Snapshots of Doctoral Research at University College Cork

2014

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

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Introduction

Welcome to the fourth volume of *The Boolean*, which presents snapshots of Doctoral Research at University College Cork. The aim of *The Boolean* is to share the outcomes of the research undertaken at UCC with a wider audience. To achieve this, the authors must describe their specialised research in terms understandable by a non-expert. We congratulate the authors in succeeding in this endeavour and we hope all readers will find the articles interesting and informative.

The team responsible would like to thank all authors for their contributions and also all involved in the reviewing of the articles, listed on the following pages.

'The Boolean' Team
September 2014

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The journal team also wish to thank Peter Flynn, IT Services, and Gretta McCarthy, Academic Secretariat, for their invaluable assistance.

For comments or queries, please contact: `boolean@ucc.ie`

Monkeying around: who's learning what at the zoo?

Courtney Keane Collins

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Prologue

The following article is an account of the research I am undertaking as part of my PhD project. Thus far, only the preliminary research is complete, therefore final results of the project are not stated here.

The school tour

It's 9am; a fully loaded bus packed with 50 excited children leaves a school. The students' faces are already smeared with traces of chocolate, their voices are raised in excited anticipation, that familiar aroma that you can't quite describe pervades the bus; the windows are heavy with condensation. This can only mean one thing — it's that time of year again...we all remember it —THE SCHOOL TOUR, and they're going to Fota Wildlife Park. Fota Wildlife Park is one of Ireland's leading tourist attractions. Every year over 12,500 children participate in Fota's formal education programme. They come from all over Ireland to visit the park, view the animals, and have fun. We assume that it will also be an educational experience, but what, if anything, do they really learn while they are there? And how do these noisy, inquisitive, eager, groups of children influence Fota's permanent residents — the animals that live there?

Learning science outside the classroom is a powerful way to educate the public about environmental and conservation issues, and it has been shown, that not only do children benefit from informal science experiences, such as a trip to a science centre or nature park, but it is also an appealing way for them to learn. Children who come in contact with nature frequently and at an early age are thought to have more positive attitudes towards nature and conservation later in life. Zoos host millions of children at their facilities worldwide each year, and commonly claim that educating their visitors is one of their primary goals. While, there is general agreement that zoos are in a unique position to teach the public about conservation issues, their ability to successfully educate visitors has been challenged. Recently, in a British and Irish Association of Zoos and Aquariums (BIAZA) newsletter, zoos are described as being caught between 'a rock and a hard place' by Dr

Maggie Esson (Chester Zoo , UK) when it comes to substantiating claims they have made about their value as educators through peer-reviewed research.

From awareness to action

Some studies have shown that zoos are successful educators, especially at improving visitors' knowledge gain and possibly even their attitude toward conservation, though many of these studies have focused only on adult visitors. A recent large scale survey-based study conducted by Dr Eric Jensen (The University of Warwick, UK) and sponsored by the Zoological Society of London that did include school children, found a significant positive link between scientific learning about animals and habitats from pre to post zoo visits. There are of course many factors that influence learning in an informal setting, which have been shown to be highly personal with visitors often constructing their own meaning from a learning experience. For example, prior knowledge and experience, visitor demographics, and follow-up experiences have all been shown to affect informal science learning. Additionally, at a zoo the size and activity of the animals, the presence of zoo staff, as well as enclosure design and enrichment use may influence visitor learning.

While there is existing evidence of visitor and even children's knowledge gain as a result of a zoo trip, it has proven more difficult to establish if zoos affect any change in visitors' conservation related behaviour, which should be the ultimate learning outcome of any visit to a zoo. According to a special edition of the journal *Zoo Biology* which focused on zoological education, authors Ogden and Heimlich state that zoo-based education should shift its focus from 'awareness to action' from knowledge gain to behaviour change. Those studies that have assessed behaviour change as a result of a trip to a zoo have tended to focus on off-site behaviour change. For example, researchers may ask visitors questions such as 'as a result of your visit to the zoo, are you more inclined to recycle in the future or buy 'rainforest safe' products?' While a visitor, may answer 'yes', it is very difficult for a researcher to follow this up with any degree of certainty. Educational zoo research should aspire to behaviour change that is measurable, relevant, and observable on-site.

The Visitor Effect

The purpose of my research project is generally to investigate what primary school children (aged 10–12 years) learn at the zoo, while specifically studying the interactions between children and free-ranging Ring-tailed lemurs (*Lemur catta*), and the effect of an educational intervention on that relationship. Unique to this project, the behaviour of the children and animals will be simultaneously recorded. This will allow for both sides of the dynamic visitor-zoo animal relationship to be examined, while also considering how or if

behaviour changes as a result of visitor education.

In the area of zoo research, the effect of visitors on animals in traditional enclosures is well documented. It is an area that is difficult to make generalisations about; and, therefore, it has generated much debate and research. Primates are by far the most well studied species. Everything from the husbandry routines at the zoo, to the 'personality' of the individual animals, to the design of the enclosure itself appears to contribute to primates' response towards visitors. Trends in the research are beginning to develop and they appear to indicate that as visitor crowds increase (particularly their noise level) primates may become more aggressive, forage less, become less social, and show more abnormal behaviours. However, very little research has been done to quantify the effect of visitors on free-ranging animals.

The players

Fota Wildlife Park has ten free-ranging ring-tailed lemurs. They are a small cat-sized primate endemic to the island of Madagascar, with a characteristic black and white striped tail. In the wild they are listed as near threatened because of habitat destruction (see Fig. 1). They are a charismatic animal that does well in captivity, and are a favourite among zoo visitors. At Fota Wildlife Park, the lemurs are restricted to the island of Fota, but they are not confined in traditional zoo enclosures. It has previously been shown that visitors learn more from animals that are free-ranging, and it also benefits the animals. However, zoo animals that are free-ranging also experience more intense interactions with visitors.

Figure 1: One of Fota's Free-range Ring-tailed Lemurs. Image: Courtney Collins.

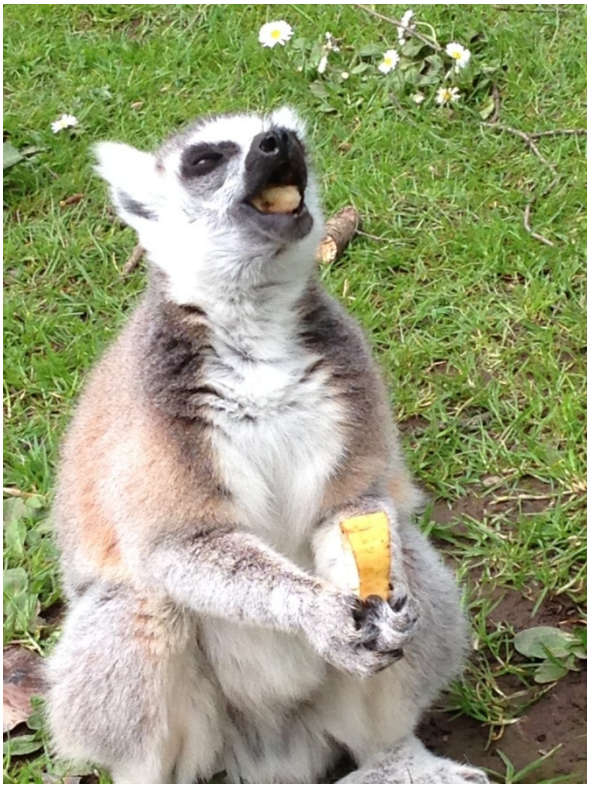

Figure 2: A Ring–tailed lemur enjoys a banana fed to it by a well-meaning visitor. Image: Courtney Collins.

Can it be controlled?

Negative visitor effects are often controlled through physical means such as barriers and sound dampening materials, but here it will be considered if education could change negative visitor behaviour and thus improve the welfare of the lemurs. It is an unfortunate fact that free-ranging animals are fed, chased, touched, and given negative attention by some visitors (especially children) at the zoo. Despite the fact that Fota Wildlife Park employs Lemur Patrol Staff to minimise the negative interactions, they still occur. Lemurs are sometimes fed ice cream, crisps, jellies and other items that are bad for their health. Figure 2 shows one of Fota's free-ranging Ring-tailed lemurs enjoying a banana fed to it by a visitor. This may seem harmless, but can quickly cause lemurs to gain too much weight and interferes with their regular diet (see Fig. 2). My research seeks to reduce negative interactions between children and lemurs through education.

What are students really learning?

Children from participating schools who visit Fota on their school tour will be given a survey before and after their visit to the park. This allows for a general assessment of their knowledge and attitude towards zoos, generally and Ring-tailed lemurs, specifically.

During their visit to the park, children's behaviour as well as the behaviour of the Ring-tailed lemurs will be observed and recorded. Some children (the treatment group) will participate in an educational intervention that relates lemurs' diet to children's diet using food pyramids; they will also have the opportunity to prepare fruit and vegetables which form part of the lemurs' daily feed. This will allow for comparison of knowledge, attitude, and behaviour of children before and after their visit to Fota, as well as between treatment and control groups. The lemurs' behaviour will also be observed, recorded, and analysed in the presence of treatment and control groups of children. Quantification of children's knowledge and attitude toward zoo animals, as well as, the interactions between children and free-ranging animals at the zoo has rarely occurred before and never in Ireland.

The science behind it

Additionally, my research will consider if there may be more to a trip to the zoo than is expected. Previously, it has been shown that many children start to lose interest in science at around the age of twelve. This has far reaching implications for future generations and is an area of increasing concern that has generated much research and interest in the last decade. There are now EU wide programmes and research specifically aimed at increasing and maintaining students' interest in science. Here, it will be considered if a school trip to Fota Wildlife Park enhances children's attitude toward science. A zoo visit is something that most children enjoy, many might even say it is their favourite place to visit, but perhaps they have never considered the science behind it? Students participating in the study will be asked questions in the pre and post surveys about their favourite subject at school, and if they like science. Additionally, during the educational intervention the fact that the zoo 'runs on science' will be emphasised and children will be challenged with questions like 'Who takes care of the animals? How does the zoo know the right food to feed them or medicine to give if animals get sick? How and why does the zoo study the animals' behaviour?' Children need continuous and sustained positive exposure to science in order to develop a positive attitude toward it, and yet, it may be equally important for children to realise that science is all around them, is part of their daily lives and that even something as enjoyable as an outing to the zoo involves science.

The Impact Factor

Given the current economic climate, and the fact that many parents may struggle to pay the fees involved in sending their children on a school tour, there is an increased expectation that children will not only have a great day out, but also learn something during a school outing. Therefore, increasing the learning potential (especially conservation behaviour change) during school visits and establishing links to science is extremely impor-

tant for places like Fota Wildlife Park. Fota is well known for their impressive education programme and even holds the prestigious Sanford Award in education and is a designated Discover Primary Science Centre, and yet there is almost no research to support claims that learning takes place when children visit the park. Therefore, this research project is important nationally in that it will emphasise zoo-based education as a way for children to increase knowledge, and improve conservation behaviour, while learning science, and most importantly —it's fun! The research will have international implications as well since the issues addressed here pertain to zoos with education programmes worldwide. Furthermore, the research enhances existing literature about zoo-based education, and brings novel information to the area by quantifying the interactions between children and captive animals simultaneously.

I would like to thank my supervisors Dr Declan Kennedy and Dr Ruth Ramsay for their help and support with this project. Also, I would like to thank the staff at Fota Wildlife Park, Sean McKeown and Lynda McSweeney-Walsh in particular, for their support of this project. Additionally, I would like to thank the School of BEES for their financial contribution to the project.

Biomarkers in Parkinson's disease

Grace Crotty

Department of Medicine, UCC

Introduction

Do you know anyone who has been diagnosed with Parkinson's disease? What is Parkinson's disease? In the Department of Medicine in UCC I am carrying out research on this condition, and I'm working with people who have Parkinson's disease (PD). I hope to increase our understanding of the disease mechanisms underlying PD along with identifying potential biomarkers for PD. What are biomarkers? Why do we need a biomarker? Keep on reading to discover more!

What is Parkinson's disease?

It is the second most common age-related neurodegenerative condition after Alzheimer's disease. It affects 1% of people over 65 years and 4% over 80 years. 30 million people are currently affected worldwide. It was first described by Dr. James Parkinson in 1817 in his book "*An Essay on the shaking palsy*". Parkinson's disease occurs when there is not enough of a chemical called dopamine being produced by your brain. People with PD classically present to their doctor with one of its cardinal motor features of resting tremor, slowness of movement or trouble with walking. However, other non-motor symptoms may also be present in addition to these motor features. These non-motor symptoms include difficulties with sleep, memory and mood along with dysfunction of the gastrointestinal, cardiovascular and autonomic nervous system. Interestingly, these non-motor symptoms, although quite nonspecific, may affect the patient before the onset of motor symptoms.

How do you diagnose Parkinson's disease?

Parkinson's disease is currently diagnosed by a doctor following the development of motor symptoms consistent with PD. We have no blood test or brain imaging technique that can diagnose PD before a significant amount of brain degeneration has already taken place. Therefore there can be a misdiagnosis of PD in 10-30% of cases, particularly in the earliest stages of the condition. In some cases it can be difficult to know for sure that a person with a tremor definitely has PD rather than another neurological condition. We can only be 100% sure of the diagnosis of PD on post-mortem brain biopsy where we can see

loss of the nerve cells producing a chemical messenger called dopamine, along with the presence of "Lewy bodies" which are structures containing deposits of a protein called alpha-synuclein.

Of note, PD can be present in a patient up to decades before the motor symptoms start. However, by the time a patient with PD develops these symptoms, more than 80% of the dopamine in their brain is gone. We currently have not identified any marker in the blood or spinal fluid to help us with diagnosing PD at a very early stage prior to the onset of symptoms. Research is ongoing to find a biomarker to do this.

What is a biomarker?

A biomarker is a parameter or an indicator of a particular disease state or a particular state of an organism. Biomarkers can be found anywhere in the body. They can be broadly classified into molecular biomarkers or imaging biomarkers. Whatever form the biomarker takes it should be simple, validated, inexpensive, as well as highly sensitive and specific for its particular condition.

Why do we need a biomarker?

Biomarkers are very important and useful for a variety of reasons. They can help with the early diagnosis of a condition, along with confirmation of diagnosis, population screening, drug development, monitoring of disease progression and of patients' responses to treatment. For people with PD a biomarker would be particularly helpful for identifying PD at an earlier stage in the disease process before the destruction of the nerves that produce dopamine in the brain. It would also increase our understanding of the underlying mechanisms of the disease and aid the development of neuroprotective strategies that could slow down or stop the disease process.

Biomarkers in PD

Our research group in University College Cork, along with several other research centres around the world, is currently searching for potential biomarkers for PD. The Michael J Fox foundation (www.michaeljfox.org) has also provided copious amounts of information and funding for research on PD. Biomarkers that have been studied can be subdivided into those that are preclinical, premotor, biochemical, genetic and imaging (Figure 1).

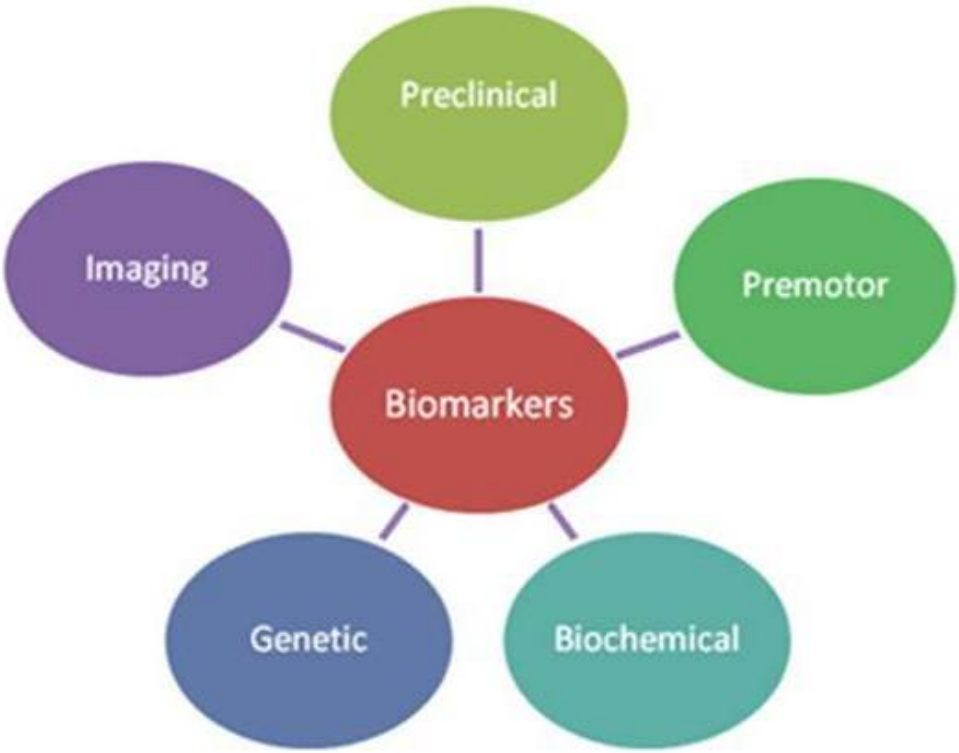

Figure 1: Biomarkers in PD. Image: Grace Crotty

Preclinical biomarkers

It is now well-recognised that people can have PD for years before they show any major symptoms. This is called the preclinical phase as they have not yet developed symptoms commonly associated with PD. Preclinical biomarkers look at risk factors that may increase a person's risk of later developing PD. Previous research has looked at patients with a positive family history for PD or abnormal brain imaging as risk factors for later development of PD.

Premotor biomarkers

These biomarkers look at symptoms other than the classical motor features that can be present pre-diagnosis with PD. Many potential biomarkers that have been identified including loss of smell, depression, restless legs and abnormal sleep activity. Unfortunately, a lot of these non-motor symptoms are quite common and can coexist in the elderly or with other diseases and, as such, are not specific to PD.

Biochemical biomarkers

Examination of various bodily fluids and tissues samples has been carried out to investigate differences between people with PD and those without. In these samples you can analyse and measure genes, proteins, fats and other small molecules. Alterations in the levels of alpha-synuclein, anti-oxidative stress markers, urate and a protein called DJ-1 have been considered as potential biomarkers.

Genetic biomarkers

Approximately 10 percent of cases of PD are genetic. Using gene sequencing technology multiple new gene mutations have been identified. They include mutations in LRRK2, SNCA and parkin which are genes that are all felt to play roles in PD. Ongoing research has also investigated alterations in the genes responsible for the protein alpha-synuclein which is found in the PD brain on post-mortem biopsy.

Imaging biomarkers

Multiple imaging techniques have been looked at in order to identify unique changes in PD. Ultrasound imaging using sound waves, along with SPECT and PET imaging which use radioactive substances to trace activity in the nerve cells that produce dopamine, have noted changes in the brain consistent with PD. Magnetic Resonance Imaging (MRI) has also demonstrated increased iron content in the brain of patients with PD.

Biomarkers in UCC

In the Department of Medicine, I am currently carrying out three different studies on biomarkers in PD. I am recruiting both people with PD and control subjects. I'm recruiting all ages because although PD more commonly affects the elderly, it can occur in people at any age. All of my studies are looking for differences between people with PD and people without it. By identifying these differences it may help me to understand more about the underlying disease mechanisms of PD and hopefully find potential biomarkers.

Non-motor symptoms

My first study is a questionnaire study which compares the presence of non-motor symptoms in people with PD with those of controls. The questionnaires include questions on gastrointestinal symptoms, sleep disturbances, pain and impulse control disorders. From

research, alterations in sleep and smell along with constipation occur frequently in people with PD.

Autonomic symptoms and pain

My second study is looking at autonomic symptoms and pain perception in people with PD compared to controls. Autonomic symptoms include problems with the way in which our nerves control our heart rate, breathing, temperature regulation and sweating. Participants fill out questionnaires on pain, autonomic symptoms and mood disturbance. They then undergo nerve conduction testing and thermal threshold measurements in order to assess the function of the nerves in their legs which are involved with movement, general sensation and temperature sensation. From research, it has been shown that the protein alpha-synuclein can also be found in the nerves of people with PD and may consequently affect nerve function.

Cerebrospinal fluid biomarkers

In my final study I'm measuring the levels of particular proteins in both the blood and spinal fluid in people with PD and controls. By doing this study I may detect a difference in the level of proteins between the two groups which can help with the earlier diagnosis of PD. In order to attain samples all participants undergo a blood test along with a spinal tap. A spinal tap is similar to an epidural that women would sometimes receive when giving birth. Both procedures are well-tolerated with minimal complications. It takes about thirty minutes in total to carry out these procedures on a general hospital ward. Following these tests, all participants will remain in hospital for a few hours with discharge home later that day.

Conclusion

It is an exciting time to be involved with research in Neuroscience, in particular Parkinson's disease. Investigative studies are being carried out throughout the world including in Cork, Ireland. PD is an age-related neurodegenerative disease and the number of people affected with PD will continue to increase as people live to older ages. Due to the ageing phenomenon, it is predicted that the proportion of the Irish population over 65 years of age will increase from 11.2% in 2002 to 27.6% in 2050. It is therefore crucially important that we identify biomarkers and neuroprotective strategies to help prevent, cure or slow down the disease process in PD. In the Department of Medicine in UCC, I hope to identify differences between people with PD and those without. By doing so, we will learn more

about the underlying disease mechanisms in PD and contribute towards the development of biomarkers in PD.

Thanks to my supervisors Dr. Sean O'Sullivan, Dr. Ger O'Keeffe and Dr. Aideen Sullivan without whom none of this work would be possible. I would also like to thank the Department of Medicine for the funding provided through the Professor Denis O'Sullivan fellowship grant. Last but not least I would like to thank the patients and their families without their generous participation in our research, none of this work would be possible. Figures were composed by the author who has permission for all images used.

Who is the cool kid? Biomarkers to help treat newborn brain injury

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> "To think is to practise brain chemistry" (Deepack Chopra)

The fight for oxygen

Imagine the birth of a child and you might picture a scene from a movie. A frantic sequence of events culminating in that last big push when the camera focuses on the faces of overjoyed, yet overwhelmed parents. Within seconds it is all over, calmness descends as the newborn child is safely placed in the arms of its loving family. Unfortunately child birth is not always like the movies. In fact, 20 in every 1000 infants can have complications during delivery and need resuscitation after birth. Instead of the typical 'movie scene' birth scenario, the experience can be terrifying and distressing for parents. Delivering the baby is now an emergency and a main concern for the doctor is that the baby might be deprived of oxygen. A world of uncertainty has suddenly been opened.

Oxygen deprivation is serious because it can interrupt the blood supply to the baby's brain causing it to swell. If this is prolonged, brain cells may die and the infant faces the threat of brain damage. In medical terms this brain injury is called hypoxic ischeamic encephalopathy or HIE. In Ireland and the United Kingdom, HIE is the third most common cause of newborn death, while globally it is thought to cause over one million deaths each year. Tragically, even survivors of the injury cause grave concern because they are at risk of debilitating lifelong neurological impairments like cerebral palsy, seizures, developmental delay or learning and behavioural problems. All of these are a major burden for the child, parents and siblings and will severely impact on their quality of life.

Thankfully, over the past decade international clinical trials have uncovered an innovative treatment which reduces the severity of brain injury sustained, and importantly improves the chances of a normal neurological outcome for the infant. This treatment is called therapeutic hypothermia or 'cooling'.

> 'Hypothermia Cure: Cooling infants to battle brain damage' The Wall Street Journal

The newborn suffering with HIE is wrapped in a cooling blanket for a number of days, as shown in figure 1, lowering the baby's core body temperature to 33-34°C from the typical norm of 37°C. Cooling has the unique ability to slow down bodily functions. In

HIE it works by slowing down the death of brain cells that can occur for days after the initial injury. Minimizing cell death is critical for improving the prospect of a life free from neurological disability.

Figure 1: Two infants with HIE wrapped in cooling blankets to undergo the therapeutic hypothermia treatment. Pictures sourced from The UK TOBY Cooling Register () and The Children's Hospital Central California (https://www.childrenscentralcal.org/PressRoom/HospitalNews/Pages/CoolingBlanket.aspx). Reprinted with permission.

To cool or not to cool?

Cooling has gained increasing popularity and is now the first line of care for newborns at risk of brain injury, but it is not the perfect solution. Researchers have found that most of the permanent cell death and damage to the brain occurs approximately 6-48 hours after birth. This means it is critical to start cooling within the first 6 hours of birth before the brain damage is irreversible. Cooling is essential for these newborns, but hypothermia itself comes with its own health risks. The most common side effects of cooling are low heart rate and an increased use of sedatives to control the infants shivering. Therefore, international consensus agrees that it is only suitable to cool infants at risk of a considerable (moderate to severe) brain injury.

These two factors are greatly hindering our ability to effectively cool infants who need it most. Even in today's sophisticated intensive care units it remains very difficult to assess the extent of a brain injury soon after birth. In fact, it can take up to 24 hours to really determine the severity of the injury sustained, meaning that the critical 6 hour window to treat by cooling can be missed. This pushes the need for early and accurate prediction of brain injuries to the forefront of neonatal science. What use is this innovative and effective treatment, if we don't know who would benefit from it? We are in a race. Each second

Figure 2: The BIHIVE study logo sourced from www.medscinet.net/BIHIVE/ and metabolomic experiments in action. Image: Niamh Denihan.

wasted is an open invitation for tragedy to strike. My PhD will tackle this problem head on.

The BIHIVE Study

What if HIE instantly alters the biochemical makeup of the baby's blood? Could these biochemicals act as markers left behind by the injury? Could these markers tell us how severe the damage is? My PhD is based on the premise that these assumptions are true. My aim is to find biochemical markers in infants' blood after they have been deprived of oxygen during birth, which will quickly and accurately identify babies at risk of brain injury. I am a vital cog of a unique research team working on The BIHIVE Study (The Biomarkers in Hypoxic Ischaemic Encephalopathy Study), see logo in figure 2. Our ultimate goal is to create a simple blood test for doctors to use within minutes of birth, which will inform them if a baby is at risk of significant HIE and needs cooling.

I am part of a 24/7 on call team on the front line at Cork University Maternity Hospital (CUMH) that collects blood samples from the umbilical cords of all babies who've had complications during delivery. These samples are carefully stored in dedicated freezers within 3 hours of birth, so that they remain perfectly intact until the time comes to analyse them. The infant's brain activity is monitored closely over the first few days of life using electroencephalography (EEG) which detects abnormal activity or seizures and brain imaging (MRI) to look for structural damage to the brain. The EEG and MRI provide us with a wealth of information, particularly on the severity of brain injury. I will use this information in combination with a state of the art chemistry technique called metabolomics, which allows me to analyse the biochemicals in each infant blood sample.

Metabolomics: a promising technology

Metabolomics is fast becoming a popular experimental technique used in science and medicine to study living organisms. It is an experimental technique which allows me to measure the levels of a large number of small chemicals (called metabolites) that are present in blood, like natural sugars and fats, see figure 2. Through these measurements I can create a unique pattern or fingerprint based on that blood sample. This fingerprint of metabolites should give us more information about the 'health' of an organism and in HIE we hope it will quickly diagnose the infants at risk of severe brain injury.

Already the BIHIVE study has published the first ever papers which look at the metabolite fingerprint of infants who were deprived of oxygen during birth and those who developed HIE. Our results demonstrated a difference in the metabolite pattern of infants with HIE compared to healthy infants who had normal births. But more importantly this metabolite pattern could predict the severity of HIE and performed better than the inadequate blood tests that doctors currently use. Our results are not yet 100% perfect and more work is needed to repeat and validate our finding, before this metabolite pattern can transition from the laboratory bench into a cot-side diagnostic test.

From the lab-bench to the bedside

Human blood potentially contains thousands of metabolites, but our experiments to date have only focused on a few hundred. In the next stage of my research I will use a chemistry tool called mass spectroscopy to conduct a broad measurement of all metabolites in the infant blood samples. This powerful tool will provide me with a clearer picture of the biochemical makeup of the blood which may improve the effectiveness of our metabolite pattern to diagnose HIE. A large amount of data will be generated by this experiment so I will work closely with statistical and computer experts to analyse it.

The main concerns with this work are that alternate factors may be influencing the metabolomic pattern or that we are finding a pattern purely by chance. Labour is an extremely complex biological process and many factors involved in labour could influence metabolites. For example, the mother's health, how long labour lasted and the type of delivery, could be influencing the patterns that we see. To eliminate this concern I will examine the mother and infant medical notes using statistical tests, to ensure the patterns that we are finding are unrelated to factors in labour. To minimise the risk that we are finding metabolite patterns by chance, I will repeat our previous experiments with samples from a new and separate group of infants. These infants are being enrolled into phase two of the BIHIVE study over the next two years with recruitment currently taking place in CUMH and Karolinska Maternity Hospital, Sweden. We expect the same metabolite pattern to be altered in these infants with HIE, this will confirm our findings are 'real'. To further

cement our results the last step will be to repeat the experiments in an animal model of HIE. I will collaborate with a research group in Australia who collect and store blood samples from piglets with HIE. As mentioned, HIE is very unpredictable and difficult to detect as the injury occurs sometime around birth, but exactly when is impossible to estimate. Animal models will allow us to control the timing of the injury and to detect exactly when the metabolomic pattern is altered.

