourage economic growth and competitiveness. Our role working with regulators involves translating the insights from our research to better enable them to understand ways in which this complex situation may be navigated.

Professor Derek McAuley

Full versions of Society and Policy Impact articles can be found at:
www.horizon.ac.uk/society-and-policy-impact/



Working in the area of privacy and ethics involving the use of the Internet and social media, a topic very much in the public domain, this Horizon research strand has attracted a huge amount of interest from different areas of society.

We talk to **Elvira Perez** and **Ansgar Koene**, senior researchers in Horizon, about how their research aims to influence policy and the way organisations treat our personal data online.

How did this strand of research develop in Horizon?

Horizon was awarded funding from the Economic and Social Research Council (ESRC) for a project called CaSMa, Citizen Centric Approaches to Social Media analysis. The idea behind this project was to look at social media - the way it's being analysed, how the data is being accessed – but importantly, this project prioritises the perspective of the users of social media rather than that of the platforms or service providers. Specifically, the ethical questions around: do people know how their data is being used, are people comfortable with the way the data is being used, do they feel that they have enough control over their data?

We approached the research from different angles: Elvira pursued youth participation on digital matters through a process called 5Rights Youth Juries; and Ansgar researched consent issues and how the companies, platforms and engineers who make the systems use the data.

Tell us about the 5Rights Youth Juries and how you engaged young people in the process?

CasMa has a citizen centric approach, but we realised that young people are usually excluded

from these debates and there was a need to promote youth civic and political involvement. We collaborated with 5Rights, the University of Leeds, and many other organisations to promote the rights of children and young people online. The result is the 5Rights Youth Juries, an engaging methodology that invites children and young people to interrogate their relationship with the Internet and digital technologies. At the Youth Juries participants are asked to consider, debate, and share ideas about the future of the Internet while providing useful facts and a safe space to discuss, reflect and deliberate about online data management, online trust, the right to be forgotten, and other internet-related issues. The juries are a form of focus group but much more dynamic, with creative prompts or scenarios that can be either real drama, video clips, or news that trigger debates.

A key output has been our report 'The Internet on our Own Terms: How Children and Young People Deliberated about their Digital Rights', launched at the House of Lords on the 31st January 2017 by Baroness Beeban Kidron, which describes the work carried out in the 5Rights Youth Juries. The report outlines the ground-breaking research process and policy suggestions, straight from the mouths and imaginations of the young participants, and aimed at ministers, industry, educators and business.



More than 200 young people have attended our youth juries.

What is the focus around the consent issues and what has the research led to?

Our interest derived from questioning how social media data is being used, and whether people are aware of this, know what they are giving consent to, or even have enough information to make those decisions. A clear indication of how this is not the case is that most terms and conditions are too long to read and the language difficult to understand; also there may be clauses stating the right to use data for research purposes, where this research is not sufficiently defined.

Those issues about consent fuelled the development of the UnBias project. This EPSRC funded project aims to work with young people to further understand how aware 'digital natives' are about algorithm bias, their attitudes and main concerns when interacting with the digital world, and their recommendations when accessing such online systems. This information will help us

to better understand the way young people interact with internet services and identify youth-led solutions for teaching critical thinking toward digital information systems. It will also provide a youth/user perspective on possible need for changes in the design standards or the regulations pertaining to providers of social media and interactive services.

What has been the impact of your research, and how have you disseminated the outputs?