Today's modern neonatal intensive care units have made huge progress in keeping newborns who suffered from HIE alive. But the rate of brain injury and long term damage has remained unchanged for the past 20 years. The ultimate goal of this work is to create a useful bedside test with significant and real health benefits for children, families and society as a whole. Identifying infants at risk quickly after birth is essential in getting the maximum benefit from cooling and reducing the neurological injury a child sustains. Even a slight reduction to the effects of HIE can benefit their long term health and quality of life immeasurably. The metabolomic pattern altered in these infants at birth is potentially the key to unlocking the secrets behind this tragic injury and the ability to measure these effects with a simple blood test is tremendously exciting.

I would like to thank my supervisors Dr Deirdre Murray, Prof Geraldine Boylan and The BIHIVE Study team, as well as; the infants, parents and clinical staff who participate in The BIHIVE Study. Many thanks to Molecular Medicine Ireland who fund my PhD project as part of the Clinical & Translational Research Scholars Programme.

Recycling heat energy — Prolonging the lifetime of industry's most invaluable resource

Philip Donnellan

Process and Chemical Engineering, UCC

> Intellectuals solve problems; geniuses prevent them (Albert Einstein)

Drive home from work. . . lights on. . . dinner in oven. . . kettle boiling. . . TV on. . . . Without energy as we know it, January might just become a little bit harder.

What is energy?

Energy is everywhere and in everything. It has become a hot topic of conversation, a buzzword which is used in every political campaign and every report on the decaying state of our environment. Statements such as "Energy is running out", have become so common that they are more likely to make you change the channel than pay attention. Nobody wants to hear it, but the unfortunate thing is that we do actually have an energy problem.

Before discussing it, it is very important to examine the word energy more closely. Energy is not running out. That is not a dramatic statement, but simply an example of how buzzwords and the use of generic terms in media reports can give a false meaning to perfectly simple statements. Energy is all around us. The desk I am writing on contains energy, the motion of my fingers over the keyboard is a type of energy conversion as is every breath I take. With no energy, it is theorized that all matter as we know it could simply disintegrate into a collection of subatomic particles. No, energy is not running out at any point in the near future. What people really mean when they talk about energy is useful, high value energy such as electricity. These sources are primarily derived from naturally occurring products such as coal, oil or gas, substances which are created extremely slowly over very long periods of time. But why use these energy sources? We have just said that energy is contained everywhere, and by everything, so why limit ourselves to using non-renewable substances like oil to provide our electricity? To understand this, we need to look at how energy moves and how we use it.

How do we use energy?

If we look at the amount of energy contained in a substance, we can refer to its energy density as being the amount of energy a very small piece of it contains (for any engineers or scientists, the type of energy I am referring to here is specific entropy), i.e.: something with a high energy density contains a large amount of useful energy (for example a can of petrol). An easy way of understanding how energy moves is to picture water flowing freely down a hill. The water will flow down but not up the hill, and similarly when it comes to energy, energy can be made "flow" from a high energy density to a low energy density (this is a slight oversimplification but it makes my point). Temperature is the most common representation of energy, something with a high temperature generally contains a large amount of energy. Thus a simple example of how energy flows is the use of a radiator. If you want to heat yourself up, a radiator is only useful if it is hot. If it is hot, then by putting your hand up against it you will feel a warm sensation. This is simply energy flowing from the high temperature of the radiator to the low temperature of your hand. If the radiator is cold, you might feel the cooling sensation of energy flowing from your hand to the radiator, as this is now at a lower temperature than your body.

In everyday life, we rely on energy conversions and transfers to make things happen for us. The lightbulb works by converting electrical energy (high energy density) into light energy (low energy density), a car works by converting the energy contained in petrol (high energy density) into movement of the car (low energy density). This is why we cannot use most of the energy freely available in the world around us to run our television sets or heat up our dinners. We need something with a very high energy density, such as electricity or very hot substances, to do these things for us. We refer to these high energy density substances as high value energy sources. Electricity and hot substances are not (generally) freely available in the world. That is why coal, oil and gas (these have exceptionally high energy densities) are used to create them. As we currently rely heavily upon these non-renewable substances as our primary energy sources, we must monitor our energy consumption and limit our usage to prevent future shortages.

We are using more high value energy than we can afford!

In industry, vast quantities of high value energy are being used every day. The two main types of high value energies needed are electricity (for running equipment etc.) and high temperature heat energy (for heating up tanks etc.). Due to its size, this sector represents a very large fraction of the total energy consumed throughout the world. Unfortunately, it also represents a large source of energy wastage. It has been reported that about half of the high value energy entering into the American Manufacturing industry is eventually being dumped into the atmosphere as waste heat. In order to put this number in perspective,

this wasted energy represents over 1000 times the total electricity usage in Ireland (and this is just one country's industrial energy waste). Clearly, we cannot continue to waste so much of this valuable resource.

Reduce, Reuse, Recycle

The heat energy wasted by this industrial sector generally has a temperature of about 100˚C. This may seem relatively high in an everyday scenario, however in industry it is considered a low energy density resource. This is due to the fact that often in chemical reactions and other processes, reacting chemicals and their tanks must be heated to temperatures anywhere up to 400˚C or even higher. As explained earlier, if we take the temperature of a substance as being representative of its energy density, we can see that the heat energy at 100˚C can only be used to heat up chemicals and tanks which have temperatures below 100˚C (picture the radiator example used earlier). Therefore in industry the heat at 100˚C is simply dumped because no further use can be found for it. Without realising it, you see this happening every time you drive past a factory or plant which has steam billowing from its chimney stacks. This steam represents a large amount of energy, and a lot of coal, oil or gas was probably burnt to originally produce it. The question is how to extract this energy? We have already shown that we cannot use it in its current state, therefore we must alter it in some way.

At this point it may seem logical when we say that what we must do is to increase the temperature of the steam. If its temperature is increased to 200˚C (or higher) once more, then there is a good chance that the plant will have some reaction or process at about 150˚C which needs heating. In this way we can then recycle the energy instead of simply discarding it into the atmosphere.

Heat energy recycling methods

This is the point where my research comes in. We are developing a system which can take in the waste heat energy at 100˚C and increase its temperature to over 240˚C once more in order to allow companies to reduce some of their energy losses. Many systems currently exist which can achieve this, the simplest of all being a simple domestic fridge. The problem with using simple systems such as a fridge is that they require a large amount of energy to operate (electricity), and thus this would not make a lot of sense as the sole purpose is to reduce energy consumption. Therefore we are using a technology called "Heat Transformers", which are able to achieve this temperature increase with almost no electrical consumption. This technology has been researched for some time, and positive results have been reported, yet all of these focus on increasing the temperature of the waste heat

energy by only 20˚C-80˚C. These systems work very well for specific applications which only require the temperature of waste heat to be increased slightly, however often much greater increases are needed and therefore this technology cannot be used. This research is attempting to further existing technology so that it is capable of increasing the temperature of waste heat by as much as 120˚C-150˚C. This would allow for a much more general applicability of such systems to industry, especially in energy intensive sectors.

Research

Due to the fact that the system does not require much electrical input, its physical design becomes much more complicated. Thus the starting point for developing a system such as this is the creation of a mathematical model with which its operation may be tested and observed. Once a fully functional model was created, initial parts of my research involved finding the optimum operating conditions for the system, determining how its performance varied when changes are made and how to configure the internal design to allow for a maximum recycling of the waste energy. Different statistical methods are used in order to determine these points of optima so that they may be one-size-fits-all solutions which can be applied to any such system (a generic example is shown in Figure 1).

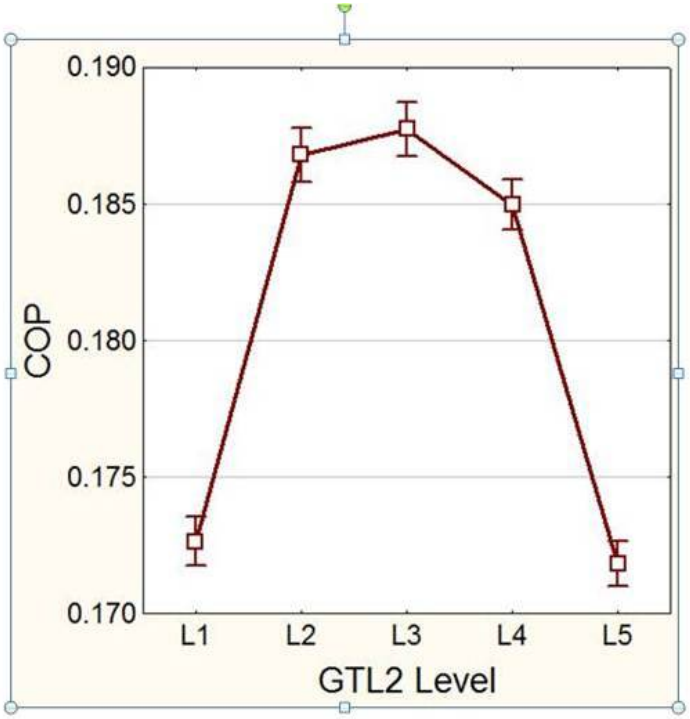

Figure 1: An example of optimisation studies being conducted trying to maximise the fraction of waste heat energy being recycled (COP), while other settings are being varied (such as GTL2 in this example). Image: Philip Donnellan.

Once these initial criteria were developed, the next step was to determine whether any

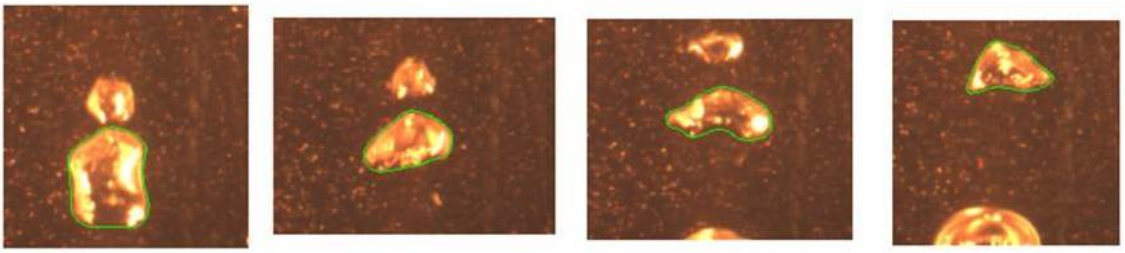

Figure 2: Dissolving Steam bubble being tracked by a high speed camera as part of a series of physical experiments to improve the efficiency of one of the pieces of equipment within the system. Image: Philip Donnellan.

industrial application (i.e.: a factory) would actually benefit from building and installing this system. While increased sustainability may be an attractive proposition for companies, determining whether something is of benefit to a company actually implies estimating the economic benefits and rates of return achievable from such a system. Over the course of this research, we talked to an Irish oil refinery and began to examine their main sources of waste heat energy. The developed system performed very well in the context of simply recycling the energy, as it was capable of increasing the temperature of their waste heat energy from approximately 100˚C to 230˚C. Therefore from an engineering perspective, the system appears to be highly suitable for application here. The problem which was discovered was that the capital cost of the unit is quite high. This discovery revealed that further work is required in order to address this problem and to reduce the total investment cost of the system. Two possible solutions were identified. The first of these is that the system should simply be used in much bigger factories. Some of the results showed that the more waste heat energy which you have to recycle; the easier it is for the company to make a profit from it. The second solution is that the design of the physical components of the system should be re-examined once more. As part of the system's design, we utilised the most common and well understood pieces of equipment within the system, as companies are generally quite reluctant to accept new or less tested methods. It has now become obvious that for this technology to work, it is vital that such cautions must be abandoned and less conventional designs developed. For this reason we picked a very important piece of equipment within the system and began to run physical experiments with the view to achieving a much more efficient operation.

These experiments examined dissolving a (relatively) cold bubble of steam into a hot very concentrated salt solution. High speed cameras were used to observe many such bubbles and to track their exact shape and size as they dissolved (some images of this have been included in Figure 2 as an example). This information allowed us to model the phenomenon. Results were quite positive with significant potential improvements observed compared to the conventional method used previously.

What's next?

All of the work completed so far as part of this research has been an attempt to develop a system which is capable of increasing the temperature of waste heat energy so that it may be reused and recycled within a factory. It is envisioned that this in turn leads to potential reductions in fuel consumption. While this design has been a success from an engineering perspective, for this type of a system to become an attractive industrial option, it needs to be capable of generating acceptable rates of return for the company. This appears to be area which should be of primary focus in future studies. We have shown that to achieve this, the selection and physical design of equipment within the system need to be closely examined to make it more efficient and cost effective. We have started to engage in this process by examining in detail the operation of (what we deemed to be) one of the most important building blocks of the system. This work needs to be conducted for all of the system's pieces of equipment however in order to ensure that this system is capable of achieving industrial acceptance. If positive improvements were to be obtained from such work, then the heat transformer may one day become one of the many tools required to combat future fuel shortages.

Philip Donnellan is a PhD student in the Department of Process and Chemical Engineering, working under the joint supervision of Dr Edmond Byrne and Dr Kevin Cronin. This research has been funded by the Irish Research Council.

Exploring the eclectic world of Richard White (1800-1868), 2nd Earl of Bantry, Lord Berehaven: collector ¦ grand tourist ¦ nobleman

Seana Vida Farrington

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The noblest motive is the public good (motto of the Earls of Bantry)

'A Great Palace of Art on Bantry Bay'

This is how Nigel Everett describes Bantry House in his *Irish Arts Review* article of 2010. Overlooking Bantry Bay in West Cork the house enjoys one of the most favourable aspects of any of Ireland's Big Houses (Figure 1). Everett's words are a most apt description for the project of ennoblement envisioned by Richard White (1800-1868), 2nd Earl of Bantry, Lord Berehaven, and for the collection of art he amassed.

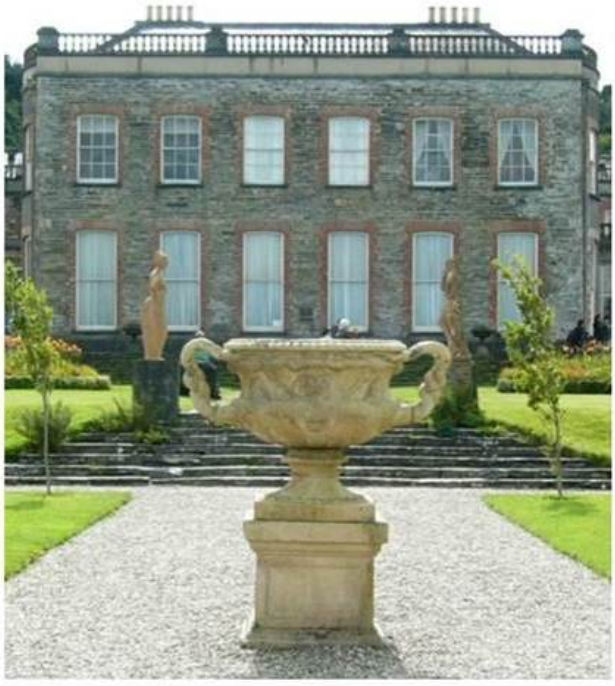

Figure 1: Bantry House, Bantry Bay, Cork. The central block is the oldest part of the house, to which the 1st and 2nd Earls added. Image: Seana Vida Farrington

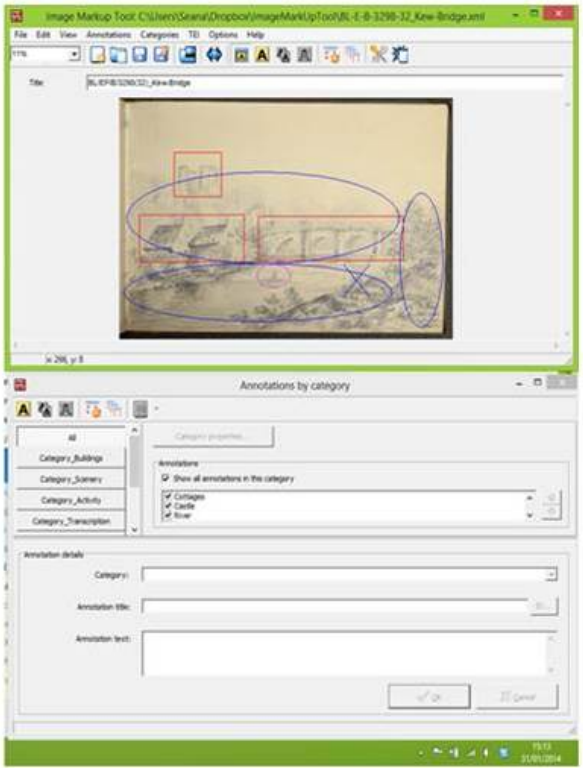

Figure 2: Screenshot showing the Image Markup Tool, used with permission from University of Victoria. UCC: BL/EP/B/3298: Kew Bridge, England.

As Berehaven travelled extensively he was often absent from Bantry. He visited the usual sites of the nineteenth century Grand Tour, also visiting Spain, Russia, the Baltics and Scandinavia. There were two activities he invariably participated in while travelling: sketching and collecting. The latter activity led to the creation of one of the most eclectic collections of art to grace an Irish home. Berehaven and his vision for Bantry House have not received sustained enquiry, which is a gap in knowledge I seek to address.

As is common in these types of houses much has been lost as subsequent generations dispersed both land and artefacts to meet their current financial needs. Added to those losses is the destruction of Berehaven's journals in a fire in the Estate Offices. Bantry and Berehaven are briefly mentioned by the novelist, poet and travel writer Lady Georgiana Chatterton (1806-1876) in *Rambles in the South of Ireland during the year1838 by Lady Chatterton* published in 1839, but otherwise there is a dearth of contemporary accounts regarding the Earl and his house.

With the loss of his journals, Berehaven's sketchbooks are the most important resource in reconstructing his journeys and in assessing how his experiences impacted on Bantry House. This research is being greatly aided by the use of digital tools and methodologies. Some are as basic as Google searches, or the creation of digital images of the sketchbooks. Other tools are more complex: for example, University of Victoria's Image Markup Tool that will be used to render those digital images searchable (Figure 2).

Fortune and Land

The White family came from English merchant stock, with the Irish branch commencing in Limerick shortly after the Williamite wars (1689-1691). The first White recorded in Bantry is Captain Richard White who settled on Whiddy Island. In 1701, he had a son, also named Richard, later known as Counsellor White; it appears to be he who began to amass both fortune and land. It is easy to imagine this upwardly mobile family deciding upon a move to the Queen Anne style house across the bay, then called Blackrock. However, they remained on Whiddy until 1765 when Blackrock was vacated by its tenants, finally allowing the Whites to take possession of the property they had purchased fifteen years earlier.

Berehaven's father (another Richard White 1767-1851) began the family's elevation in 1797, with the creation of Baron. In 1796 he had had the opportunity to serve the Crown by raising the alarm when an armada of French ships appeared in Bantry Bay. He had also housed and provisioned the Crown's officers. His elevation continued, with the titles of Viscount in 1801 and Earl in 1816. By the time Berehaven was born in 1800 the Whites were the major landowners in the Bantry Bay and Beara peninsula areas of County Cork and reasonably well-established; but their elevation was new. Arguably, this is from where Berehaven's desire to assert the family dignity and ennoble Bantry House grew.

Country Pursuits or Art

That the 1st Earl's reward may not have been much to his taste has been speculated upon elsewhere. However, he was obliged to live-up to his new position. That some enlargement of the property was planned is evident in an inscription 'Coade Stone London 1796'. Those plans may have been further expanded upon due to the recent demands upon the Earl's hospitality; John Cornforth has argued that the 1st Earl's contribution to Bantry House does not receive adequate recognition. With little taste for ostentatious display the 1st Earl's interests and tastes in life were certainly different from those of his son. He was known for enjoying country pursuits, dwelling happily among his tenants and speaking Irish; whereas Berehaven had no taste for the saddle, preferring art.

It is thought that Berehaven kept away from home due to these differences, which seems to be supported by the earliest of his sketchbooks. Dating from 1813 and 1817, they create a picture of a youth who loved to roam. They might also prove of interest to antiquaries as they contain pictures of ruins and castles no longer extant. Like many young men and women of his day he took drawing lessons under a master and in a practice that was life-long an improvement in his efforts may be noted. A sketchbook in the UCC archive (BL/E/B/3298) places him at Kew, on the Cornish coast and in Glanmire at the tender age of thirteen. So, it appears his wanderlust began early.

Figure 3: Richard White, 2nd Earl of Bantry, Lord Berehaven. Image: Seana Vida Farrington.

Lord Berehaven and the Grand Tour

> How delightful it would be for Ireland if many more of its young Peers followed Lord Berehaven's example... (Lady Chatterton, 1839)

The 1st Earl was not only a nobleman he was also very wealthy, enjoying an income of £9,000 per annum. He also married well; his wife's dowry was £30,000. In keeping with his father's position Berehaven was sent away to be educated, and while it seems Berehaven was not a favourite, presumably his first tour of Europe would have been funded by his father.

This period of travel, known as The Grand Tour, was considered to be an essential part of a nobleman's education and a rite of passage. It was an opportunity for young nobles to experience, at first hand, the art and culture of Europe and to develop the manners and contacts that would be important to them in their role as leaders in politics, diplomacy and society.

Berehaven's passports record his journeys from 1826, which agrees with sketchbooks in the Bantry Papers archive. What Berehaven was doing and where he was prior to this has yet to come to light. His early sketches suggest he spent his time between his home and various places in England. If his relationship with his father was strained, increasing tension might have prompted the young lord to begin his travels.

Treasures from near and afar

> The walls, staircase and bedrooms are all covered in tapestry — even ceilings of the staircases and passages. . . some of it very good, especially that in the drawing room, which once adorned the palace of the Tuileries (Lady Chatterton, 1839)

For over 35 years Berehaven travelled (Figure 3). He visited Europe, Euro-Asia and the Baltics. He bought art, plants and decorative items that were shipped home to be opened immediately, or upon his return. Items remaining in Bantry House include a set of Aubusson Royale tapestries made for Marie Antoinette, 18th century Savonnerie carpets, a 19th century Dutch chandelier decorated with Meissen porcelain flowers, a shrine of icons from Russia and fragments of the gilt tooled Spanish leather that adorned not only the fine doors, but every crack and crevice he could think of.

Berehaven also supported Irish craftsmen. Among the mystery items of the house are some important fireplaces. Two are of Irish manufacture and two of Italian, but with scant documentary evidence it is not possible to state with certainty which fireplaces were produced locally and which were sent from Italy. A fifth fireplace designed by Angelica Kauffman (1741-1807) is as likely to date from the 1st Earl's interventions, as from Berehaven's. There are other Irish items that due to their dates of manufacture could have been purchased by either father or son, as it is clear that Berehaven's taste was not limited to the contemporary.

In 1836 Berehaven married Lady Mary O'Brien, a daughter of the Marquis of Thomond. An established traveller by this time, Berehaven continued his nomadic lifestyle accompanied by Mary. 1843 found the couple in Rome where they sat to John Hogan, an Irish sculptor. Two fine marble busts were the result, which still grace Bantry House. With them in the entrance hall are beautiful painted tiles from Giustiniani of Naples (Figure 4), along with a number of pieces in their style; one elegant Egyptian head bears their mark (Figure 5).

This is just a fraction of what remains in Bantry House, and that is perhaps only 20% of what the 2nd Earl collected. Brigitte Shelswell- White, the estate's current owner and custodian, suggests 20% is a generous estimate. Among the most famous of the losses is a series of paintings by Francesco Guardi (1712-1793) that Berehaven purchased in Italy when only 20 years of age. This purchase places Berehaven on the Continent at least six years before the date suggested by his passports.

Information about Berehaven remains elusive. Piecing together his whereabouts through the use of his sketchbooks and purchases can be greatly aided by the use of digital tools. Digital maps and timelines, unlike their print counterparts, allow new information to be updated as it becomes available and are especially useful if hosted online in collaborative spaces.

Figure 4: UCC: BL/EP/B/3557 Bantry House entrance hall as it appeared in the late 19th century. Note the painted floor tiles from Giustiniani, Naples. ©UCC Library, University College Cork

Figure 5: Giustiniani: Elegant Egyptian head Cork: Bantry House. Image: Seana Vida Farrington.

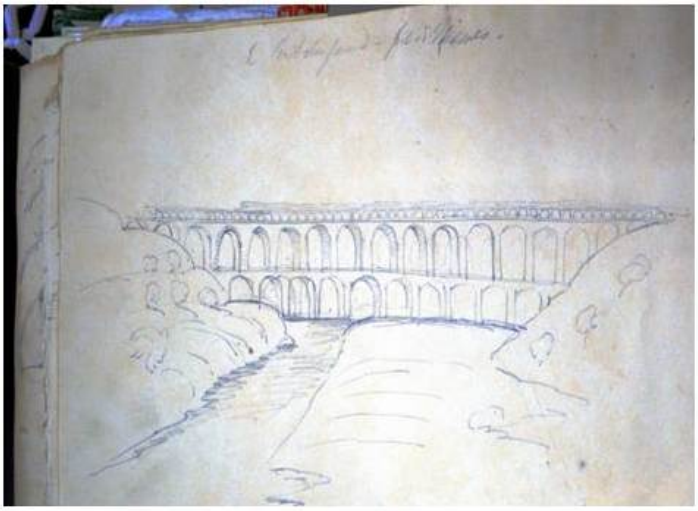

Figure 6: UCC: BL/EP/B/3306: Le Pont du Gard, pres Nismes ©UCC Library, University College Cork. Image: Seana Vida Farrington

Digital Humanities

The keeping of diaries enjoys a long tradition and we are indebted to those men and women who chose to write about their daily lives, but there are particular frustrations when working with personal memoranda. For example, diaries often contain nicknames and abbreviations that the diarist had no need to 'spell out' because he or she knew exactly to whom, or what, they referred.

Likewise, Berehaven was not concerned with posterity. Many of his sketches show unidentified places, people and objects. Even when inscribed, his annotations can be confusing. For example, his unfinished drawing '*Le Pont du Gard, pres Nismes*' references an ancient place name (Figure 6). We do not know why he left his sketch unfinished, or why he chose to use an appellation that would lead the detecting historian to Nismes in Belgium, rather than Nîmes in France. Online tools are useful with the latter problem. Typing confusing inscriptions into Google is often fruitful; even when photographic results are not an exact match, they can help to confirm a place name (Figure7).

One thing 'the digital' allows is immediacy of communication, but more importantly it has increased the options of how we can visualise and present the results of our research; the most liberating aspect of this is that our projects can remain open. Discussion can be invited, and help sought, through online fora. The 'digital turn' echoes Berehaven's own mix-and-match approach to furnishing and decorating his home. By employing technologies and methods both old and new to draw out the stories hidden within Berehaven's sketchbooks we come to more fully appreciate his buying and collecting strategies.

We will never know Bantry House in all its glory, under the spell of West Cork light coming in off the Bay, or the flickering candlelight of his beautiful Baltic chandeliers and sconces.

Figure 7: Emanuele: Pont du Gard, Roman Empire. Digital photograph. October 2007 Wikipedia.org: Licensed under the Creative Commons Attribution-Share-Alike 2.0 Generic Licence

But, it might be possible to gather enough information to virtually interpret his vision, so that we too may experience something of Lady Chatterton's wonderment.

With thanks to my supervisors, Dr Flavio Boggi (Art History) and Dr Orla Murphy (Digital Arts and Humanities) and to my colleagues in the Digital Arts and Humanities programme. I also wish to gratefully acknowledge the Digital Arts and Humanities Board, UCC; the College of Arts Celtic Studies and Social Sciences; and the Boole Library through whom this research is funded.

Ireland's unequal health care system: How did we let this happen?

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> "The destruction of the past, or rather of the social mechanisms that link one's contemporary experience to that of earlier generations, is one of the most characteristic and eerie phenomena of the late twentieth century."
>
> (Eric Hobsbawm, 1994)

Introduction

Distinct and measurable health inequalities have been shown to persist in Ireland and these relate closely to the health system. The purpose of this research is to examine the previously taken for granted assumptions that exist in relation to Ireland's health and welfare system so as to attempt to understand why it is that a deeply unequal health care system is tolerated. Specifically, this research considers the place of the social contract within the contemporary neoliberal order where it arguably has been replaced by a market contract. Furthermore, this study looks at the concept of solidarity in Ireland's health and welfare systems. In order to do this it is necessary to adopt a historical perspective and to examine the context in which an unequal system of health care has emerged and has become established and normalised in Ireland. The intention is to interrogate evidence within Ireland's health and welfare history so as to indicate the traces or early shoots of our present situation. An important intention of this research is to utilise a historical approach, informed by the work of Michel Foucault (Philosopher), that actively interrogates current circumstances through an examination of the past. There is a danger that a contemporary obsession with the progress of modernity could result in an inability to look in any other direction other than to the future. A full and critical perspective on the past is vital if we are to fully understand our current conditions. The context of Ireland's health care system is illustrated through the use of four case studies that were pivotal within the recent history of Ireland's health care system and, specifically, the discourse associated with these cases. The discourses surrounding health care, for the purpose of this research, provide a range of spaces that have enabled a particular understanding of the core concepts of the social contract and solidarity.

The Case Studies

It has been possible to identify key events in Irish health care, which have altered interpretations and knowledge within both the formal and the informal domains of concept formation. These events, which have been instrumental in the transformation of the subject of Irish health care into its currently individualised form, are considered systematically so as to illuminate the research questions posed. Some of these events have become almost metaphorical instruments in illustrating the failures of Ireland's health care and, more specifically, the manner in which the discourse has validated certain conceptions of justice and fairness within an Irish context, and of reciprocal social relationships, and of solidarity through a social contract.

The paradigmatic incidences examined are:

1. The attempted introduction of the 'Mother and Child Scheme' by Dr Noel Browne (1951).
2. The Hepatitis C contaminated Anti-D scandal and subsequent treatment of the infected women (1994-1997).
3. The expansion of the Irish private health care market beyond the statutory monopoly of the VHI with the Health Insurance Act (1994).
4. Susie Long who was a public patient who died of bowel cancer because her diagnosis was critically delayed (2005-2007).

A number of writers have sought to provide a narrative of Irish health care in an empirical sense, however, this research differs from these accounts in that it seeks to emphasise the way in which Irish health care has been influenced by the discourses surrounding it, and it illuminates the implications of its configuration in the context of a social contract and the gift relationship. Furthermore, this examination identifies the interrelationships between contesting discourses of policy, state, church, charities and people. Distinct hegemonic influences can be seen to have been influential in the creation of Ireland's health care system. The current construction of health care in Ireland is frequently described as being unique and thereby incomparable to neighbouring systems. However, it is the very establishment of this unique situation that warrants deep and systematic examination from a genealogical and Foucauldian perspective.

While Ireland's health arrangements are unique they are also exceptionally unsatisfactory, and yet they go unchallenged and largely accepted as normal despite gross inequities. It has been highlighted by other writers that a process of normalisation has taken place that has enabled neoliberalism to become regarded as common sense. Similarly, and in a closely related way, it could be argued that the ideology of individualisation and privatisation of health and social needs in Ireland has become dominant.

Findings

Examining Irish health care through seminal theories such as the social contract and core concepts like solidarity, results in an unveiling of the deep historical legacy that contributes to the system that is currently in place.

Analysis of the discourse surrounding the four case studies in this research reveals the dominance of a number of core themes. The themes that dominate these narratives surround issues such as the concept of individualism versus solidarity, the role of the welfare state under neoliberalism and how the social contract might be manifested in such a circumstance. The role of powerful actors and forces including professional powers, and particularly, but not exclusively, market forces is a further dominant theme throughout these case studies. Additionally, a distinct theme emerges surrounding the apparent acquiescence to, and acceptance or normalising of, inequitable conditions through the layering of discourses.

Neoliberalism, the welfare state and Ireland

Neoliberalism, which is shown in this research to be one of a number of significant forces in the formation of Ireland's health care system, prioritises the individual and emphasises the rational decision-making individual. The current advancing neoliberal ideology advocates the primacy of the market and accentuates individual responsibility. Such a move away from the notion of collective, societal responsibility devalues levels of altruism inherent in a universal welfare state and its policies. It has been argued by other writers that states are not mere spectators to welfare reform as a result of neoliberalism, but they shape local policies in response to wider international fiscal and political pressures. This positioning of policy makers as proactive in the face of neoliberalism counters the prevailing depiction of neoliberalism as an unstoppable force that policy makers can do little about.

Conclusion

Through these illustrative case studies we can see the social, economic, political and discursive conditions that have made Ireland's current health care system possible. The discourses surrounding these stories and the message they relay about solidarity and individualism, about the value of a welfare state and about the role of powerful groups, have in some early cases served to lay the foundations of neoliberalism's success in Ireland's health care system, while in other cases the discourses provided an accompanying normalising narrative.

This research has succeeded in identifying a number of key historical and residual factors that contribute to current conditions and has enabled identification of the precise modes

by which processes take place. This research, provides a unique understanding of the constellation of historical, political and economic factors that have framed the condition of Ireland's health system and welfare state, and contributes to a discussion on potential reformulations.

Many thanks to my superb supervisors Dr Kieran Keohane (Sociology) and Dr Cathal O'Connell (Applied Social Studies) for their excellent support and guidance.

How man fabricates nano-sized objects

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"There's Plenty of Room at the Bottom." (Richard Feynman)

Introduction to nanoworld

In this fast paced world we are constantly surrounded by novel and amusing technologies. The Apple Macbook is one of the modern devices that is used by many people. Not only has the technology in these kinds of laptops got more powerful but the devices have also got lighter than their predecessor. Today laptops can weigh as little as 1 kilo and yet are able to function hundreds of times more efficiently compared to the laptops that were introduced 10 years ago. It is well understood that technology improves with time, but what exactly is the technology involved? Just like our brain functions with the help of biological cells known as neurons, electronic devices function in the same way with help of transistors. The processing unit of any computer or laptop contains billions of transistors. For the Apple Macbook, weighing around 1 kilo, to comprise such a large number of transistors, each transistor must have dimensions of about 500 nm. How is it possible to create anything that is a hundred thousand times smaller than a strand of human hair? Nature produces biological elements from entities as tiny as a bacterium up to huge ones like elephants. But transistors are man-made and it is simply not possible to make nano-scaled objects with hammers or drills.

The term nano-fabrication comes into play. Creation of miniscule objects like nano circuits requires nano-fabrication processes for use in semiconductor device fabrication. Semiconducting materials are the foundation of modern electronics and the most widely used is silicon, as it is easy to work with (for both chemists and physicists) and is also abundantly available in nature, hence it is cheaper than other semiconductor materials. These processes rely on the following advanced integrated circuits fabrication methods: (a) selection of an appropriate base material (substrate); (b) patterning of the substrates by lithography and (c) modifying the electrical properties of the substrate. By the end of this process, devices can be ready for use in applications. In this article insights of a lithography technique used in nano-fabrication shall be touched upon.

Nanolithography

The term is derived from Greek words ‘nanos’ which means dwarf; ‘lithos’, meaning a stone or rock and ‘grapho’, which means to write. Various nanolithography tools are e-beam lithography, nano-imprint lithography (NIL), photolithography, X-ray lithography, ion-beam lithography, etc. As their names suggest they use different sources of energy for fashioning designs. Amongst these techniques, photolithography and e-beam lithography techniques are the most common and predominant techniques for nanopatterning in the semiconductor industry.

Nicéphore Niépce, the inventor of photography, first recognized the technique of lithography in 1882. He created patterns by using stones and asphalt in lavender oil on greased paper and left it under the sunlight for two to three hours. The areas that were shielded from the sun remained softer than the unshielded and were easily washed off with lavender oil, leaving behind a pattern formed by the shaded areas. Thus, the first ever photolithography process was carried out.

Modern photolithography is extensively used in industries and has a similar patterning procedure of creating the desired geometries by exposing thin light-sensitive films called ‘photoresist’ on the substrates and then selectively removing portions of the thin films in developer solvents. Resists are polymeric substances that are formulated to be sensitive to UV light; yes, even sun can do the trick! Stencils or photo-masks are made up of a flat glass area (un-shielding part) and a metal area (shielding counterpart). This mask is kept in direct contact or in close proximity with the substrate coated with photoresists and exposed to UV radiation of varying intensity and subsequently developed in appropriate solvents. A 1:1 image of the entire mask is obtained on the substrate in this manner. Dimensions as small as 70-100 nm can be effortlessly achieved by photolithography.

The consumer market, however, demands faster, more efficient and advanced MacBooks. One way to improve the efficiency is to increase the number of transistors by shrinking their size. Due to the 70-100 nm resolution limit of photolithography other techniques are being developed and electron beam lithography is one of them. Electron beam lithography (EBL) is one of the most favoured tools for patterning processes since structures as small as 7 nm have been demonstrated. Due to the ease of operation and readily attainable sub-50 nm features, this tool is extensively used in R&D centres. Moreover, since it is cheaper than setting up optical lithography with similar resolution, it is widely available in universities as well.

Electron Beam Lithography

As the name suggests, the EBL system uses a beam of electrons to penetrate through the atoms and molecules to create patterns on different materials. Just like a laser pointer, a highly focused beam of electrons that has a spot size of about 2 nm (normal laser pointer bears a spot size of 2-3 mm!) is projected on the resists creating the desired pattern. This is similar to drawing on a paper with a pen. EBL resists are a thin polymer layer deposited on the substrate prior to EBL. It is a sacrificial layer and acts as a stencil to craft the underneath substrate in further processes. EBL resists are especially formulated to respond to electrons. The electrons directly radiate a pattern on resists on a substrate making this techniques mask-less lithography. The electrons locally alternate the chemistry of the resists; either by forming bonds between the resist molecules (*negative resist*) or cleaving the bonds (*positive resists*) to make it insoluble (*negative resist*) or soluble (*positive resists*) in the appropriate developer. Polymethyl methacrylate, which is also used in constructing glass-substituted aquariums, is a well-established positive EBL resist. It is offered in a liquid state and is spun on the substrates to produce thin films ranging from nanometers to micrometers. Following the exposure to the electron beam, the resist is developed to create the stencil. The design on the resist is, thereafter, engraved through the stencil into the substrate by further processes such as wet chemical etching or dry etching involving gases such as chlorine gas. The process of the development of a negative and positive resist is illustrated in figure 1.

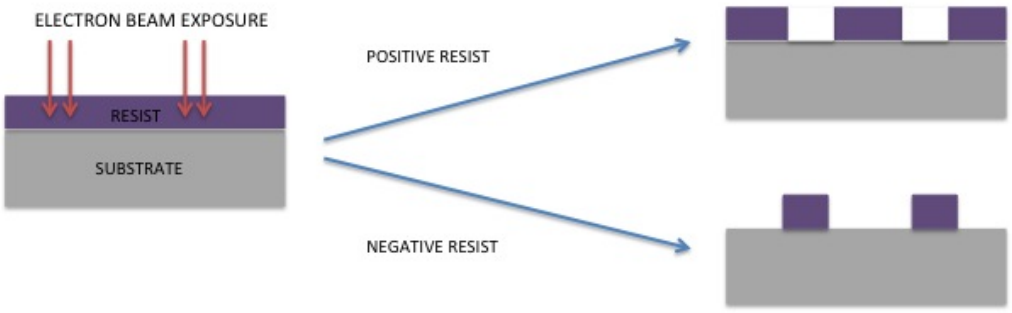

Figure 1: Schematic illustration of development of positive and negative resists after electron beam exposure. Image: Anushka Gangnaik

What is the study about?

Aim and study so far

The main motive of the study is utilising EBL to fabricate novel nano wire devices. As mentioned before, silicon remains the most common substrate to work with. As it is approaching its full potential, however, new materials are being considered as possible alternatives. Germanium has interested the semiconductor industry due to its superior capabilities for the last few years. For instance, germanium has electron mobility twice that of silicon, which simply means that a wire made of germanium will conduct current two times faster than a silicon wire. However with the good comes the bad, germanium is not easy to process due to its 'weird' surface chemistry and hence EBL patterning of such surfaces can be tricky. Germanium surface always needs to be chemically modified thus increasing the time and costs too. The potential of germanium remains unrealised to some extent due to its drawbacks and hence it is the substrate of choice for this study to explore.

Resistors and transistors are very similar in operations and they are ubiquitous components of all electronic circuits. They both regulate the flow of electric current. In the case of transistors, imagine a water pipe with a controlling tap. When the tap is closed we have no water flowing through it. However, the flow of water can be regulated by turning the tap to the required extent. An external force is required here to adjust the water flow. Thus, in transistors, a current (water) flows across the nanowires (pipe) and it is controlled by a gate (tap), which usually sits over the nanowires. On the other hand, resistors are gate-less transistors. The current flow in the resistors can be controlled by adding impurities to the nanowires. For example, another water pipe is stuffed with rocks at certain junctions of the pipe. When the water flows through this pipe, the rocks will hinder the flow of the water. Thus, impurities are introduced into the nanowires to regulate the current flow in a similar fashion. Some impurities in an electronic system are added to speed up current flow. Now, why do we need to regulate current? At home, we can plug a huge appliance like fridge into the same socket where we plug our mobiles. Both the devices, obviously, require different current inputs due to their size and function. Thus, in such a case, the transistors and resistors can help in controlling the flow of electricity through the devices.

This project involves fabricating resistors on a nanometre range on germanium substrates. The study includes measurement of resistance across nanowires of different widths. The size of the wire ranges from 1 μm down to 20 nm. There is a need to reduce the resistance and this is done by implanting the nanowires with impurities so that the maximum amount of electricity can pass through the wire and eventually through the whole circuit. This fabrication involves the use of negative resist known as hydrogen silsesquioxane to pattern germanium substrates.

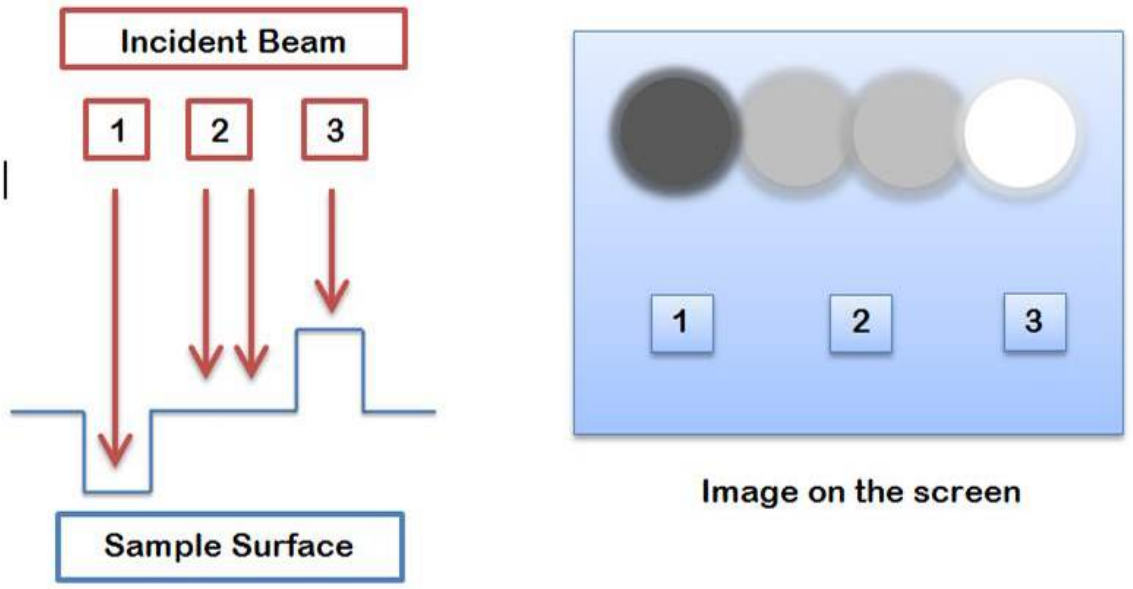

Figure 2: Illustration of image formation on EBL system. Image: Anushka Gangnaik

The current study also encompasses fabricating nanowires with positive resists known as SML and ZEP. ZEP is a well-established positive tone EBL resist that has demonstrated high-resolution lithography, i.e. capable of producing extremely fine structures. SML, on the other hand, is also a positive tone resist, which is new in the EBL industry and our studies demonstrate that this resist is suitable for EBL.

Nanowires are expected to have many applications in electronics. They are considered to be the main building blocks of the next generation transistors and reducing their dimensions has proved to improve transistor performance. Moreover, miniaturisation of the electronic components will also lead to lighter and smaller devices.

Imaging

Most EBL systems are not only used for patterning but also for imaging the tiny structures. When the same beam of electrons interacts with the substrate it kicks out some of the substrate-electrons. These electrons are called secondary electrons and are collected by a detector which generates highly magnified images of the nano-scale objects. The contrast in the image is a result of the depths on the surface and is illustrated in figure 2.

It can be seen in figure 2 that when the electron beam scans a surface, the trench will give out less secondary electrons due to the depression and appear darker in the image. Whereas, when it scans over the hill, the maximum amount of secondary electrons will be emitted and then collected by the detector and hence this area would appear very bright. In the intermediate region, from where moderate amounts of electrons will be given out, light grey areas can be observed. In this manner, when the electron beam hits the surface

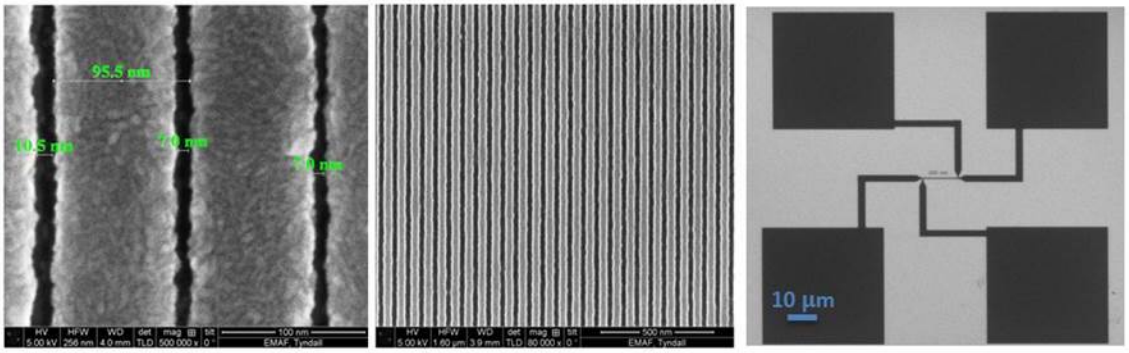

Figure 3: 7-10 nm trenches in ZEP resist, dense silicon nanowires and germanium resistor (from left to right). Image: Anushka Gangnaik

an enormous amount of electrons are removed from the surface which aid in generating complete images. Figure 3 demonstrates the EBL images of trenches on ZEP resist which appear darker due to the depression. The next image is of dense silicon nanowires, since to produce nano devices compaction of space is of utmost importance. The last image is of a germanium resistor, created using EBL. It is used to study current flow through a single nanowire that will be infused with impurities to change its conductance and hence the current flow through it.

Conclusion

EBL is thus a versatile tool that is user-freindly and can create critically small nanopatterns with lesser efforts. Nanopatterning is required to fulfil the desire for more powerful Apple MacBooks and suchlike devices. Such gadgets will be time and cost effective due to more powerful performance as a result of nano-engineering. This article gives an understanding of nanoscale fabrication that is carried out in the university with the EBL technique and its potential applications.

Anushka Gangnaik is a PhD student in the Chemistry department under the supervision of Prof. Justin D. Holmes. She would like to thank her supervisor and Dr. Yordan Georgiev for their kind guidance. Acknowledgement to Science Foundation Ireland (grant agreement no. 09-IN1-I2602) for funding this ambitious project.

The 100 billion dollar virus

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The Scenario

It's a Tuesday sunny afternoon; Mark is lying out in the back garden on a well-deserved break from work. He could easily stay there all afternoon, chilling out reading his book but he has a doctor's appointment at three o'clock. "It's only a check-up, maybe I could give it a miss, I do feel perfectly healthy" he thinks. Mark decided to go to the doctor's appointment convincing himself it wouldn't take long and he would feel great about himself afterwards. That evening after the appointment Mark didn't feel as good as he'd expected. The doctor had taken blood samples which were being sent away for testing with suspicion of a viral infection in his liver. This obviously worried Mark but also confused him as he felt fine. The results of the blood test show Mark is infected with a virus called Hepatitis C (HCV). It is causing damage to his liver which could result in liver failure and death.

Under his GP's recommendation, Mark visits a consultant to discuss his treatment options. He is informed that it could take up to a year to start treatment. He will undergo many medical and psychological evaluations before treatment begins. The treatment for his specific type of infection has many side effects including haemolytic anaemia, which is when your red blood cells are destroyed and you require a blood transfusion. Other side effects include depression, hair loss, stomach ulceration and vomiting. It is likely Mark will consume up to six thousand tablets during his 48-week treatment. The consultant also informs him that the success of this treatment is not guaranteed, 30-50% of patients will fail therapy. If the treatment fails, Mark could develop resistance to further treatment meaning he will have no secondary treatment options. The cost of the treatment could be as much as €50,000. With all of this information, Mark is questioning whether he will even start this treatment. He wishes he could return to that sunny afternoon lying out in his back garden with no knowledge of the virus that has infected his liver.

The Problem

Obviously better options are needed for the 170 million people like Mark worldwide who are infected with HCV. There should be no doubt in a patient's mind whether to agree to treatment for a potentially fatal disease. Improved treatment options are badly needed. I

am passionate about this concept and it is the focus of my PhD project to identify a new direction for improved therapeutics.

HCV is a virus which infects the human liver. It can lead to chronic lifelong infection, causing scarring to the liver and hindering its normal function. An infected individual is at high risk of developing cancer and requiring a liver transplant. HCV is a virus which infects 170 million people worldwide, 2.5% of the world's population. In Ireland alone it infects 30,000 to 40,000 individuals. WHO (World Health Organisation) has estimated the management cost of Hepatitis C over the next decade will reach 100 billion dollars. To put this into context, the commercial giant Apple is also estimated to be worth 100 billion dollars. Should the cost of caring for HCV sufferers cost this extraordinary amount of money?

The liver is a vital organ in the human body, meaning we cannot function without it. It is the waste basket of the body, monitoring the blood and filtering out the toxins, breaking them down into non-harmful chemicals. For example, liver cells process and break down alcohol turning it into water and carbon dioxide. Blood from the digestive system passes through the liver where further absorption of compounds from our food occurs. We acquire energy from the breakdown of glucose. An important function of the liver is to absorb, store and release glucose in order to maintain the energy balance in our bodies. The liver also plays an important role in breaking down toxins acquired from the environment. Therefore, the liver is crucial to our health and disrupting its functionality, as HCV does, has severe consequences.

What exactly is a virus?

A virus is a microscopic organism which has the ability to infect and replicate in other living organisms. HCV is a sophisticated virus which infects the liver cells of humans. It consists of genetic material known as RNA and structural proteins. The RNA contains the instruction manual of how the virus acts inside the liver. The structural proteins form an envelope surrounding the delicate RNA molecule. The virus gains entry into liver cells through specific receptors on the surface of the cell. This can be compared to a locked door; the virus cannot gain entry unless it uses the correct key or receptor. Once the virus is inside the cell, the RNA is released. Now, the viral RNA redirects the cellular machinery, changing the normal processes inside the cell. This is where the problem arises. If you change the normal functions of a cell, it will not function correctly. If a cell is not functioning correctly the organ will not function correctly. If an organ is not functioning normally the human body is out of balance and our health suffers greatly. This is how HCV causes disease.

HCV can be thought of as the "fatty-virus" as it needs the fat present in the liver cell to replicate. HCV also needs a process called autophagy; this is how cells can recycle

different components. HCV has the ability to hijack normal cellular functions such as fat metabolism and autophagy and use them to its own advantage, redirecting or changing the complicated balance of biology that allows the liver cells to function.

What's the plan of action?

My aim is to uncover new mechanisms in HCV lifecycle and find targets for novel treatment. I will focus on how HCV changes two essential functions of the cell. I am investigating how and why HCV changes how fat is used in a liver cell. While fat is normally considered unhealthy and not wanted in the body, in fact, it is needed for many functions. Lipids (another term for fat) are used for energy. They are also involved in forming internal structures and regulating hormone levels. Lipids are stored as lipid droplets inside cells, when the cell needs energy the lipid droplet is broken down. HCV increases the number of these lipid droplets which leads to a condition known as steatosis or "fatty-liver". HCV changes the biology of the cell resulting in more lipid droplets being produced and fewer being broken down. In my research, I have shown an increase in the number and size of lipid droplet in liver cells infected with HCV.

I am also investigating the relationship between HCV and an immune process called autophagy, which was mentioned previously. It is a method used by cells to recycle components. Liver cells have the ability to get rid of unwanted material by breaking up that material and recycling it to be used for other purposes. Autophagy is the name of this recycling process. HCV is known to use this process to replicate. Using a technique known as immunofluorescence, I can examine the actions of HCV inside a liver cell. Immunofluorescence staining allows me to label specific proteins (viral/cellular) within the cell and visualise these proteins under a fluorescent microscope. This can be used to obtain a temporal snapshot, catching the actions of a HCV protein at a specific point in its replication cycle. An example of this can be seen in figure 1. HCV proteins are stained green, autophagy proteins are stained red. The yellow colour indicates the co-localisation of the proteins. This means that both kinds of proteins are in the same place in the cell and therefore must be interacting. By understanding exactly what the virus does inside the cell, new drugs can be developed that specifically target the virus.

My research involves investigating the life cycle of HCV with the aim of discovering what exactly the virus does inside the liver cell. I plan to identify a point of weakness in the replication of the virus, a chink in the armour of the virus. This could be used as a therapeutic target with the aim of destroying the natural progression of the virus which means no progeny virus will be produced and therefore no additional healthy cells will be infected meaning that disease progression will be halted.

New treatment options are needed for HCV patients. Mark's situation needs to be drastically improved. It is not acceptable that a treatment for a disease that affects 2.5% of the

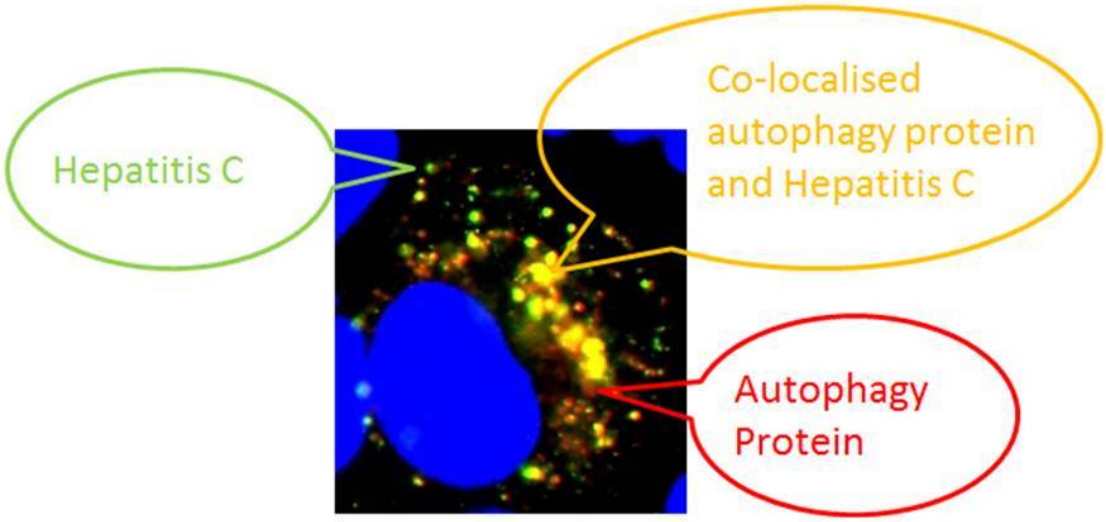

Figure 1: Liver cell infected with Hepatitis C. The image shows stained Hepatitis C proteins in green. Autophagy proteins are stained red. When the two proteins are in the same location they appear yellow. The nucleas which is the centre of the cell is stained blue. Image: Ciara Harty.

world's population has such horrendous side effects. Also, the predicted cost of 100 billion dollars for treating HCV over the next decade is unacceptable. My research aims to find a new way to treat this disease, making Mark a happier patient with a brighter future.

"Sound of silence": a secure indoor wireless ultrasonic communication system

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> "You do not really understand something unless you can explain it to your grandmother." (Albert Einstein)

Ubiquitous wireless technology

According to a report from the World Health Organization, over 1.4 million mobile phone base stations exist worldwide today, and that number is significantly increasing with the emergence of new communication technologies. What about mobile phones? The International Telecommunication Union (ITU) claims that there are almost as many mobile phone subscriptions in the world as people. And that's about 6 billion! The growth of wireless networks has enabled people to use personal devices anywhere at any time. Wireless communication nowadays has become a utility like water, electricity and gas. With the convenience and efficiency it brings, we also have to consider some issues with this technology, because it is so fundamental to our everyday lives.

Problems

One critical and urgent issue is wireless availability. Like the laptops, mobile phones and tablets we know and love today, wireless devices communicate with each other using what are known as radio waves. Useful radio waves are limited, expensive and strictly regulated. What is worse, we are simply running out of suitable frequencies to use. There is another issue you may already be aware of. We are told to switch off our mobile phones during flights because our devices may potentially interfere with on-board electrical systems. The same thing happens at home as well. You will sometimes hear a strange noise coming out of your PC speakers or headphones when your mobile phone is ringing or when you are sending text messages. Also, some studies have shown that wireless radio devices might interfere with implanted cardiac pacemakers if used close to them. These are all radio interference issues. The unwanted wireless signals will significantly degrade desired signals and reduce system performance. Additionally, wireless networks have many security threats. Because radio signals can pass through solid obstacles very easily, they can

be intercepted. For example, somebody outside your room can intercept your wireless Internet connection and steal your personal information (bank records, passwords) without difficulty.