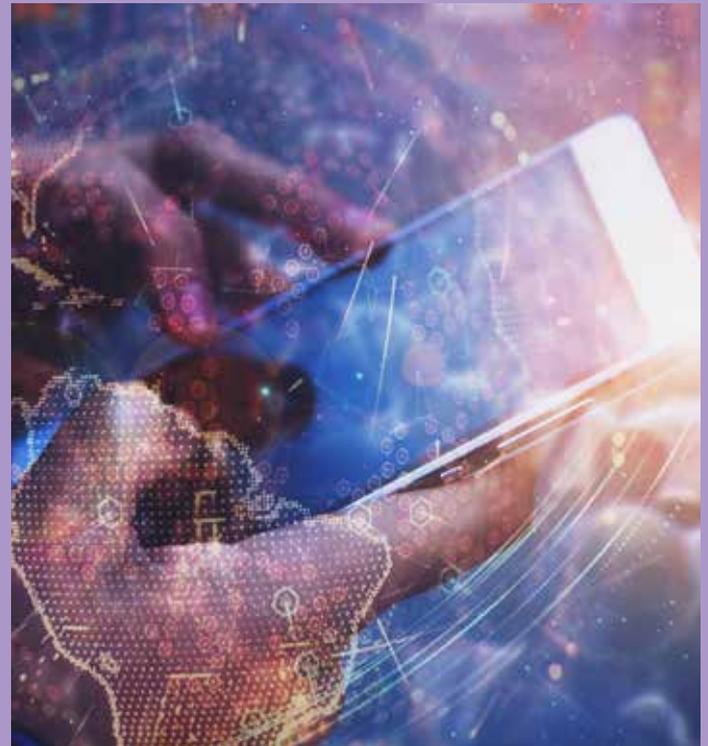
Our main aims are influencing policy, the way industry deals with personal data in provision of services, and promoting digital literacy in young people and the wider population. We do not want technology to guide us, we have to guide the technology to work for us - and technology is continually evolving. We can influence the ethical design of that technology only by generating debate with all stakeholders - users, policy makers, industry. We are providing the methodology to generate such debate.

“It made me think about how it would be if the Internet would not be around, how different it would be.”

Quote from one of the participants

“For me, one of the most exciting things about working at Horizon is the sense of contributing directly to improving the impact of the Digital Economy on society.”

Ansgar Koene, Horizon



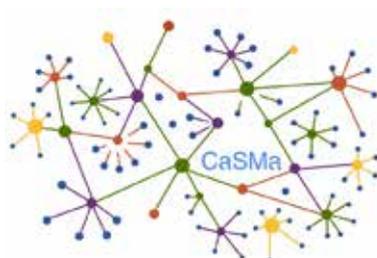
We have translated the insights from our research into responses to a number of parliamentary inquiries including the House of Lords Inquiry on 'Online Platforms and the Digital Single Market' and the 'Investigatory Powers Bill: technology issues' inquiry. In addition the team, in collaboration with the UK Council for Child Internet Safety, has contributed to 'Child Safety Online: A Practical Guide for Providers of Social Media and Interactive Services'. This guide highlights the potential impact that digital interactions and experiences can have on children's emotional social habits as well as possible interventions to achieve childhood development goals.

The UnBias project is building a network of collaborators for future research and impact. Our stakeholder group will contribute to the project through workshops and online activities around education, design standards and policy recommendations. In addition we are creating open educational resources to promote digital citizenship that

can be tailored to tackle the issues we are researching (algorithms, data privacy, digital rights), and offer an engaging methodology (i.e. youth juries) for others to use and apply.

We also communicate to non-scientific communities through our project blogs, and have published articles in The Conversation. One article (Facebook's algorithms give it more editorial responsibility – not less) was picked up by Business Insider UK.

<http://casma.wp.horizon.ac.uk/>



“Horizon and its multi-disciplinary ethos provides a unique platform to influence the internet we want. We can do that by understanding internet users' perspectives and its implications for policy development.”

Elvira Perez, Horizon



Lachlan Urquhart is a Research Fellow in IT Law in Horizon. He talks to us about the possibilities of aligning the fields of IT Law and Human Computer Interaction (HCI), so academics and designers can work together to address the regulatory challenges of emerging data driven technologies.

Lachlan, what did you research for your PhD?

I was looking to understand the role of technology designers in addressing some of the tough regulatory questions around emerging technologies, like the Internet of Things (IoT). I was interested in how much we could conceptually align IT Law and HCI - and the areas of practical crossover between the two disciplines.