Solution

Fortunately, we have sound! Sound is a mechanical vibration or pressure wave that can be transmitted through a medium such as air, water or solid materials. Human beings and animals communicate with each other by making different tones of sound. But if data signals were transmitted using audible sound the environment would be too noisy for us. Therefore, the use of ultrasound becomes attractive. Ultrasound is simply sound with a pitch or frequency greater than the upper limit of human hearing (about 20 kHz). You will not be able to hear it without the help of a proper detector. The first technological application of ultrasound dates back to 1917 when Paul Langevin was trying to detect submarines using SONAR. Ultrasound nowadays is popular for medical imaging, industrial inspection, cleaning and underwater communication. Unlike radio waves, sound waves are regulation free and they cannot interfere with current wireless devices operating at radio frequencies. There are also no known adverse medical effects of low-energy ultrasound exposure. On the other hand, ultrasound can be confined easily due to the way that it moves. Ultrasound travelling through air does not penetrate through walls or windows. So if you have sensitive data transmitted using ultrasonic waves in air, nobody can intercept indoor ultrasonic signals from the outside. Current ultrasonic technology is not a competitor to radio based wireless communication technology. It does not have the same flexibility and coverage range as a radio system has. But they can be two parallel technologies working together side by side to make more secure and reliable wireless networks.

How does an ultrasonic communication system work?

One common way to send digital data using ultrasound is simply turning on and off the transmitter. It works like a switch, using the presence of an ultrasonic wave to represent a digit '1' and its absence to represent a digit '0'. Therefore, digital data can be represented by a series of ultrasound bursts travelling as pressure waves through the air. When the receiving sensor detects the corresponding changes of sound pressure, this information can be converted back into an electrical signal and translated back to the original data.

Unfortunately, ultrasound signals can be very delicate. They can be affected by air flow, temperature changes, humidity or environmental noise. Changing temperature as well as humidity can cause ultrasound signals to fade away, thus limiting transmission to short distances of a few metres. Persistent background noise may degrade the system perfor-

mance. Hence, we need to design a smarter scheme to deliver ultrasonic Wi-Fi. My work has focused on making the most efficient sound transmission scheme against the difficulties of the acoustic environment.

Figure 1: Tap water flow and shower streams. Image: Wentao Jiang.

As can be seen in Figure 1, water flowing out of a tap is in one big stream, while the same amount of water coming from a shower head gives many tiny little streams in parallel. You can block the tap water easily just with your thumb, but can you do the same thing to a shower flow? The answer is obvious. If the water flow from the tap is blocked by interference, the whole system will suffer from it. But is there a way to make data transfer like the multi-stream water flow from the shower head?

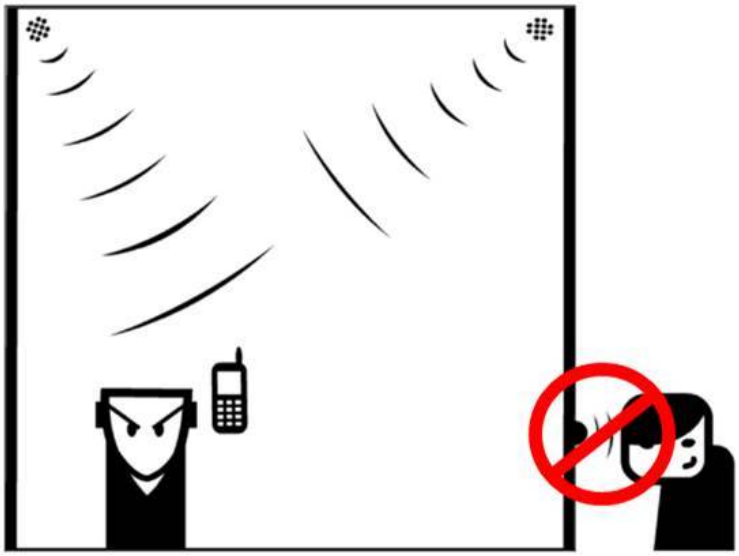

Figure 2: Secure indoor wireless ultrasonic communication. Image: Wentao Jiang.

If you go to a concert, you might have noticed that the music actually consists of different parts in terms of different pitches or frequencies. Lower frequencies may come from drums, cellos or basses while higher frequencies can be produced by trumpets, violins or horns. Vocals mainly cover the medium range frequency. Yet, you can separately hear individual instruments and voices mixed together in the same performance! Correspondingly, data signals can be divided and moved into different frequency channels. They can be added together afterwards just like a band playing music.

I have already successfully built a system that can transmit data using ultrasonic waves in air over distances of up to 5 m without error using multiple parallel data streams and the individual frequency channels separated and decoded. The next step is to build a two-way communication link. Like Wi-Fi and mobile phone networks, modern communications are mostly point-to-point systems that allow two devices to communicate with one another in both directions, simultaneously. The same idea can then be applied to an ultrasonic system. Lower frequencies can be used when transmitting the signal while higher frequencies can be used for receiving the signal. An intuitive way to understand the scheme is to place yourself in a building which is on fire. When the fire alarm has been activated, you can still talk to people who are close to you (low frequency sound) under the beeping sound (high frequency sound) from the alarm. Once the ultrasonic communication system (Figure 2) has been built, the location of your mobile wireless device can be determined by the length of time that elapses between the ultrasonic sensors installed on the ceiling sending the sound signal and hearing the returning signal. Since sound waves travel much slower than radio waves, the elapsed time will be much longer and the distance can be more accurately calculated. When the mobile device has been located, the ultrasonic sensors will be electronically turned and pointed to it, making the sound transmission more focused and more energy efficient. This also localises the signal so that other devices nearby cannot intercept it, even if they are in the same room. The ultrasonic system has been designed for indoor application and interception from the outside will be impossible.

Ultrasecure indoor wireless technology

Like many renewable energy technologies developed today, in the wireless communication realm, ultrasound can be a viable alternative to scarce radio waves as a way of transmitting data signals in certain situations. Ultrasonic communication schemes can also offer a number of advantages in terms of low cost, high energy efficiency and most importantly system security in an indoor environment. In intrinsically safe places like petrochemical plants where radio equipment is usually prohibited as it may generate antenna sparks, ultrasonic technology could be an ideal solution. It could also be used in a surgical operating theatre, where no sensitive electrical medical instruments would be compromised by radio wave interference. In aircraft cabins, it could be used as a Wi-Fi hot spot. People could log

on to social websites or send emails during flight without worrying about any interference with any on-board electronics. Ultrasonic technology could be more commonly used at home and offices, and could make life much more secure. In the future, will we use the "sound of silence" to communicate?

I would like to thank my supervisor Dr. Bill Wright for his supervision, encouragement and continuous support. I would also like to acknowledge my funding from Science Foundation Ireland (SFI) Research Frontiers Programme 11/RFP.1/ECE/3119.

Decoding bug chatter to fight infections

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> "Safe care saves lives and money. Adverse events like high levels of infections, blood clots or falls in hospitals, emergency readmissions and pressure sores cost billions. There is a serious human cost also, with patients ending up injured or even dead. Most are avoidable with the right care" (Lansley A, *The Observer* 2010).

Fungal infections

We usually link infections with bacteria. However, more than half of the world's population is suffering due to the infections caused by microscopic organisms called fungi. These conditions range from the mildest athlete's foot to life threatening meningitis. Despite diversity, only a few patients are aware that their disease is correlated with fungal agents.

Nowadays, dangerous fungi are becoming more common. The incidence of disease caused by these microscopic bugs has increased at an alarming rate and will double in the coming years. Annually, fungi are responsible for millions of deaths and billions of expenditure. High fungal infection rates are mostly related to the growing population of patients with weakened immune systems. Modern medical practices including chemotherapy, antibiotics and drugs that suppress our defence mechanisms make the cancer patients and transplant recipients ideal targets for fungal attack. Additionally, fungi thrive in hospitals and medical devices. These virulent agents remain a leading cause of infections in patients with urinary catheters and breathing ventilators due to hospital-related drug resistance. These infections often involve several types of microbes but the main agent responsible for serious problems is an elusive *Candida*. There are over 20 different *Candida* species but *Candida albicans* is a key player.

Candida albicans

In absence of bacteria, fungi like *Candida* can grow exponentially. *Candida albicans* is a well-characterised microscopic fungus which displays two modes of growth: yeast (single cellular) and hyphae (brunching filaments). It lives peacefully in the mouth, gut, vagina and skin without compromising person's health. However, *Candida* infections occur when fungi find the opportunity to increase their population. Hence, *C. albicans* is an opportunistic germ which mainly causes problems when the environment in the body becomes suitable for the bug to grow and spread. This can happen when a patient takes antibiotics

and kills the bacteria that compete with fungi for food. Thus, *Candida* multiplies quickly because the competitor bacteria are killed. For instance, during antibiotic treatment, mucosal infections of genitals are quite common in females, whereas babies, denture wearers and asthma patients develop oral thrush due to fungal agents. However, clinical evidence suggests that these nasty superficial infections are often self-limiting once antibiotic therapy is completed.

Superbugs

Doctors are now concerned about more serious fungal infections with alarmingly high death rates. Scientists are also warning that widespread chemotherapy treatments and the increased use of drugs which suppress our immune defence can cause deadly fungal diseases. Usually, fungal related deaths are caused by one of four superbugs: *Candida*, Pneumocystis, Cryptococcus *or* Aspergillus. *Given the global hospital-related blood infections,* Candida *species are the most common killers that infect approximately half million people annually.* C. albicans *is a microscopic superfungus which mostly appears as a single cellular yeast. However, it can transform to a more complex form and develop drug-resistant structures. The drug resistance of the problematic* C. albicans *is linked to its protective structures called "biofilms". Biofilms work like bulletproof vests against antifungal drugs and antibodies of our immune system (Figure 1). Hence,* C. albicans *remains the most dangerous superbug which can form biofilms to protect itself, communicate with other microbes and cause life threatening infections in humans.*

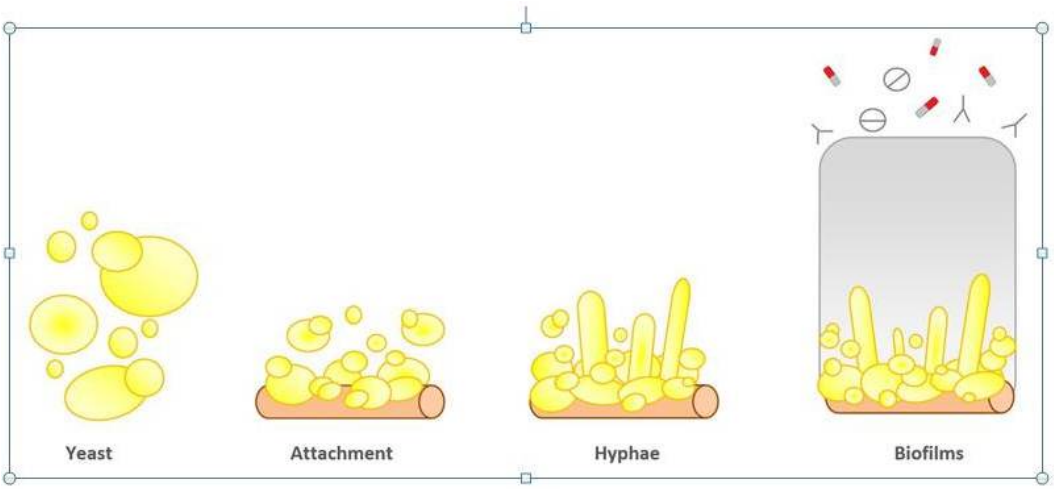

Figure 1: Schematic of fungal biofilm development (adapted from Fox and Nobile, Transcription 2012)

How bugs communicate

Large microbial populations need to communicate in order to survive. However, they have no mobile phones or internet chatrooms at their disposal. Instead, they secrete chemical molecules to signal each other and share data, such as their community size. When bacterial populations reach a certain density they take action, which includes secreting toxic chemicals (toxins), competing for food or producing light. This phenomenon is known as "quorum sensing" and is a characteristic of many bacteria including *Pseudomonas*. *Pseudomonas aeruginosa* is a common germ which infects cystic fibrosis patients and secretes quorum sensing compounds to communicate.

Normally, germs do not live in tubes on their own but in multiple microbial communities in the wild. Indeed, clinical data suggest that many infections are caused by different microbes that infect us simultaneously. These infections are called "polymicrobial". In a polymicrobial environment, diverse microbes interact with each other developing complex communication networks. Communications between a common bacterium, *P. aeruginosa*, and the fungus, *C. albicans*, are intensively studied since they are found together on many infected areas of a human body. The sites frequented by both include burn wounds and the lungs. Additionally, bacteria and fungi form biofilms on plastic medical equipment such as urinary and vascular catheters. Biofilms increase the power of germs by making them practically untreatable. *Due to this, recent research has focused on polymicrobial communities and interactions between community members*. Communications between bacteria and fungi are well-documented. The best known example is a fungal compound discovered by Alexander Fleming, penicillin, which can kill bacteria. My project focuses on fungal mechanisms (e.g. signalling pathways) which can be modulated via bacterial activity. Interactions between bacteria and fungi can be divided into five main categories:

- **Physical interactions** which occur when bacteria actually attach to a fungal cell surface
- **Chemical signalling** which involves the exchange of secreted chemicals. For example, quorum sensing molecules of bacteria that modulate fungal behaviour
- **Metabolic by-products** that are also used for microbial communications
- **Environmental changes** such as the pH fluctuation caused by bacteria that influence yeast
- **Human-host immune system** alterations which develop complex networks of interactions

Objectives of my project

From microbes to humans, genetic information is inherited via DNA. This nucleic acid is composed of 4 chemical bases, A (Adenine), T (Thymine), G (Guanine) and C (Cytosine) that form DNA sequences. Some regions of DNA sequences, known as genes, contain instructions to encode important biological molecules, proteins, whereas others can regulate behaviour of an organism according to environmental cues.

My project provides the opportunity to gain experience with two scientifically important organisms: yeast and bacteria. Overall, the aim is to identify specific fungal genes that are mostly affected by bacterial signals. Fungi are complex organisms that can sense bacterial signals with different chemical structures and biological properties. Bacterial signals are sensed by fungal cell surface systems termed, cell receptors. The signal is passed through the cell by specific proteins called, kinases. Another group of proteins, transcription factors, activate the target genes that define fungal response to the bacterial signal. Many studies have shown that bacterial signals can inhibit fungal biofilm formation. Hence, the initial objective of my research includes high throughput screening of genetically modified *Candida* strains. High throughput screening is a scientific method used to identify genes that modulate behaviour of an organism. Each genetically modified *Candida* strain lacking one protein kinase encoding gene will be tested for biofilm formation in the presence of *P. aeruginosa* molecules. Ideally, the screen will reveal the mutants that are not affected by bacterial chemicals and, in contrast to the wild type, can form biofilms even after application of *P. aeruginosa* secretions. Another aim is to develop a molecular system with the gene of interest and a green florescent protein which will enable a rapid screen of genetically modified *Candida* strains via fluorescent microscopy.

Primary screen

Fungi are usually investigated after they are cultured in different growth media. Depending on media properties, the fungi can die, multiply or form colonies, filaments and biofilms. The degree of fungal biofilm formation ability can be measured with several methods. The primary screen of genetically modified fungi was performed via a quantitative biofilm assay. An assay is an important process of a scientific investigation applied to quantify the results of an experiment. Quantification is a fundamental method of counting observations and translating them into numbers. This approach enabled a reliable estimation of fungal biofilms according to their colour. After the addition of bacterial signalling molecules and colouring solutions to the cultures of each *Candida* mutant, colour intensity of the cultures was measured and quantified. Then, all the measurements were analysed statistically and visualised via comprehensive graphs. Another fundamental strategy in biomedical experiments lies in the comparison of a control with question groups. Hence,

wild type *C. albicans* was used as a control against mutants in order to observe differential biofilm formation trends. Both wild type and mutants were grown in biofilm inducing media with and without the application of bacterial secretions.

From previous studies, it was known that the wild type *Candida* is unable to form biofilms in the presence of bacterial chemicals. Hence, any mutant lacking a protein kinase gene that could still form biofilms after the addition of bacterial secretions, was interesting for our study. Primary screen across protein kinase mutants revealed two mutants that could develop biofilms after the addition of bacterial molecules. This indicated that the missing genes could be essential for sensing the mechanism of bacterial signals since mutants lacking these genes were unable to respond to the bacterial chemicals. These findings suggested that the two genes could play a key role in the signalling pathways of *C. albicans* that responds to bacterial chemicals.

Potential benefits of my research

Millions of people have suffered from fungal infections. While some have felt discomfort because of athlete's foot others have died from meningitis, all caused by microscopic fungi. Moreover, despite the wide use of drugs, fungal infections remain a leading cause of morbidity and mortality in the hospitals. I believe I have found two *Candida* genes that may play a key role in the signalling pathways of this fungus. This contributes to our understanding of fungal virulence. Hence, my project may have multiple clinical applications. Thus, my findings are critical for the development of effective antifungal therapeutic strategies that can save lives and money.

Nina Konstantinidou is a first year Ph.D. student in the School of Microbiology and part at the HEA-funded Molecular Cell Biology Structured Ph.D. Programme. She is supervised by Dr. John Morrissey whom she would like to thank for his continuous support. Nina also thanks Prof. Clarissa Nobile for her permission to cite an adapted schematic of *C. albicans* biofilm development.

When teaching is not enough: Exploring educational computer games as a method for improving reading ability

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The problem

Imagine for a moment that you are a child once again, sitting in your primary school classroom. 30 other students are sitting with you, all at desks working at a task set by your teacher. You are reasonably content, happy to work independently on the task at hand. Suddenly, your teacher announces that it is time to put your workbooks away; you are moving on to the next lesson of the day. The lesson is English and your teacher has asked that you start the lesson by reading aloud to the class from your textbook. Panic creeps up from the pit of your stomach, your heart races and your palms start to sweat. Why? Because you know that you cannot read as well as the others in your class. In fact, you know that you cannot read as well as most other children your age. For many of your friends, reading is quick, accurate and effortless. For you, it is a slow, inaccurate, tedious endeavour that frequently causes frustration, anxiety, and embarrassment.

I think you will agree that the above scenario is definitely unpleasant. Unfortunately, though, it is one that many children encounter on a regular basis. Indeed, there are countless children in classrooms all over the world for whom reading is a major difficulty. Such difficulty with reading is not only distressing, but also likely to affect performance in a variety of school subjects; if you can't read the text, how can you understand the content? To add to this difficulty, many Irish schools have experienced drastic resource cuts in recent years. The number of children in need of support remains constant yet the resources available for such students and their teachers continues to dwindle.

Fixing the problem

Psychologists all over the world have been studying reading for a great number of years. Much of this research has focused on figuring out why some children find it easier to read than others. We know a lot about the causes of those differences, both environmental (e.g. family literacy practices) as well as those that lie within the child (e.g. the ability to process the sounds of speech). However, a clear understanding of how this research can

be translated into feasible, teacher friendly practices is much less apparent. Thus, psychologists and educators are still trying to determine the best methods to support children who struggle with reading.

One belief that has gained increasing attention in recent years is that computers can be used to effectively improve the reading performance of struggling readers. This is because they can provide individual, specialised instruction, are cost effective, and often don't require adult supervision. Furthermore, a lot of children enjoy using computers, so their motivation to work on a particular skill and enjoyment whilst doing so are likely to be increased. There are also benefits for teachers, who experience less repetition and drudgery in their teaching and have access to accurate documentation of student progress.

Quite a lot of research has been undertaken to investigate whether computers can be effectively used to improve the skills needed by children to become proficient readers. However, consensus has not yet been reached as to whether or not computer programs designed to teach children reading related skills are truly effective for improving reading ability. Several researchers have found that these types of computer programs have a small to moderate positive effect on reading ability but others have found no such effect. As part of my PhD, I am investigating whether or not the educational computer game "GraphoGame-Fluent" is an effective form of remediation for struggling readers.

GraphoGame-Fluent

The educational computer programme "GraphoGame" was originally developed in Finland as a result of The Jyväskylä Longitudinal Study of Dyslexia Project. The original GraphoGame software was designed to assist children at the very start of their formal education. Its purpose was to support children learning correspondences between letters and sounds. The training was computerised and available online free of charge in the hope that those in need could be more easily reached as it did not require the presence of a supervising adult. It was also hoped that the use of computerised training would create a "more play, less work" environment, encouraging sustained attention and involvement from the child.

GraphoGame-Fluent is an expansion of the original GraphoGame software and was developed by a team of researchers from Finland, Ireland, and Austria. The aim of GraphoGame-Fluent is to support older children from the 3rd to 6th class who experience persistent reading fluency difficulties in English.

The game is based on the idea that in order to become a truly proficient reader, children need repeated, consistent reading practice. Many children who struggle with reading have problems with accurate and automatic (fast and effortless) word recognition. GraphoGame-Fluent works to alleviate these difficulties by repeatedly exposing the play-

ers to high frequency English words which they are likely to frequently encounter in text. Also, the game includes an adaptive algorithm which adjusts the speed of item presentation to the player's response accuracy. This means that the players are always challenged to play at the edge of their ability. Furthermore, the game aims to improve the connection between spoken and written language, another difficulty faced by many poor readers.

GraphoGame-Fluent is a role playing game that consists of a number of different levels (a jungle, castle etc). The player assumes a character and progresses through each level by completing training tasks involving high frequency English words and sentences. The tasks include:

- Spoken to written word matching (the player hears a word in their earphones and matches it to the correct word on screen);
- Written to written word matching (the player sees two words in quick succession and must decide if they are the same or different);
- Sentence reading (the player decides if a sentence they see on screen is true or false);
- Word organisation (the player sees words on screen and must decide which ones belong to a certain category).

Players receive feedback in the form of a result chart after each training task. The players also earn money as they complete training tasks. They can use this money in the many shops contained within the game; clothes, jewellery, pets, and motorcycles are all available for purchase!

The study

In order to find out whether GraphoGame-Fluent could actually improve reading ability, a group of 43 primary school students were asked to play the game. All of the students had been nominated by their teachers as poor readers. They were aged between 8 and 12 years old and were in the 3rd to 6th classes. The group of nominated students was then divided into two. One group played GraphoGame-Fluent from February-March 2013 while the other played from April-May 2013.

Participants played GraphoGame-Fluent either at home, at school or both. Playing was encouraged for 25 minutes a day (Monday to Friday) for 7 weeks. An online assessment built into the game provided an evaluation of children's reading skills at 3 points throughout the intervention period (January (T1), April (T2) and June (T3)).

A group of 43 randomly selected average readers from the same classes were also recruited as a comparison group. These students did not play GraphoGame-Fluent but did complete

the 3 assessments. This allowed me to compare the performance of the poor readers playing GraphoGame-Fluent to the performance of their classmates.

Did it work?

The online assessment that took place at three time points allowed me to measure children's ability on three different reading measures and two control measures. Each player's ability was assessed in terms of time taken to complete the tasks and performance accuracy.

The first assessment allowed me to collect what is called a "baseline" measure of the participant's performance before either group started playing GraphoGame-Fluent. At this time, no significant differences were observed between the two groups of poor readers in terms of response time or accuracy.

The second assessment took place just as the early playing group had stopped playing and the late playing group had yet to start. At this time, results showed that the early playing group were significantly faster than the late playing group on two of the reading measures and one of the control measures. It seems that GraphoGame-Fluent was effective for reducing the reaction time of the players.

At the time of the third and final assessment, when the late playing group had just finished playing, no significant differences were found between either of the poor reader groups in terms of response time or accuracy on any of the measures. At T3, both poor reader groups performed at a faster rate than they had done at T2. However, the accuracy of both groups was worse at T3 than it had been at T2. Although reaction time seemed to be decreasing, so too was accuracy! This may have been due to the fact that participants were completing the same assessment for a third time; eagerness to finish the assessment may have caused a speedy but inaccurate response. At T3, both poor reader groups were still not as accurate as the comparison group of average readers.

Unfortunately, I was disappointed to find out that participants did not play the game as much as intended. Overall playing time for the early group was better (5.3 hours) than for the late playing group (4.3 hours) but neither reached targeted levels (14.5 hours). Children participating in the study played largely unsupervised at home. It appears that playing which involves adult supervision in a group setting where player interaction is possible provides the most promise for sustained playing.

What did the players make of the games?

In order to find out what the participants thought of GraphoGame-Fluent, I carried out three focus groups. Within each focus group, I spoke with between four and six students about their experience of the game. The participants had several suggestions for how the game could be improved in the future. Some of these suggestions included:

Increased opportunity for interaction:

"Let's say your friend was on it and... you could add them as a friend and then... you could play with them"

Diversity within the game:

"Do maths tasks, English and everything"

Increased opportunity for reward:

"I wanted more money!"

Increased creative input:

"I think we should make our own characters"

"Real World" research

Carrying out research is often a complex process with each type of research posing different challenges. Because this study involved participants playing Graphogame-Fluent every day in school or at home, it faced some challenges associated with this type of context. For me, the following questions needed to be considered carefully:

- ☐ Will the player's parents be able to download the game easily?
- ☐ Do the participants have access to suitable facilities at home and/or school to reliably and consistently play the game?
- ☐ Are adults available to supervise the players if necessary?
- ☐ Do the participants have the time and motivation to play the game?

For some participants, the answers to the above questions were sometimes “No!” For example, there were several children who had computers at home which subsequently broke, denying them access to the game. For others, the amount of extra-curricular activities they were engaged in sometimes meant their schedule was too full to play! Furthermore, despite a lot of encouragement on my part, some participants were not very motivated to play. Thus, the research process needed to be flexible and adaptive, ensuring the participants were granted as much exposure to the game as possible. For example, sessions were arranged within the school where participants would play the game under my supervision. This was to ensure that participants had at least some exposure to the game. It is thought that player motivation can perhaps be improved by altering the game in the ways suggested by the players e.g. facilitating interaction between players.

What have we learned?

When assessed at T2, the group who had been playing GraphoGame-Fluent were significantly faster on three tasks (two reading tasks and one control task) than the group who had yet to start playing. This suggests that GraphoGame-Fluent had a positive effect on player’s ability to respond to tasks more quickly. At T3, the poor reader groups did not differ significantly. Results indicate that whilst player speed had increased between T2 and T3, accuracy had decreased during that time. It still remains to be seen how effective GraphoGame-Fluent can be when played consistently over a prolonged period of time. Future research in this area will be informed by the valuable suggestions provided by the players and also a consideration of the practical constraints involved when offering educational intervention online.

I would like to extend my thanks to my supervisor Dr. Marcin Szczerbinski, the GraphoGame-Fluent team, and the participants, parents, and staff who made my research possible.

How to eat when I can't swallow?

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> "I had another choking session last evening. A tiny bit of salmon or salad went down the wrong way and I coughed and coughed with my loved one beating my back with a vengeance. This went on for the best part of two hours." (Mark Cato, diagnosed with Motor Neuron Disease).

Background

Imagine losing control over the muscles of your mouth and throat. Imagine not being able to chew or swallow. Imagine life without a burger or a chocolate cake. Imagine fits of coughing when you try to swallow anything. Imagine looking at food with fear, fear of choking.

Swallow difficulties can affect anyone and at any stage of life. It can be a congenital disorder — for example caused by cerebral palsy, or it can be acquired — caused by a stroke, cancer, or progressive neurological illness. When the mouth muscles stop working properly you may experience difficulties chewing food. Eating and drinking may become a very long, effortful and messy process. It can make you feel embarrassed, especially when you eat in public. When the throat muscles are affected you are at risk of choking and aspiration. This means that any drink, food or even saliva may redirect towards your lungs instead of flowing smoothly into the stomach. Long term, it can cause chest infection, aspiration pneumonia or death.

When it is not longer possible to eat and drink safely some people decide to have a feeding tube inserted and take food directly into the stomach. Others continue eating despite serious risks. The decision is always individual — an universal set of guidelines stating the appropriateness of non-oral feeding for every medical condition does not exist. Everyone has unique circumstances, which have to be considered carefully. Patient's prognosis may be an important factor: it may be "easier" to accept artificial feeding temporarily, while waiting for the swallow to improve. However, the perspective can be very different for people diagnosed with a progressive illness, for which there is no cure, such as Motor Neuron Disease (MND).

MND is a rare neurodegenerative illness of unknown etiology. It affects more than swallowing. It can cause weakness of any muscle in the body. The disease is extremely rapid. Median survival of Irish patients is just over 16 months after diagnosis. It is now recognised that MND is a multisystem disorder, which can lead to muscular weakness as well as

cognitive impairment. Swallowing problems (dysphagia) can often occur in MND. They can have various medical consequences, like malnutrition, dehydration, chest infections, aspiration pneumonia, choking and death.

We know that appropriate nutrition is an important prognostic factor in MND. Therefore it is important to ensure adequate food intake, which may not be easy if a person has difficulties with swallowing.

Dysphagia can affect people not only from a medical, but also from psychological and emotional perspective. It is a complex problem, which is often managed in busy clinics with little time available for in-depth discussions. We have to understand how people with MND experience difficulties with eating and drinking, how they cope and how they feel. Dysphagia in MND is very specific due to the nature of the disease and can progress fast and can often occur in addition to other concomitant impairments/ disabilities. It is crucial to investigate this problem in-depth in order to know how to provide effective support for both people diagnosed with MND and their caregivers.

People living with MND require extensive support which creates substantial challenges for those caring for them. Caring duties can include preparation of meals and feeding. The caregivers are often expected to know how to alter food consistency to make it easier to swallow, how to feed safely, and how to react in case of a choking episode. How hard it can be to feed someone with impaired swallow, when on the one hand you know that nutrition is very important, but on the other you are afraid of them choking? How hard it is to watch someone, who can not have their usual diet anymore?