I studied different design frameworks which were quite open to engaging with wider ethical implications of technology, and from the law side looked to see what role design already had as a regulatory tool to shape behaviour of end users. While this has been studied to some extent, I found a gap between the work in HCI - looking at how users interact with technology - and the models we currently use in IT Law, which are more abstracted and neglect how actual users use technology in practice.

To explore the implications of this, I focused on smart metering and domestic IoT, conducting in-depth case studies of regulating these types of technologies. Some examples of the real big issues are getting informed consent from users when they are using ambient technologies, and how to implement the right to be forgotten. I carried out interviews with experts from both IT law and HCI/design communities to see if the concepts I was developing in my PhD would work in practice.

Alongside this, a set of physical ideation cards were developed, centring on doing 'privacy by design' in practice. The cards are a great tool to sensitise the design community to legal issues, as law is not a traditional area of focus or familiarity for them.

How do the cards work?

To begin with we developed a deck of cards to explore impacts of the new pan-European data protection law, the EU GDPR, in practice.



Initially we focused on changes in data protection law, like new breach notification requirements or the right to be forgotten. We looked at impacts on design and how these data protection changes may best be communicated to designers. We developed a wider deck for the whole new GDPR, as part of a Horizon project in partnership with Microsoft Research. I ran a series of workshops with our deck of cards in a range of organisations and with a mix of attendees from interface designers, programmers, business strategists and beyond – all of them concerned about the impact of regulation on their work.

We concentrated on the design of a hypothetical system (such as an autonomous vehicle), and the cards were used to lead the attendees through various scenarios – for example, how would consideration of specific user types (older or young people) change the design of the system? What if there are constraints on context of use, for instance poor network

connectivity or tight budgets - what impact would these have on the design process? Lastly we introduced legal concepts, like user legal rights and designer responsibilities. How would the right to be forgotten be implemented to ensure all personal data was deleted? How can designers enact the right to data portability, to allow users to move information freely between service providers? Tricky questions to answer!

To make the law more accessible, the cards are clustered into suites of legal concepts - such as the rights of the end user, the responsibilities of the designers, definitions like what is personal data, what is a data controller, and international concerns, such as using cloud services hosted in the US. We analysed how users went through the process of using cards and how they navigated around these complicated legal concepts.

Finally I carried out a focus group discussing the issues arising out of the workshops.

Interestingly it ended up developing into a clinic, where participants were raising many different questions related to their own individual situations. It became clear that, while large companies and multi-nationals often have internal advice-giving departments, small companies do not have a support structure for this. They felt the cards would be a good entry point for them to be introduced to some of the ideas, and helping them understand what questions they need to ask during the design process.

Samples of the cards are available at <https://lachlansresearch.wordpress.com>



Our personal data is often hidden away in siloes and not utilised to our benefit. If it could be liberated from these 'big data' silos and innovative privacy-preserving algorithms used to unlock its potential, it can provide both social good and a winning service for everyone.

We talk to **James Goulding** and **Mark Iliffe** about data-driven ways to characterise human behaviour.

What is Neodemographics, and how has the project developed?

The initial Neodemographics project was funded by Horizon. We built collaborations with large UK companies (such as Boots, Marks & Spencer and Tesco) to develop a series of novel data-driven techniques to shed new light on consumer behaviour. One example approach, based on 'dynamic topic modelling', scours data for the underlying purchasing trends cutting across the market. Using these trends as building blocks, and re-assembling them in different proportions, it can characterise the distinct makeups of shoppers in a way that incorporates change over time. The team, along with our private sector partners, continues to explore where these exciting new insights take us, from new product development and consumer experiences to greater understanding of customer lifetime value.

Following the success of these initial approaches, we were then able to take these 'Neodemographic' techniques outside of UK markets, and explore how they might help emerging economies through an ES/PRC funded project called 'Opening Developing World Markets by Using Personal Data and Collaboration'.

What were the aims of this project, and what have you achieved so far?