> *(. . .) I mean for instance, my daughter and I had a curry. And it sounds stupid, doesn't it? I had a curry, and very enjoyable, obviously. Suddenly my wife, in the kitchen, suddenly broke down in tears, and I had to go out and find out what was wrong. And after quite a long time it took to find out that she just said, "I wish I could partake of the curry." So that makes me feel pretty awful to think that I can enjoy a curry and my daughter can enjoy a curry, which is just normal, and my wife is not able to. So I suggested to her that she should try some of the liquids from the curry and everything. She tried, but then she informed me that it was a bit too hot, and the Madras curry or something was too hot and it was burning her throat and that. So again we tried to get round the problem a little bit, but it doesn't work. So, you know, what can you do? How do you approach it? (a Caregiver of a person with MND*).

The experiences of the person living with MND and dysphagia have not been investigated. My research aims to address the above gap. I decided to focus on MND, as this disease progresses so fast and does not allow for any time to be wasted. Having deeper understanding of the problem means that it can be approached in a more efficient and adequate way.

My research proposal also aligns with the top 20 research priorities identified for Speech & Language Therapists in Ireland by the Health Research Board.

Research aim

The overall aim of this research is to gain a deeper understanding of how people living with MND experience dysphagia. This project seeks to investigate:

1. The impact of dysphagia on the lives of people with MND and their caregivers.
2. The main dysphagia related difficulties experienced by people with MND and their caregivers.
3. The meaning of dysphagia for people with MND and their caregivers (when it is often one of many disabilities).
4. How people with MND and their caregivers perceive dysphagia related services available to them, and their suggestions of any potential changes to these services.

Data collection

This is a qualitative research study, using a phenomenological approach for data collection and analysis. Phenomenology (study of experiences) allows in-depth investigation of what it is like to live with/ care for MND and dysphagia. A semi-structured interview design was chosen to provide in depth rich information pertaining to participants' experiences and help the researcher understand the participants in their own environment. The goal is to have the participant reconstruct their own experience within the topic under study.

A pilot test will be carried out to facilitate evaluation of the interview design and to allow for revision prior to implementation of the study, if necessary. One individual with MND and dysphagia and one caregiver will be enrolled in the pilot, following which a review of research design will be undertaken, as appropriate.

Sample size

It is expected to enrol 20 participants in total: 10 adults with MND and 10 caregivers.

Data collection

Data will be collected via multiple interviews. It is anticipated that about 60 interviews will be carried out. At least two (maximum 4) interviews are planned with each participant: to establish rapport and obtain in-depth information. Multiple interviews may also be required if participants become fatigued.

Data analysis

The interviews will be audio recorded and transcribed verbatim. During the first phase of analysis the text will be read multiple times to develop emerging themes and to search for connections between them. This process will be repeated individually for each participant. The second phase will involve looking for patterns (common themes) across the group of adults with MND and the caregivers. The findings will be described and interpreted, as consistent with Interpretative Phenomenological Analysis. Credibility will be sought by design checking, member validation and triangulation.

Recruitment

The participants will be recruited from the Irish MND Association (IMNDA) and Speech & Language Therapy Departments in Kerry /Munster and assessed accordingly to specific inclusion and exclusion criteria. The Kerry area was chosen as a convenient geographical location to ensure that multiple in depth interviews can be possible within the limits of financial and time resources. However, the research may expand to other parts of Munster if required.

The importance of this project

This innovative research project is of direct relevance to all people with MND, their care-givers, families and multiple clinicians involved in MND care, for example, Speech & Language Therapists, Occupational Therapists, Dietitians, Palliative Health Nurses and Doctors. Little is known about Irish people living with MND, therefore this research will be of particular relevance to the Irish health care system and ultimately Irish Society. It will provide insight into the experiences of people with dysphagia in MND, which may explain some decisions made by patients (for example when refusing non-oral feeding). This study can result in improved quality of life and quality of care for MND patients in Ireland, for example, with appropriate level of support MND patients could potentially be better cared for in their own homes. It could also potentially identify where services are providing excellent care (meeting the needs of this population) as well as where there are gaps. Without qualitative studies such as this, a "real" understanding of MND can not be achieved.

> The unexamined life is not worth living (Socrates).

Ireland's Medieval Woodland: An archaeological approach to understanding long term patterns of wood use, management and exploitation

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Mayo, Roscommon, Derry, Newry, Trim, Roscrea, Adare, Kildare, Kilcullen, Cratloe, Youghal, Clonakilty, — what do these Irish place names have in common? They all derive from the name of a tree or a wood. Of the 16,000 townlands in Ireland, approximately 13,000 are named after trees. Root words expressive of woods, forests and trees include coil/coillte (wood); daire/daur (oak); coll (hazel); cuileann (holly); sail (willow); iúir/eo (yew), trom (elder) and beithe (birch), the earliest written records date to the seventh century A.D. In most cases, the woods that lent their name to places in Ireland have long gone, but through the uniqueness of Irish place names, we gain a fascinating insight into the high regard in which people in medieval Ireland held the humble tree.

Historical roots

It has long been the perception that Ireland was an extensively wooded country up until the seventeenth century. We know very little of the extant of Ireland's medieval woodland as no official records exist. At the time of Civil Survey of A.D. 1654-56 many of the townlands bearing the name of woods were relatively treeless. During the early medieval period (A.D. 400-1100), woodland was already a distinct, valued zone in a generally open agricultural landscape from at least the fifth century A.D. To chart how woods fluctuated in the past, pollen analysis is primarily used to interpret past ecological change. Pollen analysis is a robust technique for reconstructing former vegetation composition and different types of human land use (e.g. agriculture, grazing and woodland management) using plant microfossils (pollen grains and spores) that have been preserved in peatlands and lake sediments.

Traditionally, trees played a pivotal role both practically and spiritually in the lives of the early Irish people as many historical references testify. The role of woodlands in the medieval social system can be observed through the Brehon Laws, the statutes which governed Gaelic life in medieval Ireland from the seventh to the seventeenth century A.D. While the legal information pertaining to trees is limited and fragmented in these documents, the scholarly works of A. T. Lucas, D. A. Binchy and Fergus Kelly have been in-

strumental in providing a solid foundation for continuing research on this subject. Woods were integral to medieval daily life, a multi-layered ecosystem providing sources of firewood, charcoal, timber, food, medicine and even shelter in times of unrest. If communities mismanaged their woodland resources they were in danger of losing their self-sufficiency. Trees were recognised as objects of economic importance and the eighth-century document, *Bretha na Comaithchesca* (Law of the Neighbourhood), served to protect woodland and regulate wood use. Strict fines were imposed if trees of certain value were cut down or damaged without permission. Trees were classified on a hierarchical ranking, based on functionality (timber quality and fruit production), cultural significance and their stance as boundary markers:

- *Airig Fedo* (Nobles of the Wood): oak, hazel, holly, yew, ash, apple
- *Aithig Fedo* (Commoners of the Wood): alder, willow, hawthorn, birch, elm, wild cherry
- *Fodla Fedo (*Lower Divisions of the Wood): blackthorn, elder, juniper, spindle, whitebeam
- *Iosa Fedo* (Bushes of the Wood): bracken, gorse, bramble, heather, wild rose

Trees also abound in Irish folklore, a frequent theme being sacred trees or *bile.* Sacred trees were found at holy wells, churches were constructed at the site of sacred trees and groves and cultural ceremonies and royal inaugurations were often performed at a specific tree (Fig. 1). The legal protection of these revered features was also documented in the eighth-century poem, *Ma be rí rofesser*, from the law tract *Críth Gablach* which reads: "A danger from which there is no escape is the penalty for felling a sacred tree" (translation D. A. Binchy). To destroy such trees would have therefore been an act imbued with wider religious and political connotations, and their veneration suggests a deep-rooted sense of cultural identity and place.

Can we see the wood for the trees?

To date, the history, use and exploitation of Ireland's medieval woodland has been largely reconstructed using historical records and pollen analysis. Despite these sources, wood use and woodland history for medieval Ireland is sporadic and discussed in broad and generic terms. Changes to local woodland were rarely recorded, unless they had a social or economic impact and local patterns of wood use and selection practices are still unknown. Evidence for explicit woodland management practices prior to the twelfth century is still elusive and continues to be debated amongst historians and archaeologists alike. While seminal work on early Irish law tracts by Fergus Kelly quotes compelling literary evidence for early medieval woodland management in the form of coppicing, the archaeological remains for direct management strategies is still under-represented. Timber, firewood and

Figure 1: St. Cuan Well, Tobarchuain, Co.Waterford. An ash tree growing from base of the well. Image: Louise Nugent.

underwood cannot be fully discerned using the literary sources, which makes wood selection and procurement difficult to interpret. Woodland reconstruction using the medieval Irish records is also highly problematic as these are often chronologically and geographically fragmented.

Pollen investigations have shown that more diverse woodland existed in Ireland than previously recognised. Despite this, very few pollen studies for the medieval period provide unequivocal information regarding factors affecting local woodland and seem to lack sufficient chronological resolution to identify precise rates of change. Regional woodland patterns are often extrapolated to local landscapes, without considering other variables, such as topography, geology and local soil conditions. Despite the qualitative (historical) and quantitative (pollen) methods currently used for charting wood use and woodland change for medieval Ireland, it is apparent that an holistic approach integrating different datasets is required to elucidate many aspects of medieval wood use, management and exploitation.

An archaeological approach

So what can a subject like archaeology offer to woodland research and can it contribute new knowledge to Irish medieval studies? My research will identify and analyse wood

charcoal recovered from archaeological sites as a new approach to understanding past woodland ecology and human activity. Archaeological charcoal is essentially the remains of the woods used by people in the past and represents the only body of material that has not been coherently assessed with regard to Irish medieval woodland. The increase in commercial archaeological excavation in Ireland over the last fifteen years has generated a huge charcoal dataset from a variety of sites that requires more detailed attention. Charcoal is the most ubiquitous type of plant macro-remains recovered from archaeological sites in Ireland, but often the most neglected. It represents (a) the product of purposeful human activity associated with domestic/industrial activity (fuel; firewood; charcoal production) and (b) events associated with the burning or destruction of a building or structure. It is a robust material, survives well in a variety of environmental conditions and is the only source of woodland reconstruction in dry land areas. Improvements in methodologies and sampling strategies over the last twenty years have also seen it emerge as a viable tool in reconstructing past woodlands.

Charcoal is uniquely placed to tease out specifics on wood selection, thus offering new information on medieval woodland composition, management and resource use. An assessment of this material will produce a comparative analysis of wood use between different medieval settlement types and associated activities. The role of lesser known wood species, species of low economic value and the presence of non-native woods will also be better represented. Charcoal also provides a high resolution site-related record of local woodland at a temporal scale congruent with the archaeological context itself. The analysis of charred wood is of special interest in regions where pollen analysis is unsuited, such as dry land zones, providing the only source for woodland reconstruction in these areas. Pollen sampling sites are confined to lake sediments and peatlands, thus limiting the range of areas for potential woodland reconstruction.

Very few pollen studies for the medieval period also provide unequivocal information regarding factors affecting local woodland and lacks sufficient chronological resolution to identify precise rates of ecological change. An increase in archaeological charcoal studies in Ireland and abroad has revealed that wood exploitation was more closely dependent on the local wood availability, something that pollen analyses cannot identify in isolation. This research can therefore offer new information on woodland change, including periods of clearance and regeneration, through secondary woodland and hedgerow indicators.

Methodology

The direct exploitation of woodland resources is best understood by analysing the physical wood remains themselves through an integrated approach. The first step of my research is to carry out wood species identification using microscopic techniques to generate a list of the woods being utilised (Fig. 2a). Other dendrological analyses, such as identifying

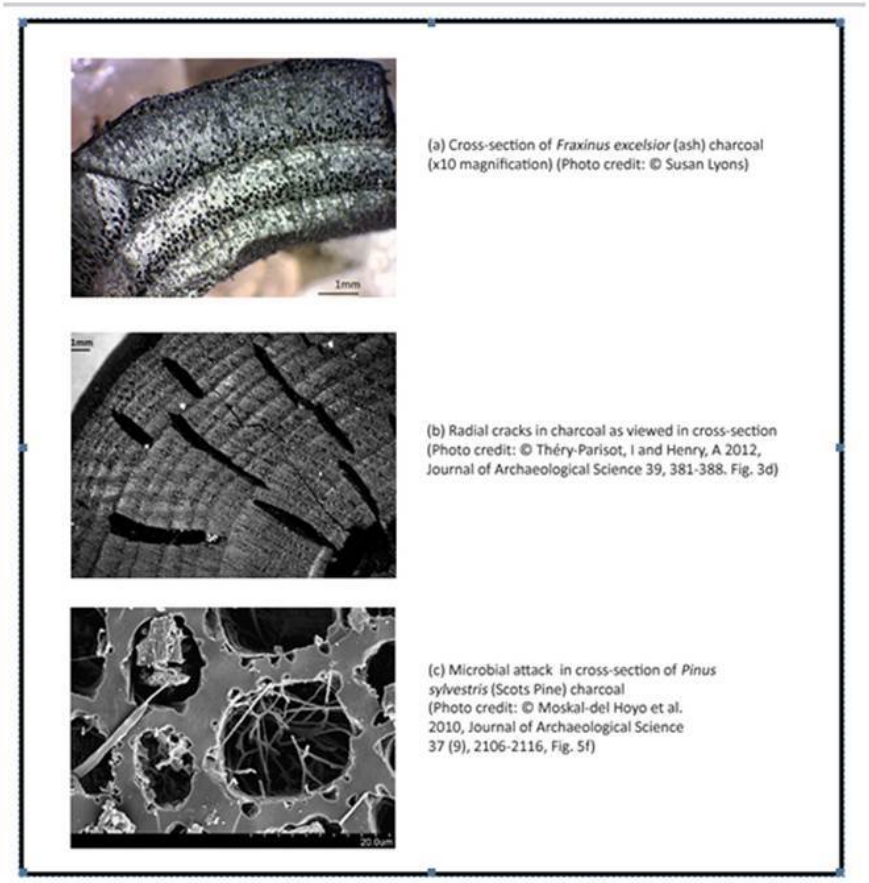

Figure 2: Microscopic wood charcoal identification and dendrological analysis

radial cracks (Fig. 2b) and microbial attack (Fig. 2c) will also be performed. This provides information on timber quality and can reveal whether wood was collected fresh or was stored. Assessing the curvature of annual growth rings will determine if small, medium or large wood was used, which will potentially help understand woodland management practices, firewood acquisition and collection strategies.

The data will be entered into a specifically designed database called WODAN (www.wodan.ie). WODAN was created in Ireland in 2010 and is the first standardised European online database for archiving archaeological wood and charcoal. The design has been developed to allow for comparable analysis and query building, which facilitates rigorous manipulation of large datasets for statistical analysis. My research will be the first to use the database to analysis charcoal assemblages specifically from medieval Irish sites. WODAN can also be geo-referenced, which will aid the second step of my research, to preform spatial analyses for wood used at each focus area selected, allowing comparisons to be made across different geographical zones. The results will be integrated and synchronise with the medieval pollen and historical data allowing for a quantitative and qualitative evaluation of the results.

Study Areas

A series of medieval sites from three catchment areas in Co. Tipperary, Co. Kilkenny and Co. Meath will form the focus for this research. The sites range in date from the early medieval (400 to 1100 AD) to the late high/late medieval (1100 to 1550 AD) and comprise a variety of urban, rural and ecclesiastical settlement. Charcoal identifications have been carried out on 30 sites by the author and a subset assemblage from each has been selected for further dendrological study.

These areas of settlement reflect social organisation, where wood resources would have been more controlled. Understanding wood collection practices will therefore help interpret patterns of woodland management and procurement at a site. Charcoal samples from well stratified deposits representing explicit archaeological activity will be targeted:

- Structural activity (post-holes)
- Domestic activity (hearths; roasting pit; rubbish pits)
- Manufacturing activity (kilns; metalworking; charcoal production pits)

Preliminary Results

To date, results are revealing that wood species of high economic value (oak, ash and hazel) were being used for building and specialised activities, such as metalworking and charcoal production. There are slight changes in wood composition between early and later medieval dated sites at local level, which could reflect cultural or environmental factors. An interesting observation thus far is the notable presence of pomaceous fruitwood (apple/pear/hawthorn/rowan) and cherry-woods, which may be indicators of orchards or garden plots. The history of orchards for medieval Ireland is relatively scant, so this project can potentially offer new insights into this subject. Pomaceous fruitwoods are also under-represented in the pollen record, so wood charcoal provides the only direct evidence that these species existed at a site.

Conclusion

Using archaeological charcoal within a multi-disciplinary framework, this research will provide a new dataset for research into Ireland's woodland history. The project will generate new hypotheses for how cultural and environmental factors influenced medieval wood use and establish a new paradigm for recording patterns of wood exploitation. It will also contribute to existing proxies for woodland reconstruction and be uniquely placed to provide a rigorous theoretical grounding for future archaeological, historical and palaeoecological integration. Woodland resources, albeit prosaic, were a vital component of Ire-

land's medieval economy. Past patterns of agriculture, settlement, management systems and secondary regrowth has severely impacted on Ireland's woodland and has altered its natural landscape. Therefore, to understand such changes we must look to the past to see how people interacted with these local resources.

The author would like to acknowledge the Irish Research Council (IRC) as the funding body for this project. Thanks also to Dr Louise Nugent, Dr Isabelle Théry-Parisot and Dr Magdelena Moskal-del Hoyo for the use of images and to my supervisor Dr Benjamin Gearey and the staff of UCC Archaeology Department for their support.

Water and agriculture: a love/hate relationship

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> Water is life's mater and matrix, mother and medium. There is no life without water (Albert Szent-Gyorgyi).

Setting the scene

Water

Although the majority of our planet is covered with water, 97 per cent of this is unsuitable for human consumption as it is too salty. Most of the remaining 3 per cent is found in land-ice which is predominately inaccessible, leaving less than 1 per cent available to humans and other animals in surface and ground waters. Water transports many substances, such as nutrients required by organisms, e.g. nitrogen (N) and phosphorus (P), but also many pathogens that cause disease. As a result, ensuring an adequate quantity of good quality water is critical to ensure human and ecosystem health into the future.

Agriculture

Food is equally important to human survival. Many other essential ingredients for life, such as carbohydrates, proteins, and fats, are only found in certain foods. This means agriculture is the most important activity on Earth, and accounts for about 80 per cent of freshwater usage; thus, the two resources are inextricably linked.

Traditionally, agriculture would not have been quite as demanding on water use. Across Europe before the introduction of the Common Agricultural Policy, farming was carried out on mixed farms which combined the growing of crops and raising of animals. From the nineteen sixties, however, European policy began encouraging farmers to maximise production outputs by specialising in a single crop or livestock system. A drive for adopting mechanisation and intensive production has since changed farming in Europe considerably. For example, the majority of pig production now occurs in indoor units which house thousands of animals at once. Not only does this increase water demands, it also increases pressures on the environment by generating higher levels of manure which, if managed

inefficiently, can lead to excess nutrients entering water-bodies causing ecological deterioration.

A love/hate relationship

While agriculture relies heavily on the availability of water for the production of crops and livestock, the relationship is in some senses one-sided. As mentioned previously, water is an essential source of nitrogen and phosphorus for organisms. Take nitrogen, for example, the most abundant element in the atmosphere but which is useless to us in its gaseous form, N_2. N_2 must be broken down, or fixed, to ammonia (NH_3) by bacteria before it is accessible to plants and animals. Phosphorus, on the other hand, is not found as a gas in the atmosphere. Instead, it is stored in rocks as phosphates and usually enters water naturally after erosion has occurred. Though essential for the growth of life, excessive quantities of nitrogen and phosphorus in waterways can result in the water becoming unsuitable for many common uses. This is where a major crack in the relationship forms.

When we eat plants or animals containing nitrogen and phosphorus, our bodies take up a certain amount of the nutrients. The surplus nutrients are then excreted. The same can be said for livestock. When thousands of animals are housed in relatively small areas, however, their excreta can become problematic. Pigs' manure, for instance, is usually high in phosphorus which makes it a good natural fertiliser for tillage farmers. Nevertheless, if excessive amounts of phosphorus are spread on land, it runs the risk of runoff or erosion into rivers and streams. Nitrogen in the form of nitrate is also beneficial to crops. However, nitrate is very soluble, meaning that it not only reaches surface waters with run-off but can percolate through the soil to the groundwater below. Nitrogen as ammonium (NH_4^+) is also found in manure. From ammonium, ammonia (NH_3) is often lost to the atmosphere through volatilisation, a process whereby the compound vaporises to its gaseous state. It can, however, form an aqueous solution if it comes in contact with water prior to volatilisation occurring. In this liquid state, ammonia can find its way to waterways through runoff.

Too much of a good thing

Nitrogen and phosphorus are often considered limiting factors in the growth of populations of some species in ecosystems. This means that without enough of these nutrients, certain organisms will not be able to grow. On the other hand, excessive amounts of nitrogen and phosphorus in aquatic systems lead to a process known as eutrophication. Eutrophication promotes the growth of simple plant organisms such as macroalgae, or seaweeds, and phytoplankton. Phytoplankton, the most common of which is algae, tends to inhabit the upper levels of the water column and flourish with increased nutrient levels. Consequently, these algal blooms prevent sunlight from reaching plants in the lower

Figure 1: — Sea lettuce bloom in Courtmacsherry Bay recorded in October 2012. Source: Graham McAuliffe.

levels; thus, inhibiting their photosynthesis. Once the algae have consumed the nutrients in the water, they die off and fall to the bottom of the water-body as bacteria begin decomposing the organisms. The bacteria that break down the algae consume oxygen, and because photosynthesis is prevented, oxygen production by plant-life is halted. Without oxygen, higher trophic organisms such as salmon cannot survive and either die off or migrate. This not only has an impact on the biodiversity of a river, it also reduces the value of the water because fishing tourists may stop visiting an area.

Transitional waters, such as estuaries, can also be affected. Figure 1 demonstrates the severity of a sea lettuce (*Ulva maxima)* bloom as a consequence of nutrient enrichment in Courtmacsherry Bay, Co. Cork. Rather than a depletion of oxygen, however, here the seaweed is becoming stranded on the shore and decomposing thereafter. Though the primary source of nutrients in the estuary is disputed, the effects are not. The algal bloom has had a devastating impact on locals and tourists alike. Many boats' engines, for instance, have been destroyed by the infestation, and the area can be plagued by noxious odours, especially on hot days. In 2009 a taskforce was set up, funded by taxpayers, to remove the dead vegetation from the area. However, the team was unable to remove adequate amounts resulting in the area still being plagued by this manmade nuisance today.

WFD Ecological Status	Trophic Status	Water Quality	Q-Values
High	Ultra-oligotrophic	Unpolluted	5, 4-5
Good	Oligotrophic	Unpolluted	4
Moderate	Mesotrophic	Slightly Polluted	3-4
Poor	Eutrophic	Moderately Polluted	3, 2-3
Bad	Hypertrophic	Seriously Polluted	2, 1-2, 1

Figure 2: — Breakdown of river water quality determined by the Water Framework Directive. Source: EPA.

Ammonia can also be a concern for aquatic ecosystems. Under certain conditions, determined by pH and temperature, ammonia can be highly toxic to fish resulting in disfigurations or death.

Rekindling the flame

Water and agriculture's faltering relationship has not gone unnoticed. In an attempt to protect European waterways, the EU developed the Water Framework Directive (WFD) in 2000. The aim of the directive is to ensure all aquatic resources in the EU reach good or high ecological status. For rivers and streams in Ireland, this means achieving a Q-Value of 4 or greater. Q-Value standards are determined by the biological diversity observed in rivers. The associated categories are represented in Figure 2. Based on Q-Values, water sources are divided into the following four categories based on their potential to reach specified goals: at risk; probably at risk; probably not at risk; not at risk. The 'probably' categories acknowledge that sufficient data are unavailable, but when they are acquired, the outcomes are probable based on current records.

The research project

Ongoing freshwater monitoring by the Environmental Protection Agency (EPA) highlights the fact that agriculture is the greatest contributor to slight and moderate pollution in Ireland. The EPA's findings, however, do not delineate the amount of pollution derived from individual sectors. Therefore, the novelty of this project manifests in determining the contribution of the pig sector to river water quality. The pig industry in Ireland is highly regulated by the EPA and local authorities; but, to the best of this author's knowledge, research to date has not considered risks posed to water bodies when intensive pig farms are concentrated in one particular area.

Methodology

Based on information available from the EPA, a river and its tributary have been identified as a study site. To protect the identity of participants in the study, the location of the study site cannot be revealed. Nevertheless, the EPA has acknowledged that the rivers are at risk and probably at risk, respectively, of not reaching WFD goals. Despite an urban wastewater treatment plant (UWWTP) being highlighted as the primary polluter in the area, consultants tasked with assessing the river basin district note that piggeries in close proximity to the rivers may also be contributing to some of the pollution detected.

In order to accurately assess the contribution of the piggeries, an environmental risk assessment (ERA) methodology is being used. This methodology is usually a desk-based approach reliant on secondary data; however, as a result of insufficient information and data, this project is modifying a typical ERA by acquiring primary data. The first step in an ERA is to identify hazards, such as nitrates, ammonia, phosphates and pathogens, for instance. The ERA then determines the risks they pose to human and ecological health by assessing the Predicted Environmental Concentrations (PECs) against the Predicted No-Effect Concentrations (PNECs), taking exposure pathways into account.

This ERA is a multidisciplinary study which draws upon a range of tools. For example, all available secondary data is currently being examined to determine potential hazards. Interviews with the rivers' recreational users and local residents will be conducted to establish perceived risks and potential exposure routes. Water sampling and chemical and biological analyses will be carried out to fill gaps in available data. A sampling site can be seen in Figure 3. Once sufficient data have been acquired, statistical and hydrological models will be created to predict future risk to water quality in the area.

Preliminary findings

According to The Central and Regional Fisheries Board, one of the rivers is inhabited by brown trout (*Salmo trutta)* and salmon (*Salmo salar*), making it an important recreational river. The report notes that trout tend to grow slowly in the water-body. An Annual Environmental Report (AER) of the UWWTP effluent shows that the plant has been discharging an average of 2.633 mg ammonia L^{-1} per annum. In addition to the chronic loss of ammonia from the UWWTP, AERs from certain piggeries suggest that acute losses of ammonia also occur sporadically. The United States EPA advises that chronic NH_3 levels at 1.9 mg L^{-1} or acute levels at 17 mg L^{-1} can be toxic to fish. These findings indicate that NH_3 is a hazard in the study region which might account for the slow brown trout growth rates observed by The Central and Regional Fisheries Board. Other hazards are currently being identified.

Figure 3: – A photograph displaying a sampling site at a bridge located in the study region. Steps provide access to the river from the bridge above. Source: Graham McAuliffe.

Expected outcomes

This research will complement work carried out by the EPA and Teagasc under the WFD. While extensive water monitoring has been carried out nationwide, gaps in knowledge exist. By examining the contribution of the pig sector to water pollution in a small area, and predicting risks of future possibilities, this project will advance knowledge of Ireland's freshwater quality and its potential of achieving WFD goals. A model for risk assessment of agricultural inputs to water systems is being developed using a range of methods across numerous disciplines. Future research will be able to utilise this approach to determine the risks individual agricultural activities pose to surface water quality both nationally and internationally.

I would like to acknowledge the Department of Geography, UCC, for funding this project. I would also like to thank my supervisors, Drs Colin Sage and Deborah Chapman, for their regular feedback and advice.

Doughnuts and the Fourth Dimension

Alan McCarthy

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Introduction

Those of you with a sweet tooth are no doubt already familiar with the delicious doughnut, but did you know there is much more to that simple pastry than meets the eye? Here's an experiment: take a sheet of A4 paper and roll it up, now try to join the two open ends without bending or making any corners on the paper, go on I'll wait. . . . .impossible right? Well that's because we are stuck with only three dimensions, add in one more dimension though and you can! What's more is that if we lived on the surface of that doughnut, the world would look a lot like the surface of the Earth does to us now-flat as far as the eye can see (but a lot sweeter if you choose to eat the soil). My research is on understanding all these 'flat' doughnuts (called tori in mathematics) and how to make new doughnuts from old ones by 'melting' them into new forms (because you can never have enough doughnuts!). Just to give you a taste of the full thing (!), it turns out that doughnuts really are all about the shape of the icing you use.

So today I'm going to give you three recipes to make some 0-calorie, four-dimensional doughnuts and for those culinary theorists out there, I'll also give a little insight to the magic behind these recipes.

Half-Ring doughnuts.

Ingredients:

1. Icing (of your favourite flavour)
2. Icing tube
3. Rolling Pin
4. A bowl
5. 4-dimensional dough (available at all good mathematical bakeries)
6. An oven
7. Optional: A physicist, ability to move between three and four dimensions, patience

Step 1:Taking your bowl and icing tube, in a continuous fashion, draw a pattern of icing all the way around the bowl, coming back to where you started.

Step 2:Take your four-dimensional dough and flatten it using your rolling pin. Then roll it up into a sausage like shape.

Step 3:Place the sausage-dough along the bowl so that it matches up with the icing design from step 1.