A key factor in meeting the UN 2030 Agenda for Sustainable Development is actually measuring progress. However, intelligence

of this nature is traditionally extremely hard to come by in emerging markets – censuses, social infrastructures and open data often just don't exist in these regions. This hinders not only local companies, but seriously impacts on human and economic growth, deterring foreign investment from entering the market. Lack of geo-demographic intelligence in the developing world can also seriously hamper the progress being made by government organisations and NGOs, such as the Red Cross and the World Bank.

And yet, while emerging countries are often infrastructurally poor, they are data rich. Most of the population in Tanzania, for example, own a mobile phone and carry out payment transactions with the device. We recognised that by engaging the private sector, we could leverage digital footprints to create new social data sets of a comparable quality to, if not better than, traditional census and survey data.

This has grown from strength to strength and we now work with a wide network of data providers in these emerging economies to investigate just what market knowledge can be derived from that digital footprint data. We've fused mass transactional event logs with open geospatial data and developed new mathematical techniques to generate novel intelligence 'layers' - mobility models, transport networks, financial flow maps and new forms of data-driven geo-demographic segmentations - all aimed at supporting decision makers and business growth, and changing the way in which we think about collecting market intelligence.

Photo taken by Mark Iliffe, licensed under CC by SA 4.0



At the same time we were aiming to meet the goals of the sustainable development agenda.

What other projects have developed from the original research?

In the UK we have worked with psychologists, Boots and a nutrient tracking company Nutracheck, to analyse patterns in behaviour when people make healthy or unhealthy eating choices. We've had a Knowledge Transfer Partnership with a marketing company, Krow Communications, where we explored the space between business data, personality and marketing. These are now combined into a new project called 'machine-learned personality' – a novel method that can use big data to measure personality and predict economic and social behaviour.

We have received funding from the British Council/Newton Fund to model the transmission of dengue fever in Malaysia; an ESRC-NERC-DFID grant for 'Big Data for Flood Resilience in East Africa'; and the Gates Foundation for 'Financial Data Mapping in East Africa'.

In a linked project, team members have also worked extensively with the World Bank on the Ramani Huria (<http://ramanihuria.org/>) - an effort to map over 1.3 million residents in Dar es Salaam, Tanzania, Africa's fastest growing city. As part of this, we have collected vast amounts of geodemographic data through community mapping of neighborhoods (crowdsourcing information from local community members). We've built on these

open data outputs with the mining of mobile phone data (through collaboration with an African telecommunications company, TiGo). Thanks to this experience, we have been able to extend the work via funding from Horizon to analyse aerial imagery of the whole city collected from drones and, in partnership with companies such as IBM Research Africa and DigitalGlobe, we are examining how these datasets can automate analysis of road conditions, land use, and the serious issues of slum expansion due to rapid urbanisation.

Give us an example of impact from your research.

As part of our research we have helped scale out the mapping in Dar es Salaam to cover 3.5 million people, and this has provided a de facto baseline map of the fastest growing city of Africa. Dar currently has a population of 5 ½ million people, but eventually it is predicted to become a mega city of over 10 million in the next 15 years. This unplanned rapid urban expansion, along with global warming, has resulted in the city suffering biennial flooding with no adequate draining network.

The extensive mapping has enabled us to identify the most flood prone areas, predict impacts and work with individual communities to build community resilience groups. These will help maintain infrastructure, clean drains and provide dumping sites to reduce the risk and impact of flooding. It has also pinpointed priority areas for development organisations and the government to build infrastructure.

In addition, analysis of mobile phone data has allowed us to generate mobility models of unparalleled granularity for the city, and these are now informing transport policy in the region. Much of the data we have contributed to has emerged from community mapping, and is entirely free and open on Open Street Map.

What is the key learning from the international work?

Two or three years ago the country would have depended on traditional government agencies to solve the developmental problems, but there is now the growing realisation that this is not the way forward, and we can provide a shortcut through the process by mediating with private sector bodies and NGOs. By training the next generation in new digital approaches, they will return to their countries and be ready to support the development of new processes within government institutions that are going to be better, leaner, and more efficient than the current traditional slow-moving ones.