Step 4:Bake until your pastry is golden brown and exists in a higher dimension. (At this stage you can ask for the help of an adult physicist to make sure you haven't broken any rules of the universe, after all no one wants to infamous for accidentally making a naked singularity! The shame would be unbearable).

Congratulations you've just cooked a (flat) four dimensional doughnut!

The Theory

Like any good chef I haven't revealed all of my secrets in the recipe, but you look like a trustworthy sort of person and seeing as it's just the two of us let me explain exactly what is going on here. Some good questions to ask here are "What exactly is going on here?", "What is 4-dimensional dough?" and "How does the baking actually work?" allow me to explain.

What is 4-dimensional dough? /How does the baking work?

The idea behind the baking is essentially the following: imagine that you have drawn out your design using the icing, then to each part of the icing I attach a circle, if for example the shape I drew were a circle then what I end up with is a normal everyday ring doughnut. However, I'm not making just any old doughnut, mine is in four dimensions (so that my doughnuts can be flat and I can eventually retire to live on them without falling off the surface!) and so what I want to do is adapt this idea from three dimensions to four. The way to do this is to simply go from attaching 3-dimensional circles to the icing, to attaching 4-dimensional circles instead. What's a 4-dimensional circle I hear you ask! Well imagine I had a hula hoop, which will do as a stand in for our 3-dimesional circle. Then I can describe it by telling you how wide it is and how high off the ground I am holding it, a 4-dimensional circle is almost exactly the same except it has another measurement in addition to width and height. So really the 4-dimensional dough and baking is just the attaching of these circles to the icing which is why I call them half-ring doughnuts (mathematically they are called Hopf tori after the mathematician Heinz Hopf who discovered this method of attaching circles in 4-dimensions).

Flat doughnuts

Ingredients:Same as the ingredients for half-ring doughnuts.

Step 1:Make two half-ring doughnuts using the previous recipe.

Step 2: From each of the half-ring doughnuts cut out the dough with icing on it.

Step 3:Using some icing join the two pieces of dough together at a single point.

Step 4:Bake.

Congratulations, you now have a (no-ring) flat doughnut!

The Theory

Here we start with two half-ring doughnuts and extract the bits with icing, the design of the icing may have changed slightly with the move of it from 3-dimensions to 4-dimensions. It will turn out that the doughnut that we end up with will again be flat, but of course since I'm not attaching any circles anywhere unlike in the first recipe, the doughnut I end up with will be totally different to any I've made before. In fact all flat doughnuts are made in this way with them being flat coming about as a result of the two half-ring doughnuts being flat.

My Research: Finite Type Flat doughnuts, doughnuts for the lazy.

The previous recipe is a bit hard, it requires us to be able to work in 4-dimensions and the icing patterns can be very, very complicated, so for those of you dimensionally-challenged, I present my own special recipe for making a special type of doughnuts which also double as a recipe for people like me who are lazy and can't be bothered with intricate designs (and for those who forget to set the oven timer when baking!)

To eliminate the really complicated designs and to not have to worry about how long we bake, let's only use icing designs that

1. Don't drip off the bowl when heated.
2. Eventually stop melting when heated.

If we only use these designs, then what we get are icing patterns that always stay on the bowl no matter how long we forget them in the oven and who, if we leave them baking for long enough will not keep changing.

If we only use these designs and bake in the usual way then what we get is some flat doughnuts that stay flat doughnuts no matter how long we bake them. In fact over baking them allows us to melt the icing and make different types of flat doughnuts just by over baking and not by having to make different icing designs from the start. Hooray for being lazy!

The Theory

So why did I include the rather ominous looking title 'finite type' in the heading, what does this term mean? Well, imagine I have a piece of string placed in a circle around a globe. Then using my thumb I can add a little bump to this shape so that it is no longer a circle and I can do this several times. This is essentially what happens when I 'melt' the icing, so what I would like from this recipe is to only use designs that stay on the bowl (I need this to be able to use my previous two recipes) and more importantly eventually stop melting so that I know when the baking is finally complete. Mathematically these sort of designs are known as finite type (i.e. they only melt a finite number of times before stopping) and what makes this recipe so special is that given any flat doughnut from recipe one or two, I can produce a finite type flat doughnut that is very, very (in fact as many verys as you want) close to the shape of the doughnut you have given me without having to resort to complicated designs or existing in four dimensions. In fact the motivation behind my research is precisely this, while we know a lot about the half-ring doughnuts and know that flat doughnuts that do not involve the use of a circle exist, they are not very well studied. My research allows us to start with something we know (the half-ring doughnut) and melt it into a flat doughnut about which we know very little and by studying what the melting does we can then say something about the flat doughnut that we end up with. In particular these objects are important as physicists are almost certain (within 0.4% of being absolutely certain) that the universe is flat and so in studying these flat tori we can attempt to understand a potential model for the shape of the universe.

I would like to thank my supervisor Dr. Martin Kilian for all his help, in particular for his help in preparing this article and to Nicholas Schmitt at Universität Tübingen for his kind permission to reproduce the included pictures.

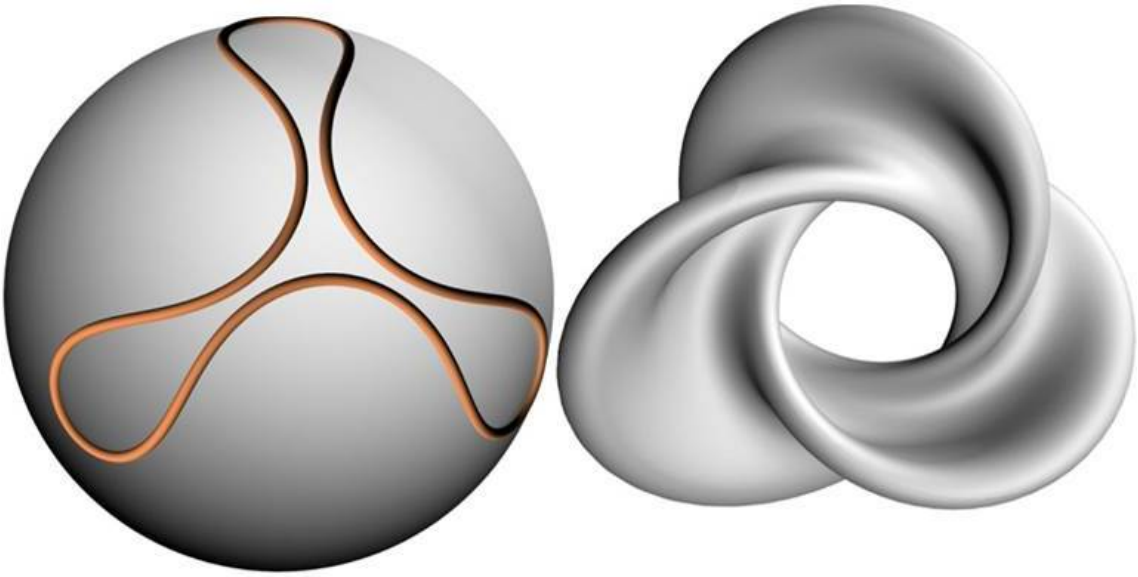

Figure 1: Some icing and its corresponding doughnut (3-dimensional version). Image used with kind permission from Nicholas Schmitt (Universität Tübingen).

Microcompartments: Mini but Mighty

Karen McCarthy

Department of Microbiology & Alimentary Pharmabiotic Centre, UCC

Imagine for a moment, that instead of bacteria being your enemy, they can become your weapon against disease? That by manipulating their good traits, we can use them to work for us? It is true that often we see bacteria in a negative light, as sources of infection and disease, but beneath this bad reputation is a real potential for solutions to many of our human problems.

Bacteria — A Brief History of Time

Bacteria are the most diverse and abundant life forms in the world, with over 70,000 known species. They survive and thrive in every environment and location — be it in icy glaciers, fiery volcanoes or even within the acidic stomach. While we have all heard of them, how much about their function and structure do we understand, even now?

Well, their cells are structured in a relatively simple fashion — they break down nutrients, chemicals or light to provide them with energy, and they then must remove or excrete the waste produced; essentially much the same as us humans, albeit in a simpler system. It is due to this principle of a simple system, that bacteria have evolved or developed many different adaptations to help them survive better in particular environments. Already, humans have observed some of these bacterial adaptations, and have seen the benefits and applications — such as using the ability of Lactic acid bacteria to produce acid in milk, leading to cheese and yogurt production, as illustrated in figure 1.

Often, we now see that many environmental or health issues we humans deal with, can benefit from bacterial intervention. Using antibiotics and bacteria-produced vaccines has helped defeat many illnesses, and perhaps this role can be expanded even further by exploring the bacterial world. Using or modifying bacteria for benefits has long been a staple of research, and can perhaps be misinterpreted by the public due to the controversy surrounding the phrase “gentically modified”. However, for research purposes, this is a saft and long established practise, allowing us to utilise bacteria for increased benefit. This method was first truly used to allow insulin, for diabetics, to be produced on mass, using genetically modified *E.coli* cells.

Figure 1: The benefits of bacteria in our lives. Image: Karen McCarthy.

The Miniature Factory

Approximately 20% of known bacteria contain a small, distinct structure within their cells, called a bacterial microcompartment. These microcompartments, or MCPs, consist of a hollow shell, which is made completely of protein. Their hollow interiors provide a space for various chemical reactions to occur, protected from other parts of the cell.

This ability to produce an MCP appears to play a role in the survival and capabilities of the bacterial cell — after all, bacteria are a relatively simple system, so why would they invest several percent of their genes in making these MCPs unless they offered a benefit for them? Waste not, want not is a key motto of the bacterial world.

For example, imagine that these MCPs are like little factories, inside the bacterial cell. They offer an enclosed space where reactions or processing can take place. Like a factory, they take in a particular material, and produce a product of benefit. This must be an efficient and speedy process, which must not unduly waste the effort and energy of the cell and so is only turned on when the raw materials are available to make the product. To avoid disruption to other essential chemical reactions going on at the same time, the factory walls keep the work process separate from the rest of the cell. Having all the specialized machinery (enzymes) in the same place makes the whole process more efficient.

In this role, the MCPs work to selectively take in chemicals originating from the cell's metabolic processes or from the cell's surroundings, and then allow a process or reaction to occur within the space of the MCP. These reactions can be diverse, perhaps removing

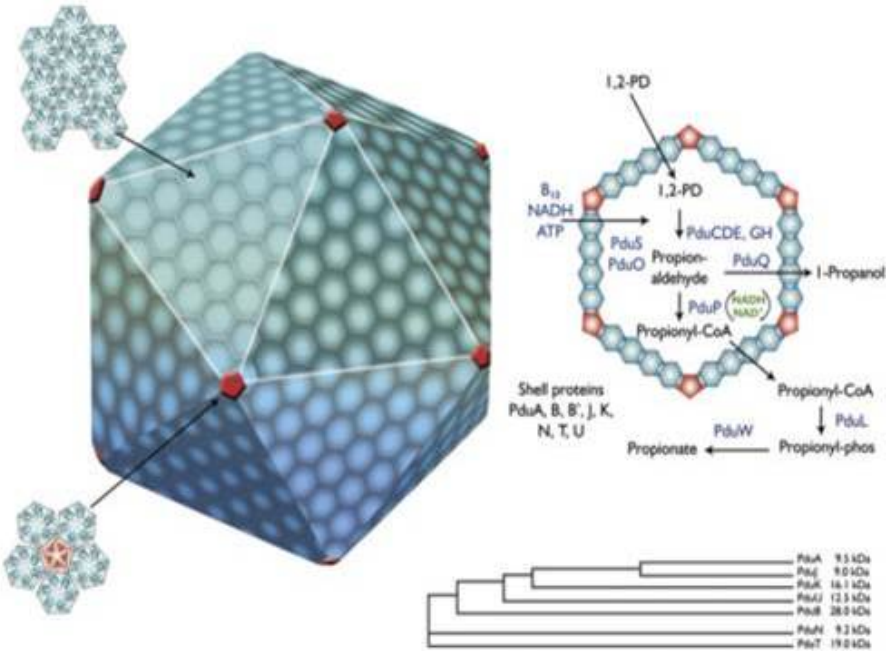

Figure 2: Diagram demonstrating the unique structure of the microcompartment. Image: Dr Josh Parsons, with permission from Molecular Cell, 2010.

metabolic waste from the cell, or breaking down a chemical to allow it to be used by the bacteria.

Differences & Associations

There are an increasing number of different types of MCP now recognised, in many different species of bacteria. The Pdu MCP, which is the focus of my research, is activated by the presence of the chemical 1,2-propanediol (1,2-PD) in the environment around the bacterium. The bacterium can then take this 1,2-PD, and start chemical reactions in the Pdu MCP, resulting in the production of a new chemical, propionaldehyde, which it can process into two more chemicals which the bacterium can use for energy and food. The Pdu microcompartment can also transform a slightly different chemical, glycerol, to an antibacterial chemical, 3-hydroxypropionaldehyde, also known as reuterin, and even further transform reuterin to 1,3 propanediol which is used as a building block in the production

Figure 3: Cartoon illustrating the idea of the MCP functioning as a factory. Image: Karen McCarthy.

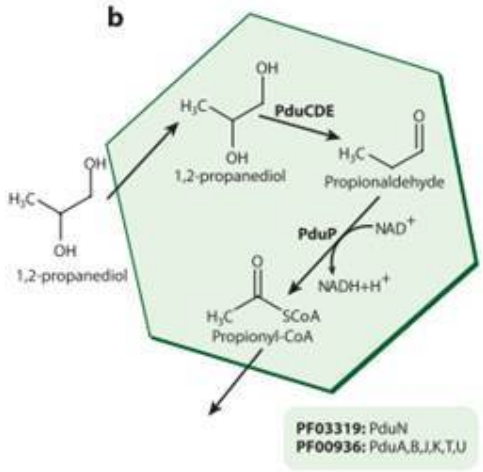

Figure 4: Cartoon illustrating the chemical reactions occuring within the microcompartment. Image: Cheryl Kerfeld, 2010.

of polymers (large molecules).

The Eut MCP is another common type of MCP, which takes up the chemical ethanolamine. This Eut MCP is associated with nasty or pathogenic strains of *E.coli*, and *Salmonella* bacteria which cause serious food poisoning. In the right conditions in the intestine, the Eut MCP helps these bacteria to grow much faster than their competitors and cause disease.

But how can this process, or these MCPs play a role in our lives? Well, using molecular technology and by genetically altering, or modifying the bacteria, we can manipulate and change different MCPs. In the cases of good bacteria, we can use the MCPs to process specific chemicals, leading to the production of useful products. Or, in the cases of bad or pathogenic bacteria, we can try to use metabolic processes in the MCP to damage or destroy the bacterium which contains the MCP, which may prevent the bad bacteria from causing infection.

Study Aims

As part of my research, I focus on bacterial MCPs, particularly in the probiotic species *Lactobacillus reuteri*. My research is based around the idea or hypothesis of using the metabolic activity of bacterial MCPs for disease therapy options. In particular, I am using the case study of hyperphosphatemia, a medical condition where excess phosphate builds up in the bloodstream in patients with kidney failure due to excessive phosphate absorption from the gut. This can cause many health problems, with the only current resolution involving expensive pharmaceutical medication.

If we could use safe MCP-containing bacteria to take in the excess phosphate from the gut, and remove it even temporarily by a reaction in the MCP, could we possibly use this as a

therapy? This concept has been coined by our laboratory as the Microcompartment Enhanced Biological Phosphorus Removal (MEBPR) – the expression of a phosphate storing enzyme (*ppk*) within a MCP inside bacteria.

Answering this question is my primary research focus, and requires using several different methods. *Lactobacillus reuteri* has many desirable traits as a bacterial model, which is why I use it for my research. It has a naturally occurring *pdu* MCP, which I previously mentioned, and which is triggered by the presence of the chemical 1,2-propanediol. Also, a key aspect of using this strain is its status as a GRAS (generally regarded as safe) probiotic bacteria, which means it is very safe for metabolic rewiring.

Lactobacillus reuteri also has a natural phosphate storing enzyme. My objectives include the possibility of using this enzyme to store excess phosphate from the environment, using the MCP as a focal point for these reactions to occur.

At this current stage, many of the enzyme-MCP constructs have been created, and will soon be tested in the laboratory. Within the bacteria, increased phosphate storage can already be seen, but we don't yet know if this will be enough to make the bacteria effective phosphate removal machines.

Conclusion

If this experiment is successful in its objectives, the ability to use MCPs in probiotic bacteria would open up many possibilities for therapeutic use. Whilst there are still many obstacles regarding this step, it could become a hugely beneficial and successful tool for treating certain illnesses and ailments.

Microorganisms, and bacteria in particular, hold the secrets to many things due to their ancient age on this planet. Already we exploit and use them to enhance our lives, through food fermentation, the product of alcohol and even the production of antibiotics — could it be possible to add the exploitation of bacterial microcompartments to this list?

Research, exploration and creative thinking may reveal more.

Karen McCarthy is a Ph.D. student in the Department of Microbiology and Alimentary Pharmabiotic Centre, under the supervision and support of Prof. Mike Prentice. She is funded by the Health Research Board (HRB).

Maidens, Magic, and Manipulation: The Female Presence in Sir Thomas Malory's *Morte Darthur*

Karen Moloney

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Introduction

The legends of King Arthur and the Knights of the Round Table are preeminent in medieval lore, as literary history celebrates these valiant knights on their illustrious quests; these crusades, however, were very often affected, or even entirely motived, by love, lust, or a damsel in distress. What of those women whom these knights loved and lost, or feared and fought? A distinctly male presence remains the primary focus of medieval literature; my work aims to explore how the dynamic of these medieval texts is influenced and motivated by the consequences of female endeavours, in terms of an autonomous feminine presence in the narrative world, and the authority with which this is presented. My focus lies primarily with an exploration of this female form in Sir Thomas Malory's *Morte Darthur*, a fifteenth-century text which presents the Arthurian world governed by the king and his renowned company of knights, based on the author's reworking of both French and English source materials, plus additional material original to Malory himself. My studies take the concept of King Arthur and his Round Table Knights as being the definitive symbol of the essence of chivalric society and all it represents in terms of nobility, virtue and courage–indeed, as being a vehicle for the portrayal of the ultimate paragon of masculinity–and call it into question, as it is the actions of these men, and the consequences of their behaviours, which indicate the beginning of the unravelling of this society, and its eventual destruction as it essentially implodes under the weight of its own responsibility. My work examines the role of the female within this narrative dynamic, with specific regard to the accountability of women in the eventual failure of masculinity, and following from that, of society, in the text.

The World of the Author and the World of the Text

Who, then, were the women who populated the reality of the author's world? My research begins with an examination of the social positioning of the female in the fifteenth century, in order to be able to make an effective comparison with the portrayal of women

in medieval literature. The analysis of the feminine presence in both a historical and literary context paves the way for a study of the specific depiction of the female in her various forms in the *Morte Darthur*, in comparison with this contemporary interpretation. As publisher, William Caxton's Prologue to the narrative presents the text to his audience in a very specific fashion, addressing both "lordes and ladyes", clearly denoting the intended recipients of this text to be both male and female. While fifteenth-century England was a patriarchal society ruled by male dictates, research has ascertained the influence of the aristocratic female of the time, in possession of land and independent wealth which awarded a certain economic and social authority. Similarly, the world of the Arthurian court is a predominantly male sphere, where masculinity reigns supreme; there exists, however, as in Malory's own surroundings, a demographic of women in possession of a certain authority which affords them social influence–though it may be exerted in the most subtle and understated of ways. An exploration of the actuality of the circumstances in which Malory wrote offers a platform for a more comprehensive study of the world of the text he created, while a knowledge of the similarities between the two realms presents today's reader with a sense of the social circumstances and psychological placement of the audience into which this text would have been received, and their ability to identify with it as such.

The Feminine Presence in Medieval Literature

Having established the social and economic positioning of women in society at the time, and therefore gained an understanding of the audience through which such material would have been circulated, my research goes on to provide an analysis of the manner in which the portrayal of women in fifteenth-century literature draws from the social reality of the time, with a detailed exploration of texts such as *Floris and Blauncheflur*, *Havelok the Dane*, *Bevis of Hampton*, and *Guy of Warwick*. These texts precede Malory, dating from the thirteenth and fourteenth centuries, demonstrating the literary positioning of the female in medieval romance while establishing the expectations of Malory's audience based on these well-recognised tales. These narratives are constructed based on both Anglo-Norman and French legends, and can be found in various manuscripts penned by different scribes. As such, particular authors are not established; the tales presumably originate from a male hand, in keeping with the literary tradition of the time. The objectification of the female in these texts emphasises and exaggerates the subordinate female; for example, Blauncheflur of *Floris and Blauncheflur* is repeatedly treated as a commodity throughout the progression of the narrative, traded and sold at the discretion of male authority. While her value is celebrated, it is a worth based on her commodification as opposed to being a recognition of her autonomous person. Similarly, the Middle English *Havelok* sees the rewarding of women through arranged marriages. These marriages are seen as a prize which will elevate the social standing of those ladies, in spite of the fact

that they take all autonomous decision or self-governance from the women. Fundamentally, women's presence and behaviours are recognised, and rewarded, but in a very much defined manner which calls for their objectification in order for them to be recognised at all.

The fact that women have worth is not questioned, but the way in which this worth is measured is skewed toward the all-encompassing judgement of the male; virginity, for example, is seen as being a worthy prize and a valuable commodity for a woman to hold, making her all the more precious in the male market. While these compliments may seem to be somewhat back-handed in essence, in terms of their usefulness to society at large and men in particular, women are applauded for certain virtues seen to be definitively feminine, such as talents in the arts, healing capabilities, emotional strength and a nurturing nature. The scope for discussion here is vast, as different feminine qualities are highlighted while women fulfil their various roles; the feminine is very much present in these texts, and is often celebrated as such, but the fact remains that the female capacity for success in medieval narrative is almost always defined in terms of the male. Indeed, the presence of a female, taking an active role in a male/female dynamic, is usually an example of a woman's actions being utilised as a narrative tool in order to propel the narrative and position the dominant male in relation to the subsidiary woman.

Female Authority in *Le Morte Darthur*

How is Malory's Arthurian world influenced by these women, who exist within the delineations of social expectation? The female may not seem to be a prominent presence in the world of medieval literature, following from the patriarchal strictures laid in place by the reality of fifteenth-century English society. As evidenced, however, while their influence may be subtle, it is absolutely present, and actively so, as becomes extremely clear in a study of Malory's Arthurian kingdom. Here, the feminine maintains a constant presence in the world of the text, although it is not necessarily always a positive one. My research examines the role of women in Malory's text as being perhaps the most dangerous threat to the survival of the chivalric knight, through the elements of disguise, trickery, and sexual manipulation. The theory underlying the beliefs of the true chivalric knight, as outlined in the Pentecostal Oath to which all Knights of the Round Table swear their allegiance, assumes a fundamental respect towards the female, while ensuring the male retains authority in her protection. A closer exploration of the boundaries of the male/female dynamic in *Le Morte Darthur*, however, indicates the possibility of the balance of power being tilted in favour of the supposedly fragile woman. The very concept of chivalry is rooted in the protection of the vulnerable female, yet the manipulative woman may harness this perception of her sexuality in order to twist it to her advantage, and manipulate these knights who are ruled by their moral integrity.

As such, the idea of emotional control is a powerful one, based on the paradox that the vulnerability of the female places women in a position where they are subject to men, yet because of this perceived fragility, they retain a great deal of power and influence in chivalric society, where knights are bound to protect. This is used to the detriment of various knights throughout the work, including Lancelot, who is driven to sheer madness as a result of feminine manipulation. Even Merlin, who is in possession of a supernatural knowledge, succumbs to the temptations of lust to the extent that his obsession leads him to be thwarted by the woman who is the recipient of his unwelcome attentions. While the chivalric world demands the utmost respect for the protection of the female, in doing so it allows a woman with dubious aspirations an arena in which to exploit and beguile, to suit her own ends.

In keeping with the Pentecostal Oath, respect for bodily integrity is of paramount importance to the concept of chivalry. Knights are sworn to protect and preserve the physical purity of the vulnerable female, yet this preservation remains equally important in terms of masculine chivalric integrity. Lines between enforced sexual aggression and persistent seduction can often be blurred, as can the element of consensual relations, which reflects realistically on the laws of Malory's own social reality. Sexual possession in the text, however, is a treacherous area in terms of both the masculine and the feminine; for example, while Elaine of Astolat dies for her unrequited love of Lancelot, Lancelot himself suffers at the hands of Elaine of Corbin, who employs both worldly deceits and otherworldly enchantments in order to seduce him, leading to his consequent madness.

Sexual integrity and physical possession of a lover are therefore extremely powerful tools, particularly when viewed in terms of the empowering element of virginal purity. Virginity as a valuable commodity is presented time and time again in medieval literature, and more powerfully than ever in Malory's *Morte Darthur*, where, for example, Perceval's sister's virginal state allows her to sacrifice her blood, the purity of which saves the life of a terminally diseased lady. Here, the precious nature of virginity is manifest, but this is not a uniquely feminine attribute in Malory's text; in relation to the male, succumbing to the temptations of fleshly gratification will irreparably tarnish a knight's virtue, leaving him unequipped to achieve that ultimate goal of the Holy Grail. Lust and sexual temptation arise repeatedly as obstacles facing the chivalric Knights of the Round Table, determining the fact that rape and sexual aggression therefore hold significant consequences for both parties, male and female, with feminine sexuality proving just as much of a threat to male integrity, as the threat of rape is to the physically vulnerable woman.

Malory's conscious awareness of this paradox of female fragility is debatable, bearing in mind that he made certain changes from his source material which encouraged the notion of feminine virtue, such as his reluctance to acknowledge a physical relationship between Lancelot and Guinevere. These source alterations tend to emphasise the concept of the vulnerability of the female on the whole, which in turn highlights the paradox of the

power afforded by this perceived fragility. This is not to say that Malory's *Morte Darthur* exclusively presents the female as a destructive force; the text does present women of admirable stature demonstrating the best of feminine virtue. In terms of influence in the narrative, however, the dynamic which exists because of the male perception of femininity is most effectively examined in terms of the exploitation of this masculine consciousness.

Conclusion

In essence, my research aims to comprehensively explore the concept of Malory's treatment of the female in comparison with his literary contemporaries and the actuality of the woman in society of the time. This encapsulates the fact that although the majority of the active primary roles in Malory's text are tilted towards the male characters, the dynamic of the narrative is hugely influenced and motivated by the consequences of female endeavours in an intricate subtext. My work incorporates the presentation of the female in this patriarchal domain as being vulnerable and in need of protection as she simultaneously manipulates this perceived fragility to challenge masculine control, with the intent of presenting an innovative interpretation of feminine authority in an exploration of the physical, intellectual and emotional placement of women in Arthurian literature.

With gratitude to my supervisors, Dr. Andrew King and Dr. Kenneth Rooney.

The experience of 'home' in dementia care

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'I am somewhere I am not supposed to be'

You awaken in the early hours of the morning with a feeling of disorientation and strangeness. Shifting in your covers, you realise that the room that surrounds you is not your bedroom at home, but rather a communal dormitory with other sleeping bodies in beds mere feet from you. You are confused and frightened; moving to step a foot out of bed, an ear-piercing alarm suddenly shrieks through your head. The bodies around you stir awake, and turn towards you with irritation, telling you to 'stop it', to 'shut it off'. Another body opens the door of the room and bundles you back into bed. The alarm stops. After a while, confused, afraid, and inexplicably drowsy, you fall asleep again.

Wandering the hallways of this building later that day, you struggle to remember how you got here. Who are these other people? No-one will answer your questions. You touch your wrist where it hurts from earlier — a strange woman tried to remove your clothes and wrestle you into a bath so you struck out at her and demanded your privacy. Despite this intrusion, you surmise that you must be in a holiday home, and even talk to the others about how your family will be around shortly, only to hear them turn to one another and mutter 'delusions'. Saddened and confused, you sit down in a chair, and though others come to try to chat, you can't bring yourself to engage with anyone. You long for your own home — the pictures which hang on your wall, your green garden, the familiar scent of your own blankets, and the memories you've created there with your friends and family. Here, it is all unfamiliar.

When familiarity is lost

As unreal as the above scenario may seem, it is one which is faced every day by many persons with dementia living in long-term care. Persons with dementia find themselves undergoing several transitions — not only does short-term memory decline in dementia, but general cognitive abilities, personality features and close relationships also change. As the disease progresses, families can no longer deal with the person with dementia living at home any longer, and many find themselves entering long-term care. This can be very difficult for both the person with dementia and their family, and can result in feelings of betrayal, loneliness and disorientation. Persons with dementia also often engage in what is called 'problematic behaviour', reacting to this upheaval in a number of ways:

- By constantly searching for exits, asking to leave, or trying to escape;
- By wandering around the residential home, seemingly aimless;
- By lashing out at caregivers, becoming physically aggressive;
- By refusing medication or food;
- By withdrawing from social interaction.

Much of this behaviour can be traced from the fact that these persons are displaced. They are no longer living at home, no longer living with their family. Instead, they are surrounded by strangers, often perceived as acting unusually, and carers, who carry out care activities with them that they may find intrusive and undignified. Moreover, these persons are living in a communal environment that, as illustrated by figure 1, is (by its very design) impersonal: carpeted floors are replaced by linoleum; thick, family-sewn quilts replaced by standard issue blankets; bathrooms accessorised by grab rails and hospital disinfectant. The impersonal nature and unfamiliarity of the environment leads to confusion and distress on the part of the person with dementia as they try to make sense of their environment and re-enact what they consider as 'home' in this unfamiliar setting.