The key opportunity is working with communities in the places where we carry out the research, and this includes academic institutions. We are therefore building a network across East Africa that can come together and do this sort of work with us.

And the future?

Future research challenges involve investigating how such community-curated open data becomes sustainable over time, how we can



generate business models that encourage the private sector to contribute data for development, and understanding how the skills gained by community members and government officials can be leveraged for wider societal and economic benefit.

The problem is that as fast as a city can be mapped and citizen's behaviour understood, rapid urbanisation ensures that data is out of date – even with big data approaches. We are now embarking on a project that brings together all the datasets (satellite, drone images, call data records) and by partnering with other organisations, will build models of not just how a city has been or how it is now, but how it will be in the next few years. We believe these near-future predictions will be invaluable for informing successful policy decisions such as transport planning and health.

We are also very encouraged by the potential - if we can achieve so much in Tanzania, what about other African countries and other emerging nations? We are now expanding the

Neo-demographics approach to South Africa and Kenya, as well as building relationships in Botswana, Uganda, Malaysia, Vietnam and Cambodia as potential areas for future work collaborating with different partners.

Any final comments?

Although we have worked on vastly different application areas – health and wellbeing, marketing, community mapping - they are all underpinned by a common process and goal - to unlock the potential of doing social good via the personal data locked away in silos and unavailable to us. As Neodemographics developed and started to produce real economic, societal and policy benefits, we recognised a need to provide our services on a larger scale, and are now training the next generation to take the skills into industry and other organisations. To this end the University has established the N-LAB as a permanent centre of excellence for International Analytics - See page 36 for the story of how the team has developed over the time in Horizon.

Since the launch of Ramani Huria in 2015 and as of Feb 2017:

Over **1.3 million** citizens affected

29 neighbourhoods mapped

1254 km waterways mapped

3396 km roads mapped

450 mappers trained

10 disaster prevention teams established

Joel Fischer talks to us about CharloT - a home energy advice toolkit to show how far a home is providing a comfortable and healthy environment for the people who live in it.



How did the CharloT project begin?

CharloT developed from a collaboration between the Centre for Sustainable Energy - a national charity delivering energy advice - and the Universities of Nottingham and Southampton. The project was set up with the aim of providing better advice to householders in fuel poverty, focussing on vulnerable people who may suffer serious health impacts from living in cold, damp homes. Fuel poverty is a major societal problem, affecting around 4.5M people in the UK alone.

Energy advisors have little data to work with on property and lifestyle, and this means they struggle to provide personalised advice on how to reduce energy use while keeping warm at home. The initial stages of the project involved the development of an internet of things (IoT) sensor kit to provide information on the temperature, humidity and energy consumption in the home, and importantly a process to enable analysis of the data and diagnosis of issues such as damp, mouldy and cold conditions, and unaffordable energy bills. This toolkit is of particular interest to energy advisors, housing associations, public health professionals, health visitors and social housing managers.

How has the project developed?

Later stages of the project involved working with householders who contacted the Centre

for Sustainable Energy Helpline to gain advice on energy consumption. We invited them to test an early stage energy kit with small wireless sensors placed in key areas around the home, such as the kitchen and living room. Electric and gas consumption was monitored and sent, along with anonymised temperature and humidity data, to a secure server. The data was visualised in interactive graphs and viewed on tablets, showing a story about householders' living patterns and their energy use. Maximum, minimum and average values of temperature, humidity and carbon dioxide levels, along with electricity and gas prices, were also provided which allowed energy advisors to discuss energy issues with householders.

As an example, the kit demonstrated that one house was being heated during times when it appeared no-one was in, and we were able to discuss this with the home owner and provide rapid solutions to address this issue. Feedback from participants was very positive – they found being able to access visual information was more engaging to them, and they were more likely to respond to the advice and make the necessary beneficial changes.

With funding from Horizon, we have further developed the hardware and software to maximise scalability and promote further deployment of the kit. In addition, new data

analytic capabilities are also being considered to advance further research into this area.

Where else has the CharloT kit been used?

CharloT is available open source: <https://github.com/horizon-institute/chariot> and an article appeared in Energy World – the magazine of the Energy Institute. CharloT technology has also been used in a number of other projects. Recently, CSE is using the toolkit in a the “Quantum heater trials” project with Bristol City Council to test the performance of new storage heaters before the council invests in installing them at scale. Chariot is also used in the InnovateUK-funded Energy Game Changer project “MyHouse”, which aims to create an online game using real world data from the Chariot kit to help users reduce their energy use in a playful way.

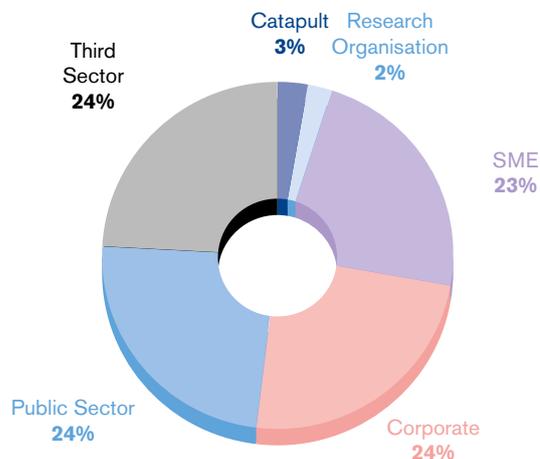
“CharloT is a potent tool in the delivery of energy advice, allowing diagnostics of the home’s energy performance, identification of anomalies and opportunities for wiser energy use.”

Nick Banks, Centre for Sustainable Energy

Non-academic Partner Engagement

At the core of the Research Councils UK Digital Economy Programme is 'user-led research' – the mission being to work with leading edge technology adopters and carry out our research 'in the wild' with the relevant users. To this end, Horizon has grown a network of over 200 partners spanning diverse organisations from major corporations through to small and medium business enterprises, as well as independent creative practitioners, third sector and government. This includes organisations based in the UK and Europe, and as far away as China, Africa, and the USA. Our research investigates the opportunities and challenges for organisations in the adoption of digital technology, especially as the technologies become widely available to society at large.