Displacement in home and identity

This research seeks to understand how persons with dementia create a sense of 'home' in long-term care settings, and by investigating how they remember their own homes in order to understand their aspirations of 'home'. Through this, I will be able to make recommendations concerning how we might be able to foster 'homeliness' in dementia care settings. By doing so, we can alleviate some of the difficulties faced by both carers and persons with dementia, and aid the quality of life and sense of independence of persons with dementia.

Figure 1: Interior of one of the dementia care settings featured in this research. Image: Kellie Morrissey.

Drawing from the work of Bachelard, who emphasised the sensory properties of 'home' in his 1958 book 'The Poetics of Space', this research places emphasis on the metaphor of the house as the 'home of memories.' Our memories, Bachelard writes, are sensory and deeply personal, and thus our memories of 'home' are constructed through our lived experience. Despite this degree of personalisation, 'home', to Bachelard, does not have to be a static place, as throughout our lives we move time and again, making each new dwelling place our 'home.' However, once we enter a nursing home, several things may stand in the way of our considering the place a home:

- The presence of unfamiliar others;
- The sense of being 'watched' at all times;
- The unfamiliarity and 'clinical' feel of the setting;
- The relative absence of choice and loss of autonomy.

It is true — we become attached to places throughout our lives; often so much so that these places and spaces become part of our identities. This so-called 'place identity' can be threatened by disruption to our living environment: think about how persons displaced by natural disasters are quickly labelled as 'victims', and how persons with dementia become 'patients' or 'residents'. Environmental psychologist Proshansky theorised that it is through our physical localisation that we learn many of our social roles — our roles in the home (daughter, mother), in the school (peer-group membership) and in the neighbourhood (ethnic group membership). Once persons are displaced and live in a dementia care setting, once their memories degrade and they are left with little stimulation, a lack of familiarity and a lack of remembrance of 'home' leads to a loss of a sense of self and purpose.

Creating privacy during transition

Persons whose dementia is mild to moderate often suffer the most when they enter a long-term care setting — many remember their home and family and are distressed that they are now away from both. Others are not so sure of the details of their situation, but have the sense that they are now living somewhere that they are 'not supposed to be'. The transitions of these persons tend to be long and problematic, and as a result they may turn to wandering or aggressive behaviour in order to maintain their sense of self and make sense of their environment.

In order to adjust to communal living and to deal with the unfamiliarity of the environment, persons with dementia use what have been called 'resistance strategies' order to create a sense of privacy away from the 'gaze' of carers. These include:

- Chatting with others and selecting friends' groups within the care home;

- Selecting certain seating arrangements to facilitate 'hiding' from staff;
- Feigning sleep when not interested in a certain task or activity.

While much previous research on the topic of 'home' and dementia has focused on these 'resistance strategies', my research looks at the creative ways in which persons with dementia adapt the social and physical environment of long-term care in order to create a sense of 'home', resulting in increased familiarity and comfort within the environment. It also explores the ways in which people with dementia might like to experience 'home', and to understand what 'home' means to them.

Methodology

My research is currently underway in two dementia care settings in the south of Ireland, which provide comparisons for each other — one a community hospital and the other a private dementia care home. My research uses ethnographic methodology — a type of research methodology which aims to give an 'inside view' of the culture and ways of living of groups of people – in order to understand the lived experience of residing in dementia care and how residents create a sense of 'home'. This is investigated via participant observation over the course of 18 months, and consists of a systematic process of taking field notes based around continuous involvement in the life and activities of the dementia care setting.

As well as observing and joining in in the life of the dementia care setting, unstructured, informal interviews and 'in-situ' conversation during creative activities allows me to bring the focus in tight to explore how persons with dementia would ideally like to experience a sense of 'home'.

Methodologically, this research also considers how persons with dementia might be fully involved in qualitative research as participants. To date, few studies have attempted to investigate the lived experience of persons with dementia in research, and instead have focused on caregiver accounts. This research investigates the experience of persons with dementia through creative methods (e.g., art and music workshops — some output from art workshops is seen in figure 2, above) which have been shown to aid persons with dementia to express emotions and help to retain cognitive ability.

Findings

This research is currently ongoing; however, preliminary findings from this research are that persons with dementia create 'home' in dementia care in different ways:

- Through selecting seating arrangements in order to sit with friends;

Figure 2: Painting by participants during creative sessions. Image: Kellie Morrissey.

- Through inventing different scenarios explaining their situation — being served meals means that they are at a hotel, or in a café;
- Through domestic tasks — dusting windowsills and tidying up magazines;
- Through engaging in activities such as singing, dancing, watching favourite films and reminiscing;
- Through socialisation during time shared with others — sitting down to eat meals together;
- Through caring for each other — for example, reading the newspaper to another whose eyesight is poor;
- Through personalised objects and personalised environment — photos on the wall and family-made 'life storybooks';
- Through self-care and keeping up appearances — painting nails and curling hair.

Barriers to 'homeliness' have also been identified:

- Confusion over the identity of others in the care setting — staff and other residents;
- Being given medication and treated as a patient;
- The unfamiliar or clinical environment which lacks personalisation and causes confusion (due to layout issues or lack of signage);
- The behaviour of others — for example, the distress of one resident may cause another to become distressed;

- Locked doors, alarms and sensors which prohibit free movement through the care setting;
- 'Days out' — although therapeutic for most residents, the way in which they are handled can be problematic for others;
- Not being trusted or left alone with ceramic mugs or cutlery;
- Unmonitored television access can lead to distressing or generally unsuited/uninteresting material being seen;
- Having to conform to a certain schedule of eating, sleeping and socialising;
- Carer intervention in self-care and hygiene activities.

Implications and interventions

The findings of this research have much to say on how daily life in a dementia care setting is experienced, with a particular focus on how persons with dementia experience and create instances of 'homeliness'. Further research will delineate the circumstances in which this sense of 'home' is experienced; through this understanding, we will be able to ameliorate the experience of dementia care settings in order to foster a sense of 'home'. This may be applied in carer/nurse training, in layout and activity planning for persons with dementia and in technological design. Applications of this research will lead to increased comfort, familiarity and independence, and a decrease in problematic behaviours and distress for persons with dementia.

With an ever-aging population and €1.69 billion spent on dementia care in Ireland each year, it is imperative that every area is investigated in order to alleviate not only the financial and societal burdens that the disease entails, but also to understand how the empowerment and high quality of life of persons with dementia can aid in promoting creativity, participation and independence. Through understanding and fostering 'homeliness' and familiarity in the care context, this research will do just that.

Thanks to my supervisor, Professor John McCarthy, and to the carers, nurses and participants whose involvement in this research has made it possible.

Triggers to action on child developmental concerns

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> Apprehension, uncertainty, waiting, expectation, fear of surprise, do a patient more harm than any exertion. (Florence Nightingale)

Parental concern about child development

If you want to know if a pre-school child is developing normally just ask their parents whether they are concerned. . . right? Yes, this approach is regularly used by health care professionals who work with parents to assess normal growth and development as part of preventative child health services. However, this approach is not always successful and parents may be reluctant to express their concerns to a doctor or nurse. So, do we know what triggers parents to go and seek help about a growth or development concern? Well no, because most of the studies already conducted have been about trying to measure parents concern about child growth and development.

Assessing normal child development is challenging not least because children grow rapidly and often in spurts. Developmental delays are relatively common but not all of them indicate developmental disabilities. However, it is important for any delays in growth or development to be assessed so that any deviations from normal development are identified promptly and treated if appropriate. Referral to early intervention services is most effective if it happens early and ideally before a child goes to school. The consequences of late identification of developmental delay are as follows:

- ☐ Unfavourable effect on child health and behaviour
- ☐ Adverse impact on future academic and social functioning
- ☐ Parental distress
- ☐ Impaired family functioning
- ☐ Economic costs for society

These consequences highlight the need to understand how parents' concerns about child development problems can be identified and expressed as effectively and efficiently as possible.

Study design

In this study I wanted to understand how parents made sense of their concerns about their child's growth and development problems by exploring their experiences. Using a methodology called Interpretative Phenomenological Analysis, developed primarily by Jonathan Smith, helped me to design a study where I tried to make sense of parents' experiences. This entailed moving beyond describing the experiences and endeavouring instead to interpret them. I interviewed parents of 15 children who had various child growth and development concerns. The purpose was to listen to them describe their experiences of trying to make sense of a concern that there might be something wrong with their child, through to seeking help from a Health Care Professional. One theme discovered between parents feeling "uncertainty — a little bit not sure" and going to "Get the problem checked out" was called "Triggers to action".

Triggers to action

Parents rarely described just one trigger that prompted them to take action in addressing their child's concern formally with a doctor or public health nurse. More often than not there was a combination of themes: 'Usual disposition — to panic or not to panic'; 'Affirmation from Family'; 'Seeing the Child's Vulnerability' and 'Time Passing' (see Figure 1 below).

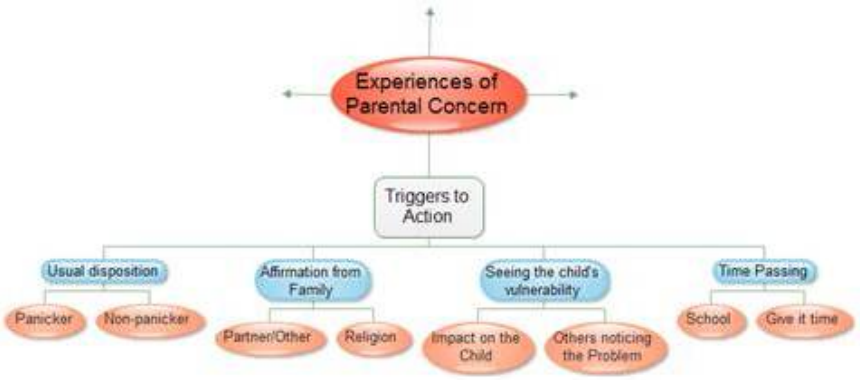

Figure 1: Triggers to action themes and subthemes. Image: Helen Mulcahy.

The themes identified within "triggers to action" will be further explained in the following sections.

Usual disposition — to panic or not to panic

"Usual disposition" was identified as a trigger for action for parents. This finding described parents who were panicking and not panicking as motivations or *triggers for action* to go

and seek help; a finding not found previously in studies on parental concern. Parents described in detail their usual disposition with reference to how they reacted generally when dealing with child health-related concerns. Their accounts were particularly insightful in understanding how quickly they acted on concerns. There were parents that had concerns yet did not act quickly on them. Some of these parents described themselves as the non-panickers and depicted themselves as quite laid back. They were happy to 'let nature take its course' within reason, or 'let them grow out of it'. There were other parents who were quite proactive in their actions and just went to 'check it out' with a health care professional when they had a doubt of any kind. Alternatively, some parents adopted both approaches depending on the nature of the concern. One parent's account of going into a complete panic when she thought her daughter had a squint was notably different to her more measured reaction in response to the child's speech and language concerns. This finding suggests that parents' fears can be heightened by the visible nature of an observable problem requiring immediate assessment by an appropriate healthcare professional. Parental anxiety and assertiveness were previously found to prompt help-seeking in child illness scenarios. However my findings in relation to parents' usual disposition have important clinical implications. Healthcare professionals should broaden their assessments in preventative healthcare settings to include identification of those who may be more likely to adopt 'a wait and see' approach. These parents may require more probing of any potential child development concerns.

Affirmation from family

Family and friends were found to be triggers for action to seek help, a finding not previously discovered in children with developmental concerns. Family affirmation in the form of them seeing what the parent could see with the child seemed to give strength to parents to go to a doctor or public health nurse and express their concern. At other times family or friends explicitly said that the parent should go and 'check it out'. Support from family and friends were also valued by parents. This finding supports previous studies where social supports were found to reduce uncertainty and validate parental concern in instances where there were fears about childhood illness. There was also evidence from previous studies of other people being direct with parents relating to children with faltering growth. However, in that context it implied criticism of parents about their parenting ability. In contrast in my study it is possible that other people in the non-panicking parents' circle were simply drawing attention to the problem by just noticing the child's problem or advocating explicitly for a more proactive response to get the child's problem checked out. Perhaps these family and friends were familiar with the non-panicking parents' usual disposition and believed this problem with the child was one that required more immediate action.

Seeing the child's vulnerability

It seems inevitable that the vulnerability of the child would be identified as a trigger for action because parents invariably act in the best interests of dependent small children. Findings indicated that parents were cognisant of the physical and emotional impact of the growth or development problem on the child but it rarely was a sole trigger for action. Although one mother was keen to get her daughter's speech and language problem addressed before she went to school because she was worried about others calling her 'a baby'. Parental worries about trying to protect their children from being teased at school were found previously, albeit in older children with Developmental Coordination Disorder and also in those who were overweight. The findings from the current study point to the need for doctors and public health nurses to explore parents' perceptions of the impact of the child growth or development concern on the child, and their perceptions regarding school readiness. This may shed further light on the nature of the child development problem and trigger expression of concern.

Time passing

Whilst the passing of time influenced parents' actions they did not describe it explicitly as such. Instead parents alluded to time passing when they spoke about how fast their children were growing or developing. It is widely acknowledged that young children grow and develop quickly. Caring for young children is demanding for parents and sometimes parents are forced to confront or assess what is happening developmentally. One mother captured this best when she spoke about being 'aware' of her son's developmental problems but when her older daughter commented about him 'losing his words' she said children sometimes are good to point out the obvious. She said she had been too busy with all the other things going on in their lives to see. It is almost like time passing is variable in speed and parents sometimes may think they have more time to deal with an issue and then a deadline like starting school looms which triggers action.

Conclusion and implications for practice

Triggers to action as a combination of factors were not previously found in studies relating to parental concern about child growth and development. Given the complexity of child growth and development it is unsurprising that triggers to action would be a multifaceted theme influenced by the broad determinants of health. Therefore, this finding is very important in terms of understanding what influences parents to decide to go and get their child's problem checked out. In terms of implications for clinical practice it implies that there is need for doctors and public health nurses to adopt a model of care that incorporates the physical, psychological and social determinants of health. This will ensure the

holistic needs of the family, beyond a mere disease/disability dimension are appropriately assessed. Preventative child health services rely on close collaboration between health care professionals and parents, to ensure any deviations from normal growth and development are promptly identified and addressed. The findings from this study show that assumptions should not be made about the factors that trigger concerned parents to act.

Thanks to my supervisors Professor Eileen Savage, Chair of Nursing and Head of the School of Nursing and Midwifery and Dr. Rhona O'Connell.

Who Cares? Women with Breast Cancer and Their Significant Other

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"No one is useless in this world who lightens the burdens of another." Charles Dickens

Introduction

The news comes. What was feared is now a reality. Devastation. The words "you", "breast" and "cancer" echo throughout the room. What happens now? Who do you turn to? Nearly 3,000 women are diagnosed with breast cancer in Ireland on an annual basis. The above scenario for them is very much a reality. A diagnosis of cancer is devastating. It is not only the disease itself but the treatments, life alteration and in some cases acceptance of defeat that the person endures. With cancer it is rarely one individual who suffers. With breast cancer (one of the most commonly diagnosed cancers in Ireland) an invasion on the woman's identity can occur, bringing great distress. The people who support women with breast cancer throughout the diagnosis and disease play a vital part in the maintenance of the woman's wellbeing. It is human nature to seek out comfort from other people. The main area of support that a woman will receive comes from a familiar person, someone close to the woman who already had a relationship with her, prior to the diagnosis of breast cancer. The relationship between women with breast cancer and their significant other is highly beneficial to their care. The significant other is predominantly the partner or spouse of the woman however, others such as siblings, mother, child or friend have been identified as being significant others for women with breast cancer. This is specifically true in situations where the woman may be unmarried/separated or their partner may be deceased. Regardless of whether it is a spouse or other significant person, this relationship acts as a support structure throughout the cancer journey. It supports the psychological, emotional and physical aspects of the woman's life. This paper is a discussion on the importance of the relationship between women with breast cancer and their significant other. It provides the background for a PhD study that will examine this relationship and its potential implications on the health of the woman with breast cancer and her significant other.

Background

Breast cancer is recognised globally as one of the most common cancers. Described as a chronic disease, breast cancer poses great stress and challenges to the individual and their loved ones. Often breast cancer can result in physical and/or psychological problems that the woman may seek support for. Within the current healthcare system the majority of continued care to women with breast cancer is provided by family and friends. This is due to care being transferred from acute hospitals to outpatient clinics. As a result of this, the process of informal care, care provided by family and friends, is increasing within the breast cancer context. It is estimated that over half of all care is provided by informal carers. On an annual basis it is estimated that informal carers save the health service in Ireland two billion euro.

With increasing pressure on the health service the process of informal caring has become increasingly prevalent. This support includes physical assistance with the management of side effects, emotional support, financial help and spiritual guidance. Women with breast cancer have indicated the importance of having a close individual involved in their care. Significant others who are involved in the care of woman with breast cancer can promote positive outcomes. Supportive relationships have been linked with lower levels of depression, anxiety and stress. Exploring the relationship between women with breast cancer and their significant other may provide reasons as to why these outcomes are positive.

The Benefits of Relationships between Women and Their Significant Other

Relationships and their quality have been seen to significantly impact on women with breast cancer. It has been recognized for several years that social support in breast cancer is an important factor which may affect the general well-being of those diagnosed with cancer. Relationships can affect the woman's adjustment to the breast cancer and the woman's overall health outcomes. Women diagnosed with breast cancer who have supportive, communicative and involved significant others are seen to exhibit better adjustment to the breast cancer. The support and connectedness provided by another assists women in dealing with the breast cancer. The fact that research focusing on the relationship between women with breast cancer and their significant other has not been conducted previously provides an interesting and enlightening focus for my PhD.

A breast cancer diagnosis not only affects the woman diagnosed but also has huge implications for those involved in their life. The diagnosis can alter the existing relationship that was present. Side effects of the breast cancer treatment including fatigue, lethargy, hair

loss and nausea can all affect the woman's relationship with their significant other. This can be detrimental to the woman's prognosis as women with breast cancer have identified the strong need to maintain close relationships with their significant other. The significant others of women with breast cancer have also stated the importance of the maintenance of the relationship.

The concept of connectedness is strongly linked with the quality of the relationship that the women with breast cancer and their significant other experience. Feeling close to someone throughout the breast cancer journey is essential to the wellbeing of women. It is also important to maintain the relationship and while change is inevitable in breast cancer, the extent of the effect that the breast cancer has on the relationship is a research area that is ripe for investigation. Results of the study could enhance care for women with breast cancer and their loved ones.

Methodology

The lack of available studies specifically focusing on the woman with breast cancer and their significant other has prompted this study. The possible outcomes could be seen as beneficial to identifying support networks for women with breast cancer and as suggested above may impact on healthcare costs. Future focus on the mechanisms of the relationship between the woman with breast cancer and their significant other needs to be considered.

A quantitative study will be conducted using validated questionnaires. The components being measured are relationship orientation (type of relationship), relationship behaviours (this relates to how the individuals in the relationship act towards each other whether supportive or dismissive), relationship mediators (responsiveness to breast cancer diagnosis and disease) and relationship outcomes (satisfaction with relationship and commitment to each other) and health and disease outcomes. The questionnaires will be distributed to both women with breast cancer and their identified significant other. This is to ensure that both perspectives of the relationship and health outcomes are obtained. The women will be asked to identify who they see as their significant other, this is to ensure that it is the woman's view that is taken into consideration and not the researchers. A number of questionnaires will be used to ensure that each relevant area of the relationship is investigated. The questionnaires will measure each of the variables above. By measuring several dimensions we can gain an overall view of the relationship and its impact on health outcomes.

Aspects of the Relationship

Relationships orientation involves the attachment style of the individuals involved in the relationship. This is how well one individual bonds with the other. There are four relationship styles or orientations. These are secure, avoidant, ambivalent or dismissive. Assessing the type of relationship that the woman with breast cancer and her significant other has is beneficial, as this relationship style affects how well the woman and her significant other communicate with each other. For example women who have secure relationship styles will be more open and secure in their relationship. Women who have avoidant relationship styles will disengage from communication and avoid difficult situations in the relationship. Those with an ambivalent relationship style will be disingenuous in their relationship. Individuals with dismissive relationship styles will be unsupportive in the relationship and provide little security.

Relationship behaviours involve the acts within the relationship such as support, caregiving and social negativity. Support is the provision of aid to another. This is important to assess in this study as support is one of the highest ranked needs that women with breast cancer have. The need for the significant other of the woman to feel supported is also important and for this reason support in terms of what the woman receives and what the significant others receives will both be assessed. Caregiving can involve all the daily acts of providing assistance with physical needs as well as emotional needs such as listening and comforting. Social negativity involves the negative or confrontational aspects of the relationship such as arguing, ignoring etc. These need to be assessed as negative behaviours within the relationship may affect the well-being of those involved in the relationship. Individuals who are involved in argumentative and confrontational relationships will have poorer coping strategies and as a result poorer outcomes both in terms of the relationship and in their overall health.

Those items that mediate the relationship such as partner involvement and responsiveness are important. How well a partner or significant other deals with the diagnosis of cancer and responds to treatments or side effects can influence how well the woman diagnosed copes with them also. The relationship outcomes regarding relationship satisfaction and commitment are determinants of the health of the woman and their significant other. Individuals with higher satisfaction in their relationship and a greater sense of commitment will cope better with breast cancer and endeavour to overcome the challenges that breast cancer brings. After assessing the above criteria in terms of the relationship, the health status of the woman and their significant other will be assessed using a scale to measure quality of life. The results will indicate whether relationship style, behaviours, mediators and outcomes influence the quality of lives of women with breast cancer and their significant other.

Conclusion

The relationship between women with breast cancer and their significant other(s) is inherently complex and multidimensional. The process of this relationship works on the basis that when one party is unwell the other provides the necessary act of caring. The relationship does not flow in one direction rather it is haphazard in nature, continually changing to meet the demands of those involved in the relationship. In breast cancer the quality of life, psychological, emotional and physical aspects of the woman are significantly enhanced when care is provided by a familiar person. However, the physical and mental burden that caring can place on the woman's significant other can impact on both people in the relationship. The relationship can also impact on the adjustment to breast cancer. Research that explores and contributes to the understanding of relationships among women with breast cancer may enhance knowledge around the relationship process and its impact on outcomes for these women. The primary function of research is to provide an insight into the understanding of impacting factors with an aim to improve outcomes. Women's significant others are already providing support (both physical and emotional) and comfort as well as attempting to remain in the role they had prior to the breast cancer diagnosis. Although the connections between relationships and health are well established, less is known about the interpersonal processes through which relationships influence health outcomes. Exploring the relationship between women with breast cancer and their significant other(s) may provide insight into the act of caring within a relationship context. An insight into the nature of caring relationships women with breast cancer experience would enhance healthcare professionals understanding of the crucial role that women's significant others play throughout their breast cancer journey.

With appreciation and gratitude to my supervisors Professor Josephine Hegarty, Dr. Mairin O Mahony, Dr.Mark Corrigan and Dr. Suzanne Denieffe for their support. The Ashling Rosanna Murphy is in receipt of the UCC Strategic Research Fund.

Easily Distracted? Take a Load Off

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> "Everyone knows what attention is. It is the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. . . . It implies withdrawal from some things in order to deal effectively with others and is a condition which has a real opposite in the confused, dazed, scatter-brained state which in French is called distraction." (William James)

Everyday Attention

In the words of the famous early psychologist William James, everyone knows what attention is. It is a part of everyday life and you have probably never given the processes involved much thought. You want to pay attention to one thing and ignore something else? No problem, right? In fact, directing attention is an effortful process, dependent on many factors, both internal and external. Just imagine the following situation:

You're attempting to read something important but have so far read the same paragraph a dozen times because you keep getting distracted. Sights, sounds, smells and thoughts that are far less important than what you are reading keep drawing your attention. You abandon the book, deciding to take a break. You decide to play a video game to relax. An hour later you are enjoying your game when you are interrupted by a friend waving their hand in front of your face. They claim they have been calling your name repeatedly but you appeared not to hear them.

How could a person display such variation in their ability to attend to the current task? Why are we so easily distracted in certain situations but resolutely focused in others? What happens to the distractors that we attempt to ignore? We intuitively imagine that the unattended information is simply not processed, but consider this familiar scenario:

You are at a party. There is chatter all around you but you are engaged in conversation with a friend, clearly ignoring the 'background noise' caused by other guests. However, someone across the room mentions your name in conversation and you immediately turn your head.

Though you appeared to be ignoring all other conversations, you could not have recognised your name unless you were processing the speakers' words to some degree. In psychology this is known as 'The Cocktail Party Effect' and has been debated by attention researchers since the 1950s. It raises questions about where the 'selective' part of selective attention takes place. When we choose to ignore something, how deeply do we process it?

Psychological research has attempted to answer these questions for many years and a promising model of selective attention has emerged, called Perceptual Load Theory. My PhD research takes this theory and uses it to investigate attention in driving; a task where distraction can have fatal consequences.

Selective Attention behind the Wheel

Selective attention is what allows us to focus on relevant information and ignore distractors. Failures of selective attention happen when we accidentally attend to the distractor instead of the task-relevant information that we want to attend to, i.e. sitting in a lecture and getting distracted by fellow students chatting. It is not the same as the kind of 'distraction' caused by divided attention, where you attempt to do two things at once, i.e. texting while in a lecture.

When people think of distraction when driving they tend to think of using mobile phones, smoking, eating, etc. Those are examples of divided attention and while they are very important for driver safety, my PhD is focused on the more fundamental process of selective attention. When driving, your eyes receive a wealth of information from the road scene including vehicles, road signs, pedestrians, billboards, shop fronts, etc. How do you focus on the safety-critical visual information while resisting the lure of flashing billboards and 50% off sale signs?

Perceptual Load Theory

Perceptual Load Theory predicts when distraction will occur and has two components; perceptual load and cognitive load. Perceptual load – the amount of visual information present in a scene — determines whether distractors will be admitted to the brain and processed at all. This selection is based on capacity limits, akin to a bouncer outside a nightclub. If the target information is of high load then the club is full and the distractor is refused admission. Imaging studies have shown that under high perceptual load, the brain doesn't even process distractors. It is as if you become blind to their presence because you simply don't have the capacity to process them. Since they are not processed, they cannot affect behaviour and the individual does not become distracted. If, however, the target stimuli incur low perceptual load, the brain's processing capacity is not reached and so the distractor is processed along with the targets. Even though you don't intend to process the distractors, attention will proceed automatically until the capacity is reached, processing targets and distractors indiscriminately. Figure 1 shows how target information and distractors are processed in situations of high and low perceptual load — under high load, distractors cannot be processed due to capacity limits. In contrast, under low perceptual

load both targets and distractors are processed indiscriminately.

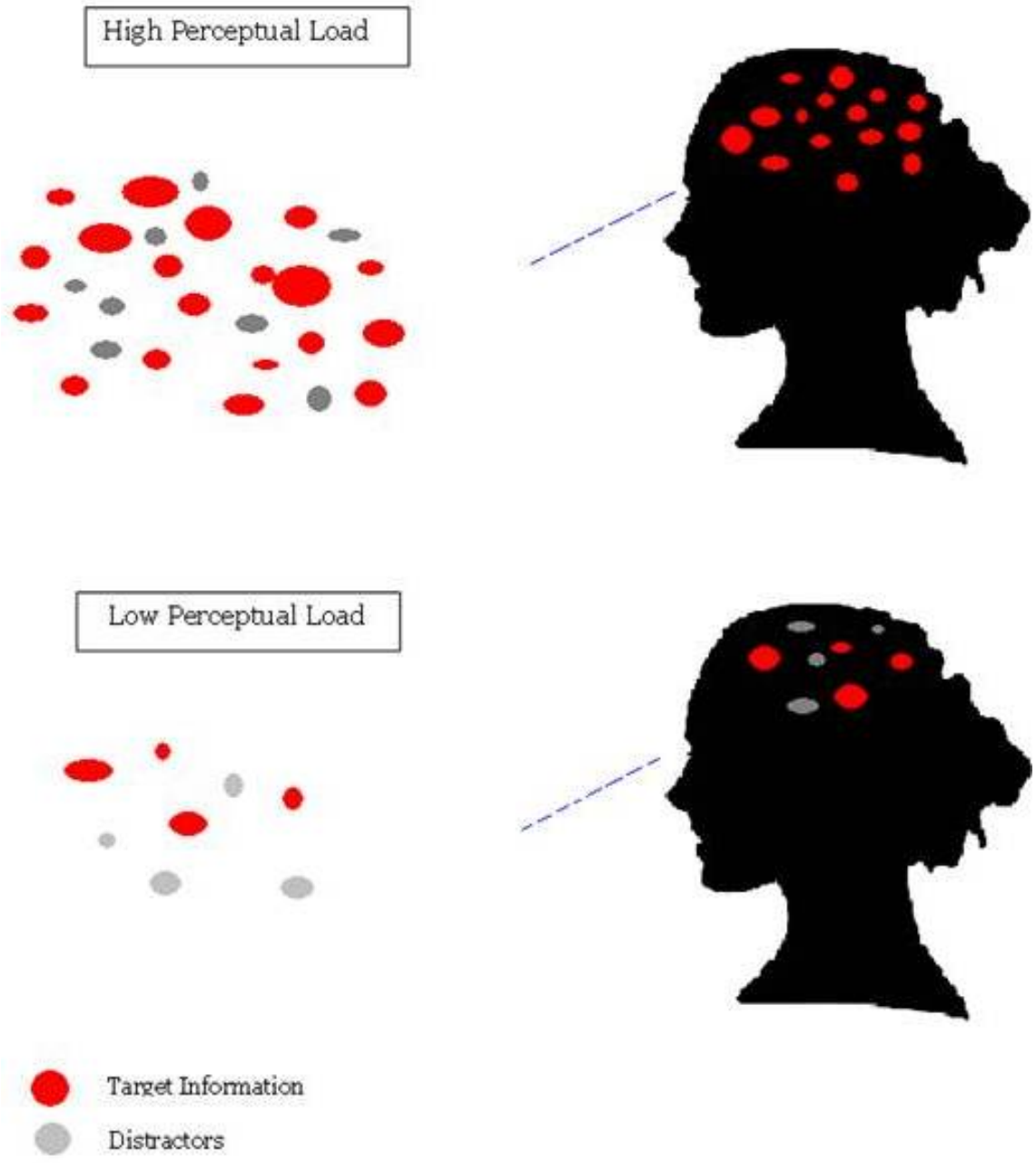

Figure 1: : Attention under High and Low Perceptual Load. Image: Gillian Murphy.