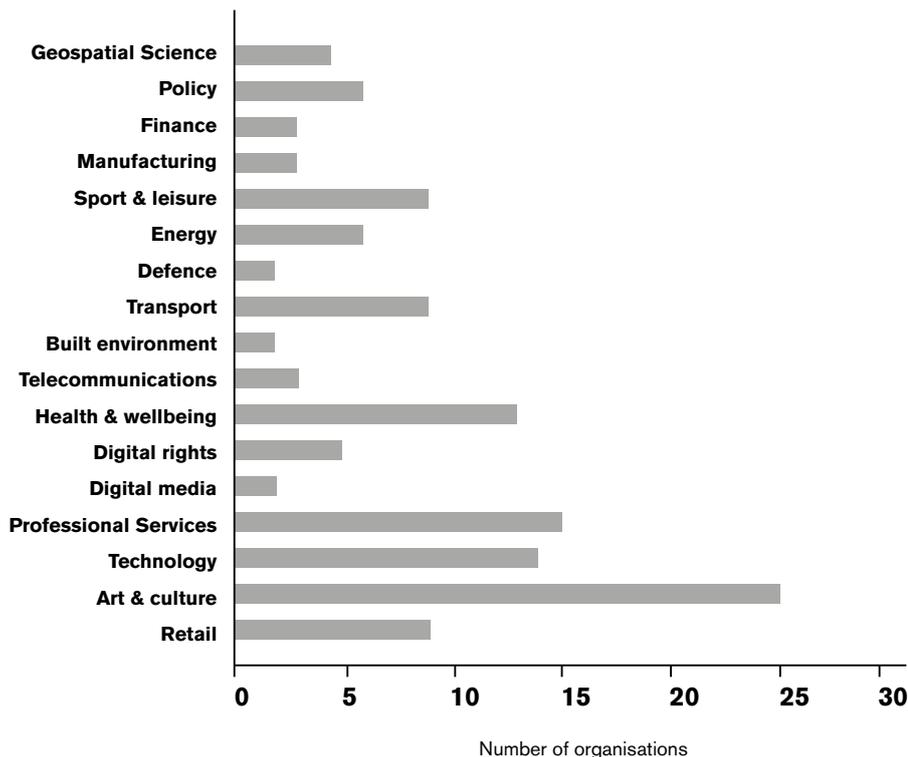
Type of organisation



Sector engagement

Matching our interdisciplinary work with a range of partners across sectors is important for us to demonstrate the impact of our tools and technologies in a variety of real-life applications. We have a long history of working with

organisations in the arts and cultural sector, and the Horizon Media Campaign over the last few years has been a focussed effort to scale up such projects leading to a dramatic increase in the activity with such partners recently.



Professor Steve Benford comments:

“With the cultural creative industries copyright, intellectual property and design rights are key, and the digital is both challenging and transformational. The Media Campaign provides an umbrella to unite a unique portfolio of projects linked to this sector; including partnerships with major corporations (BBC), venues (Motorpoint Arena Nottingham and National Ice Centre, Tate, Galleries of Justice and other museums and galleries), agencies and hubs (B3 Media, Broadway, Creative Quarter) and small independent producers (Ariel, Blast Theory, Mudlark, Urban Angel, Medikidz).”

As we move into the Horizon Services Campaign we will be reaching out to partners in other sectors to collaborate on services for mobility, for health & wellbeing, and for consumers.

Supervising PhD students in the Horizon CDT:

"This is the first Centre for Doctoral Training student that we have had. We are very excited to have a sustained relationship with a PhD student over a long period of time and we are trying to embed aspects of their research in our work."

Matt Adams, Blast Theory

Training

"We really benefited from Ben Bedwell's understanding of the cultural sector and strategic thinking behind creating dynamic visitor destinations, and his knowledge of new dynamic digital tools."

Sarah Tutt, Dance4

How we work together

Working with partners is of paramount importance as it informs our research and ensures that we are addressing relevant and key areas to support digital economy growth in the future.

Over 50% of our network of partners is currently engaged in collaborative research and impact with us. We work with partners as appropriate to the organisation and research project, resulting in a great diversity of types of interactions. As examples, they may have a particular problem that they need help with and which we can address, or they bring specialist skills to projects, or they act as intermediaries, where they give us access to real end-customers enabling us to conduct consumer research.

Professor Derek McAuley and **Dr Sue Jones**

Knowledge Transfer Partnerships

"As Knowledge Transfer Associate (KTA), I had the benefit of being embedded in both the advertising industry and as a researcher in Horizon, thus opening up two paths for my future career."

Vanja Ljevar, KTA

"As a direct result of the KTP, we developed a ground-breaking new approach to data analytics that allowed, for the first time, a 'picture' to be created of a brand's customers that predicted their future transactions."

Malcolm White, Krow Communications

Consultancy

"We valued Horizon's cross disciplinary approach to smart mobility and will be feeding the outcomes of the project into our ongoing work in this area."

Jon Scott, Ford Smart Mobility

Research Collaboration

"We find working with the Horizon Centre helps us explore broadcasting futures with experts across a range of creative and technical disciplines."

Phil Stenton, BBC R&D



Success Stories

Our mission is to encourage and propagate interdisciplinary working among all our staff and students, and this applies all the way through their career trajectory.

We support the development of our Research Fellows, providing opportunities to further their skills and training through the supervision of student projects, teaching, working in an interdisciplinary environment, and learning how to construct successful research proposals and excellent academic publications.

Our Centre for Doctoral Training introduces PhD students to industry, working across many different disciplines to develop them into future research and industry leaders.

Professor Derek McAuley

The Foundation of N-Lab

When the Neodemographics project (see page 30) started in Horizon, there were just three researchers working on the project. With the success of the research, and the receipt of external funding for various new applications of their data science techniques, the team expanded to nine PhD students, six Research Fellows and a number of associated staff from various disciplines - Psychology, Geography, Mathematics, Business, Computer Science.

Recognising that a substantial research group had grown within Horizon, they applied to the University of Nottingham strategic development fund to develop N-LAB, a separate permanent centre for International Analytics within the Business School. The aims of N-Lab are to continue to expand the group's work and set up a multi-disciplinary Masters course in data analytics to feed into the pipeline of data science skills that industry has needed for a long time.

This opportunity has resulted in career progression for many of the team and enabled sustainability of one of the key research strands in Horizon.

The staffing of N-Lab will consist of:

- **Professor Andrew Smith** – Director of N-Lab and Professor of Consumer Research.
- **Dr James Goulding** – Deputy Director of N-Lab, Assistant Professor in Analytics and previously a Research Fellow in Horizon.
- **Dr Gavin Smith** – Data Science lead, Assistant Professor in Analytics and previously a Research Fellow in Horizon.
- **Dr Mark Iliffe** – Geospatial lead, and previously Horizon CDT student, Horizon Research Fellow.
- **Dr Robert Cluley** – Assistant Professor in Marketing Analytics.

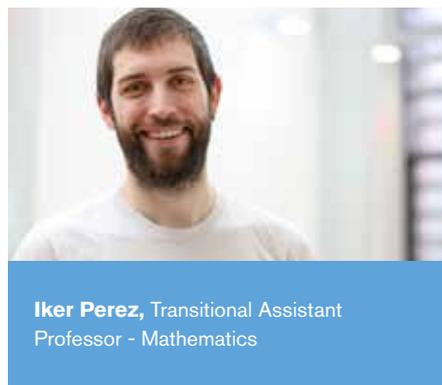
Future recruitment of staff will follow once the Masters in International Analytics is up and running. We wish them all well with their new venture.



N-LAB Neodemographics

Other success stories

Three Research Fellows have progressed to Transitional Assistant Professor posts in Horizon:



Three Horizon CDT PhD students have obtained Research Fellow posts and are now working in Horizon:



“I feel very lucky to have had the experience of doing a PhD at the Horizon Centre for Doctoral Training; the PhD process was exactly right for me as a multidisciplinary researcher, and as a mature student getting back into education. I have been able to come back to the field of Psychology whilst also incorporating my other interests. My current job as a researcher in the hub is very varied and satisfying and I am looking forward to continuing my development within the post through both internal and external collaboration opportunities.”

Liz Dowthwaite, Research Assistant

What's Next?



The increasing popularity of 'as a service' is the driving force behind our Services Campaign, which targets business innovation in online services, whether digitally native ones that manage human data, or ones in which digital services increasingly control physical infrastructures. Our second campaign will strive to continue the legacy of the Media Campaign in driving public and industry engagement.

As an example, some consider that we are moving away from the model of vehicle ownership to rental, where companies like Uber have transformed the way that people use private hire vehicles. However, in wider transport or mobility, we still have siloed sources of information about travel options with the human very much at the centre of processing all the data – in future we need services that consider all options and enable truly flexible modality switches between transport types.

The 'as a service' notion also applies within the contexts of healthcare and consumer goods.

From personal health apps to using technologies to support doctors in their work in hospitals, technologies have the potential to transform the way that healthcare is delivered and monitored.

Today in using many services we enter into 'deals' – in return for 'free' services, we exchange personal data. How well do we understand these transactions, and how in control of them are we? How should we design these services to ensure that people receive a high quality and personalised service but are protected from how their data is used?

These areas present significant ethical, legal, privacy and security challenges. In Horizon we continue to conduct research to understand these challenges and to ensure we are able to deliver service solutions that balance these issues with the value to the end consumer.

Professor Derek McAuley and
Professor Sarah Sharples

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