Under low perceptual load, where your capacity-dictated, perceptual 'bouncers' have processed both targets and distractors, how do you choose which to attend to? This is where the second component of Load Theory, cognitive load, becomes important. Executive functions in the brain select targets, but their success is determined by the level of cognitive load you are currently experiencing, i.e. what other operations your brain is undertaking at the same time. Cognitive load has the opposite effect to perceptual load — when cognitive load is low, distraction is less likely to occur. Distinguishing between distractors and

targets is effortful and so if you were engaged in another task (e.g. trying to remember a phone number), you would be more likely to accidentally select a distractor for further attention, allowing that distractor to interfere with your thoughts and behaviour.

Applications

While this theory has been well established using artificial, computer-based tasks, the applied benefits are relatively unexplored. Lapses of attention cause problems across Ireland, every minute of every day. A doctor misses an unusual shape on an X-Ray. A farmer gets distracted while operating dangerous machinery. Teachers in every town and city struggle to get unruly pupils to look at the board instead of out the window. Driving is perhaps one of the most high-stakes attention tasks that we perform and my PhD is using this theory to investigate when distraction is likely to occur on the road. The Road Safety Authority recently announced that road deaths in Ireland increased in 2013, for the first time since 2005. Road safety remains a huge problem in this country and there have been many educational and legislative efforts to resolve this.

As discussed, perceptual load relates to the processing load incurred by the task you are trying to perform. In a driving scenario, low perceptual load could be slowly driving on an empty street, whereas high perceptual load might be travelling at high speed in heavy traffic, in a busy urban area. High perceptual load decreases susceptibility to distraction, similar to what happened to the video game player at the beginning of this article. This leads to the rather counterintuitive prediction that making the task *more difficult* can actually *reduce* distraction. The effect of load is evident both within and between sensory modalities, for example when driving in perceptually demanding conditions you may stop processing the sounds coming from the radio.

Cognitive load relates to what else is going on in your mind while performing a task. For a driver, high cognitive load might be incurred by trying to remember a complex series of directions while driving. High cognitive load increases the likelihood that you will become distracted, as you are less capable of selecting targets from distractors.

How exactly does perceptual load affect drivers? Using UCC's state of the art Driving Simulator Laboratory (see Figure 2), I will be conducting a series of experiments, taking into account the interaction of load with emotional states, driver experience and dealing with unexpected hazards. Is perceptual load beneficial for drivers — helping them to ignore distractors such as billboards and shop fronts? Or is it detrimental — preventing them from detecting hazards such as pedestrians and approaching vehicles? Knowing how perceptual and cognitive load affect drivers will allow us to better understand driver attention at a basic level and will have implications for road design, driver education and legislation.

Figure 2: UCC's Driving Simulator. Image: Gillian Murphy.

I am a member of the People and Technology Research Group in the School of Applied Psychology. I would like to thank my supervisors Dr Ciara Greene, School of Applied Psychology, UCC and Professor John A. Groeger, Department of Psychology, University of Hull. I would also like to thank the Irish Research Council for funding this PhD.

Learning the Language of Games

Jack Murray

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What do I do?

When people ask me what I do for a living I give my answer in phases. I start with the vague, though technically accurate, answer that I am a PhD student. When this invariably leaves my questioner unsatisfied the second question follows swiftly: "Well what are you studying?" again I will dissemble and answer that I study literature. This answer satisfies many and I breathe a sigh of relief, but for some this is still too vague. When pressed on what kind of literature I offer up my last line of defence and answer that the specific object of my research is video games. For those who have already pursued the question this far, it is of course unthinkable that they not pursue it further, especially after so sudden and unexpected a twist. Broken and defeated, I am left with no other choice than to answer their questions in detail and at that point it all becomes a bit... academic.

Video Games? Really?

My final answer is often met with a certain amount of surprise, even incredulity. "I thought you said you studied literature!". To many people my academic background of English literature, philosophy and literary theory seems like a strange match for my chosen field of research. People ask if I am really a computer scientist and when I say that I am not their confusion only grows.

Video games and literature meet on contentious ground. The question of whether or not games are art (or can be art) is one that has been debated by academics and within the media for some time with no argument scoring a decisive victory. In spite of their ever increasing commercial success and the fact that they have been a part of our cultural milieu for over forty years games are still treated with suspicion by cultural commentators. As recently as January 2014 The Guardian newspaper featured an article arguing against recognizing games as art and film critic Roger Ebert's 2005 claim that games could never be art has achieved lasting infamy among advocates of game culture.

My own position on the matter — typically for an academic — requires some explanation. Given my chosen career path it should be clear which side of the debate I favour but the question of whether or not games are art, or can be art, or *should* be art, is not one that

can be reduced to a simple yes or no answer. The umbrella term 'game' and the cultural space that it refers to encompasses a broad range of media categories, many of which are as different from each other as they are to more traditional media like film or the novel. Attempts to create a coherent definition of just what a game is have been stymied by this diversity for almost as long as games have been the subject of disciplined study.

Yes, I believe video games have the capacity to be art but that does not mean I believe that every game is art or even that every game should aspire to the status of art. Some games are better understood as sports, some as toys and some defy categorization altogether. It would be a disservice to the diversity of games and the imagination of those who create them to attempt to force a definition as art upon all of them, just as it is a disservice to unilaterally deny them recognition within that cultural space.

It is important too not to valorise those games that deliberately seek to belong in the artistic space over those with other priorities. Games are a diverse medium suited to many different kinds of cultural expression. The question of whether or not games are art is really only one part of a larger investigation.

"I study literature."

Literary theory may seem like a strange lens to apply to the study of video games but it is an approach that has already yielded a surprisingly large body of work. The academic discipline of game studies has its roots in literature departments, other researchers like me who wanted to tackle the mystery of games' uncertain cultural status using the tools with which they were familiar. Literary theory offers many surprisingly productive approaches to the study of games and many of these interactions had been mapped out well before my own research commenced. My research focuses on a specific subset of literary theories, those that are concerned with the figure of the author, and what these theories can offer the ongoing effort to map the language of games.

The Author

What is an author? This is a deceptively complex question. In the two years I have been pursuing my research it is one to which I have heard many and varied answers. Theories of authorship go back as far as the works of Plato but close scrutiny of who, or what, the author is is primarily associated with certain French thinkers of the 20th century and the set of methodologies that are collectively referred to as Critical Theory.

In the model of authorship proposed by these theorists the author is an imposer of limits. There is a distinction drawn between an act of writing, which is viewed by these theorists not as the creation of brand new material but the arranging of pre-existing material in

novel patterns, and an act of authorship. To be an author is to claim ownership not only of a work, but also of all the possible meanings of that work. The author is a figure who defines — but in doing so, limits — meaning.

The original theorists put forth this definition as part of an attack on traditional understandings of authorship. Though the vigour of that attack has died down in the half century since it was first put to paper many of the concepts it introduced remain useful to cultural theorists such as myself and the author remains a figure subject to much academic enquiry.

Games and The Author

The lens of authorship can offer much when it comes to the investigation of games but games have much to offer the study of the Author in turn. Games are a challenging space for authorial expression because compared with older media they offer the user an unprecedented level of involvement in the process of creating meaning. Though no-one has been able to settle on a stable definition of what a game is, most would agree that it is a common characteristic of games that they facilitate play.

Play itself is something of a vexed term when it comes to definitions but can broadly be understood as a balance between freedom and structure. Play is made possible by the imposition of rules. This is as true of simple children's games like Tag as it is of more complex games, including video games. Rules create a framework within which play can take place but within that framework players are free to express themselves and explore the limits of the system they have chosen to participate in.

Play, therefore, is reminiscent of the Author-Reader relationship. Authors provide stability, a limit on possible interpretations of their work but within those limits the reader is free to take their own meaning. Authors are the rules and readers the players. This parallel was drawn in the original texts in which the theories of authorship that I deal with were first put forward but it could not be claimed that it was done with any foresight of what was to come. Game theorists have largely dismissed the literary appropriation of 'play' as a workable methodology for the study of games.

Nonetheless, fruitful work can be found in the study of game authorship. Questions present themselves immediately. Who is the Author of a video game? Is it the designer? The programmer? What of the writer and the artist? Does the player have a role in the authorial process? Do games have authors at all? Going in the other direction we can ask what games have to offer theories of authorship. Games offer a new perspective from which we can examine the figure of the author and the relationship between author and reader.

The Product

Which leaves perhaps the most important questions: why is any of this important? Who will benefit from my research? My specific aim is to produce a document that will be of use to game developers and that will facilitate the creation of better game content.

From my interactions with industry professionals as well as from the games I play it has become apparent to me that, although it has not yet been strongly identified as such, the question of authorship is one of great importance to the continuing development of games as a form of cultural expression. In order to better understand how the games industry is grappling with this issue I am gathering data by means of two surveys, one aimed at developers and one at gamers. The purpose of these surveys is to quantify these groups' understanding of authorship and how it effects their work and play. Equipped with this data I aim to unpack the issue of authorship in games in a way that is industry focused. Many games grapple with the role of the author, sometimes deliberately but more often incidentally. I aim to facilitate developers and gamers alike by further developing the critical tools through which the concept of authorship can be better understood specifically in relation to games.

The knotted issue of authorship is one that the gaming medium, by its very nature, cannot help but engage with. The importance of the author-consumer relationship is hard-wired into the medium at the most fundamental level, in a way that is simply not true of other media. Game developers already recognize the great importance of this relationship but the language to engage effectively with it remains underdeveloped. It is the aim of my research to document and clarify the different types of authorial expression made possible through games and, through a better understanding of the author-player relationship, to facilitate our understanding of games as a vital contributor to our culture.

‘Why will you Jews not accept our culture, our religion and our language?’: James Joyce’s Jew through the Eyes of Jewish America

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Introduction

Just as James Joyce is the most important writer since Shakespeare, his Jewish-Irish character, *Ulysses*’ Leopold Bloom, is the most fascinating fictional Jew since Shylock. All authors must struggle with Joyce’s overwhelming legacy, but what of writers who are themselves Jewish? How do they envisage Bloom and relate to his complex sense of identity—as a Jew, as an Irishman, but most fundamentally as a human being?

The three greatest Jewish American writers of the twentieth century, Philip Roth, Bernard Malamud, and Saul Bellow, were all deeply influenced by Joyce. Each of them responded to Joyce’s masterpiece by rewriting it from the perspective of an American Jew—just as *Ulysses* itself is an Irish rewriting of Homer’s *Odyssey*. What draws these authors to Joyce? Is it their shared heritage of exile and a lost homeland, or Joyce’s powerful use of language? When asked how one can tell if a novel is Jewish or not, Roth argues that it was not the characters or themes that make it so, but rather: ‘it’s that the book won’t shut up’. These Jewish-American novels cannot stop talking about, and to, Joyce’s compelling fiction. This article seeks to explore this canorous conversation.

Home from Homer

In *The Odyssey*, on his homeward voyage, Odysseus finds himself trapped in a cave by Polyphemus, the one-eyed Cyclops. To escape he must deny his identity, tricking the monster into believing his name is ‘Nobody.’ Joyce refashions this story by transforming the Cyclops into a belligerent and xenophobic Irish drunk (ironically named the Citizen) who takes exception to Bloom’s Jewishness. For the Citizen being Irish is a very narrow category, essential components of which are a strict adherence to both the Catholic faith and the Irish language. Bloom possesses neither of these traits, but considers himself no less Irish than his adversary. Unlike Odysseus, Bloom does not escape by repudiating his

identity; rather he confounds the Citizen by telling him that Jesus, too, was a Jew. The Citizen's reaction is comic—'By Jesus... I'll brain that bloody jewman for using the holy name... I'll crucify him so I will'—however, Joyce's argument that being Irish transcended language and religion, was serious and, at the time, revolutionary.

A Bellow of Being

Though Bloom considers himself Irish and has a rich multicultural heritage, with a fascinating hodgepodge of Protestant, Hungarian, Jewish, Spanish and Catholic kin, for many Irish he is regarded simply, and derogatorily, as a Jew. Saul Bellow, the Russian-parented, Canadian-born, culturally Jewish, American citizen, thoroughly understood Bloom's predicament. That is why, in his 1953 novel *The Adventures of Augie March*, Bellow reimagines Bloom's barroom brawl with the Citizen. A policeman with a 'one-eyed emphasis'—reminding the reader of Homer's Cyclops and Joyce's narrow-minded Citizen—imprisons the young Jewish Augie March, symbolising the anti-Semitism that pervaded the United States during Bellow's adolescence. So while Bellow was certainly inspired by *Ulysses*, the author did not need to read Joyce to comprehend oppression and prejudice; rather, his life provided ample examples. When applying to study English Literature at Chicago's prestigious Northwestern University, Bellow was told by the head of the department to try something else, as he was: 'not born to it'. Though more subtle than the Citizen's rant, this was no less an attack on a Jew's right to belong to a nation, and thus study its language. Bellow gained revenge not by studying literature, but by writing it. *Augie March* brought Jewish fiction out of the tenements and into the American mainstream consciousness. The opening line is a defiant rejection of those who questioned Bellow's nationality: 'I am an American, Chicago born'. From *Augie March* on, Jewish writers have dominated American literature.

Malamud's Mother Tongue

Out of the eleven American winners of the Nobel Prize for Literature three (including Bellow) have been Jewish. One prominent reason for the incredible success of Jewish-American literature may be the very fact that its practitioners were 'not born to it'. The Yiddish that these authors encountered as children provided them with an innovative vision of how English could be adapted to create new modes of expression. Philip Roth describes the hybrid nature of his mentor Bernard Malamud's use of language as follows: 'English that often appeared... to have in large part been clipped together from... the least promising stockpile... around: the locutions, inversions and diction of Jewish immigrant speech, a heap of broken verbal bones that looked [lost], until he came along... to make them dance to his sad tune'. Malamud's 1961 novel *A New Life* makes clear

its debt to *Ulysses* by quoting it in epigraph: 'Lo, levin leaping lightens in eyeblink Ireland's westward welkin'. The quotation is taken from a chapter set in a maternity ward, where Bloom is visiting an acquaintance, and in modern English it means: 'Look, lightning flashes in Ireland's westward skies'. The sentence's archaic nature is the stylistic means by which Joyce highlights the poetic effect the Irish language and Irish artists have had on the development of the English language, as he more plainly argues elsewhere: 'The Irish, condemned to express themselves in a language not their own, have stamped on it the mark of their own genius and compete for glory with the civilized nations. The result is called the English language'. In *A New Life*, Malamud further plays on the term 'levin' which means 'lightning' but is also a common Jewish family name. The protagonist, Seymour Levin, moves from New York to the West Coast—with plans to teach and study English—following in the footsteps of a mysterious Irishman named Duffy, symbolizing Malamud's own march behind, and beyond, the works of Joyce. Like Joyce, Malamud was the midwife for a new type of language, born out of the union of Yiddish and English. Inspired by Joyce's fusion of English and Irish, Malamud jolts to life (as if by lightning) the dying Yiddish tongue, transplanting it into the body of American English speech.

Ignoring the Roth of God

Being of a younger generation than either Malamud or Bellow, Roth has been less inspired by Bloom's all-encompassing vision of *nationality* and *belonging*, than by his remarkably modern vision of *sexuality* and *longing*. Though Roth grew up in an era when the Jews—emulating the Irish before them—moved from lowly immigrants to integrated Americans, he remained very influenced by his Jewish cultural background. In *Ulysses*, Bloom lets neither his Jewish heritage nor the strict Catholic environs of Ireland affect his lusty desires. His day is spent admiring various women around the city, with a stop at the beach to masturbate through a hole in his pocket, blissfully unencumbered by either Jewish or Catholic guilt. Thus engaged, Bloom emits a simple phrase: 'At it again'. Roth has praised the powerful simplicity of these three words, seeing in them a 'combination of resignation, delight, and tolerance' that symbolises all he admires in Bloom; it is, he has recently admitted, his favourite expression in literature. Roth's own ode to onanism—the scandalous *Portnoy's Complaint* (1969)—is infused with the sexual chaos of 1960s New York. However, it takes its inspiration from *Ulysses*, a novel written almost a half-century before, and set in the unlikely milieu of turn-of-the-century Dublin.

Irish Roots, Jewish Blooms

That America's most eminent Jewish authors grounded these books in the rich soil of Ireland's greatest novel says much about the parallels between these two cultural groups.

It also brings us full circle to the title of this paper, a question put to Bloom by another Irish citizen: 'Why will you Jews not accept our culture, our religion, and our language?' Why should Jewish authors accept a single national culture or language to the exclusion of their own, when it is a combination of all these elements that leads to fiction intricate and nuanced enough to explore such hybrid identity?

I would like to acknowledge the invaluable support, insight, and encouragement provided by my supervisors Dr Lee Jenkins and Dr Maureen O'Connor. I am also grateful for the generous funding provided by the Irish Research Council and the School of English.

‘Knowledge is power’ — making sense of wind farm data

Frank O’Connor

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Introduction

The Irish wind energy sector is booming. In 2012, Irish wind farms supplied enough energy to provide about 15% of Ireland’s electricity demand and power 1.12 million households. In March 2014, The Irish Wind Energy Association (IWEA), an organisation committed to the promotion of wind energy in Ireland, highlighted a planned €7 billion investment in the sector, with a confirmed project pipeline of over 180 new wind schemes. According to a recent TCD/ESRI report, this will bring the total number of jobs in the sector from 3,400 at present to over 8,400 and see a doubling of production of clean, indigenous, renewable energy.

The modern wind turbines, which will be rolled out as part of these new schemes are a far cry from the turbines installed over four decades ago at the first commercial wind farm, constructed in 1980 on Crotched Mountain, New Hampshire, USA. A modern turbine such as the Vestas V167 offshore wind turbine would tower above those early wind turbines. The V167, standing at 187 meters is seven meters taller than London’s Gherkin building and has a rotor diameter of 164 meters, into which you could comfortably fit the London Eye. Back in 1980, in New Hampshire, it would have taken a wind farm of over 266 of these early turbines to match the generating capacity of a single V167.

Modern wind turbines like the V167, are not merely big machines, they are also complex and robust machines. Unlike traditional power plants, which operate in controlled environments inside large bespoke plants, wind farms are increasingly found in remote locations like on the side of mountains or out at sea. They have to be able to operate in a range of challenging environmental conditions, such as in high winds in stormy weather, severe turbulence due to complex terrain, and ice and snow in cold climates. Given these challenges, a relevant question is, how much does it cost to build and run a wind farm, and how does this cost compare to the cost of building and running traditional power plant?

Table 1: U.S. Energy Information Administration (2013) LCOE cost types descriptions

Cost Type	Description
Capital	Costs associated with building the plant
Operation and Maintenance (O&M)	Costs associated with running the plant
Transmission	Costs associated with delivering the energy to the customer
Fuel	Costs of fuel

The cost of wind energy

One accepted method of calculating the costs associated with generating electricity is known as the levelised costs of energy (LCOE). LCOE measures and compares costs across different sources of generation and is calculated by dividing the total lifetime cost of a generating plant by the total value of electricity generated, and is usually expressed in units of currency per megawatt hour ($/MWh.)

A study by the U.S. Energy Information Administration in 2013 calculated LCOE for a range of power plants over an expected operating lifetime of 30 years. The study broke out costs into the following four categories:

The chart shown in figure 1 shows a comparison of five power plant types. The U.S. Energy Information Administration report contains information on a wide variety of plant types, however a subset of just five plant types are presented here for the sake of clarity.

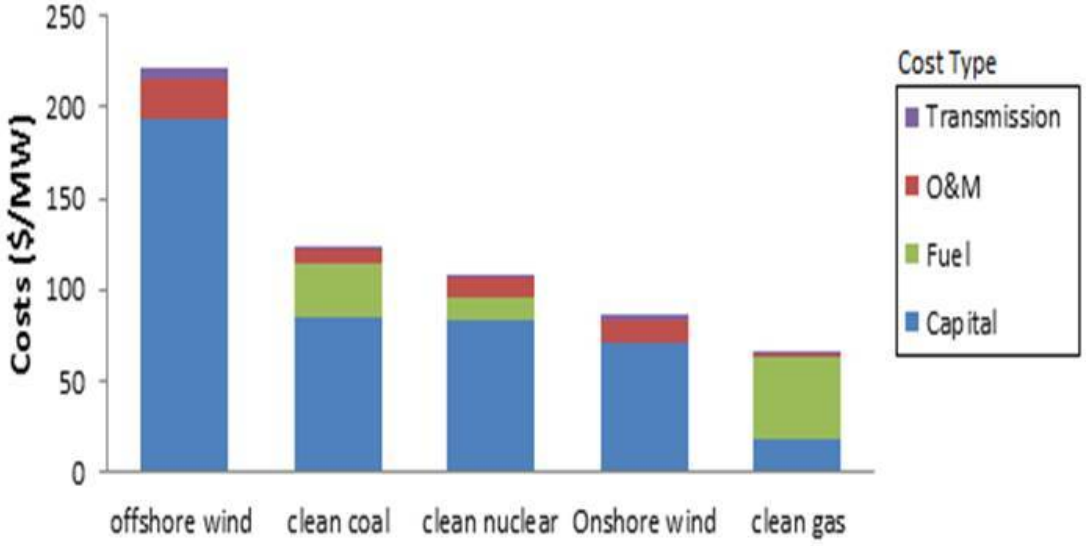

Figure 1: U.S. Energy Information Administration in (2013) LCOE cost breakdown

We can see from figure 1 that the two biggest cost categories are capital costs and fuel costs. It should be said that newer technologies often have higher capital costs, which generally fall over time, benefiting from economies of scale, and improvements in tech-

nology. Fuel costs vary, but given the non-renewable nature of most fuels, one may expect the cost to increase given sufficient time.

The final two cost categories are Operation and Maintenance (O&M), and transmission costs. Transmission costs are the lowest cost category and O&M costs are the third most significant cost category. O&M costs include service and maintenance of the assets as well as the cost of replacing and upgrading, failed or underperforming components. Information is essential for managing O&M costs. Having access to better information about how a wind farm is behaving helps operators make better O&M decisions, which lead to improved plant reliability and ultimately lower costs. Making sense of wind farm data, and enabling wind farm operators to better manage O&M costs are one of the aims of this research project.

Wind farm data

Systems which manage wind farms often generate very large volumes of data. It is not uncommon for these systems to report a single issue multiple times, making the task of counting issues and their associated equipment failure times, complex and labour intensive. Issues are often reported in ambiguous and unintuitive language. If issues are classified, it is usually to a coarse proprietary classification system which is of little or no use when counting issues, particularly when tabulating issues across multiple vendors.

It is often the case that there is a very loose coupling between the data produced by machines (like alarms and events) and data produced by humans (like maintenance and service reports). It is not uncommon for records of work, undertaken to maintain or improve the assets, to be either poorly recorded, e.g. as unstructured written reports, or not recorded at all. This means that attempting to automatically analyse data for correlations between alarms and events, and maintenance activities, is difficult if not impossible.

Finally, there is a wealth of information around the boundaries of wind farms that have a significant role in helping to placing machine data in the correct context. For example, information about the location of assets in the wind farm (longitude/latitude, altitude, etc.), data on component failure rates, relationships between assets (operational dependences on some other asset, like a substation), etc. This information often only exists in the heads of experienced experts, is difficult to formally capture and can be lost when key personal leave the organisation.

The research project

The aim of the research project is to improve the accuracy and reliability of wind farm data, and to build a computer based system that will make better sense of wind farm data.

There are two stages to the project:

1. Knowledge capture and transfer
2. Expert system implementation

The first stage, 'knowledge capture and transfer', involves collecting relevant wind farm data and organising it into a format that can be effectively processed by software. This process involves identifying and defining important wind farm concepts (e.g. Turbine, component, alarm, time, service-report, cost, etc.) and also the important relationships between concepts (e.g. Alarm X *affects* turbine Y). The data will be modelled in an ontology, which is a semantic framework for organising information.

Ontologies facilitate three important properties for defining knowledge. Firstly, they allow for new information to be easily added in a structured, formal and connected fashion. Secondly, they ensure that the data set is of good quality, as ontologies facilitate the automatic checking of data consistency rules. Thirdly, ontologies facilitate the sharing of information between systems, between humans, and between humans and systems.

The data in the ontology will be described along three dimensions: thematic, spatial and temporal. The thematic dimension describes some quality of the data (Turbine X *isAffectedByAlarmCode* YYY). The spatial dimension describes where the event occurs (Turbine X is located at coordinates XXX). The temporal dimension describes when the event occurs (Alarm X occurred today).

The second stage, 'expert system implementation' involves designing and implementing a computer system that emulates the decision-making ability of a human expert, and can use the wind farm ontology to make better sense of the data, by inferring new, useful and meaningful facts about the wind farm. A simple illustrative example is, if the ontology knows that Turbine A has a Component B, and Component B is affected by Alarm C. The ES will be able to infer that Turbine A is also affected by Alarm C even though the system was not explicitly told about the connection between Turbine A and Alarm C.

The ES will also offer a query engine which acts rather like a search engine. The difference is that this query engine will have some semantic knowledge about the concepts and relationships in the ontology. So for example it will 'know' what a turbine is, and it will be able to traverse the network of connected turbine concepts (e.g. Alarm, components, etc.). In this way it will be possible to 'ask' the ES some sophisticated questions. An example of a query is:

> "Find all turbines that have alarms for the generator component where these alarms occurred after a maintenance activity."

The query engine will be able to discover related maintenance activities because both alarms and maintenance activities will be related through the temporal domain (i.e. Time).

The ES will provide wind farm operators with a rich framework for querying wind farm data in an intuitive and sophisticated fashion. This will lead to the discovery of new patterns of behaviour in the wind farm data, which will result in a more nuanced understanding of the wind farm. This in turn will allow wind farm operators to better manage their assets and will lead to lower O&M costs and improve plant reliability.

The Irish Wind Energy Association (IWEA) has highlighted over 180 new wind schemes planned for Ireland alone. The long-term viability of these projects will depend on how well costs can be managed. This research project will deliver a set of patterns for formally capturing wind farm knowledge along with software capable of querying wind farm knowledge in a connected and semantically aware fashion. These two things taken together will help wind farm operators discover important patterns hidden in the morass of wind farm data and assist with the important goals of lowering O&M costs and achieving higher plant reliability.

In Summary

Wind turbines are large, complex machines which have to operate in increasingly challenging environments. The systems which manage wind farms often produce poor or incomplete operating and maintenance records. Unlike traditional generating plants which are housed in climate controlled complexes, wind turbines are affected by a range of external conditions, like cold weather, high winds, turbulence from complex terrain, etc.

This project will provide a robust semantic framework which will enable all relevant wind farm information to be captured and organised in a formal structured fashion. This knowledge-base can then be queried by a computer based ES which will unlock the hidden knowledge of the wind farm, by providing a means to explore the data in a much more connected fashion. Having better information for a wind farm will help wind farm operators make informed, evidence based decisions about how to operate the assets, which will improve reliability, lower costs and in turn increase the viability and sustainability of the wind energy sector.

I would like to acknowledge the support of the Irish Research Council (IRC), for funding this research, my two supervisors, Dr. Paul Leahy and Dr. Richard Kavanagh for their advice and guidance, and my Employment partner ServusNet informatics for their continued support.

Fishing for a sense of cultural identity and place

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Introduction

A strong sense of identity and place attachment has always been a characteristic of fishing families. Originally from a fishing family I identify myself with this particularity which engenders a distinctive relationship with the sea. Cultural geography is very much focused on place and how people 'live their lives' in particular places. How people develop attachments to specific places is a key element in cultural geography. While much of the research conducted on fishing communities to date has focused on policy frameworks and its economic importance, the cultural and social dimensions have largely been overlooked. Fishing not only provides an important source of food and employment but is a way of life for many inhabitants of coastal communities and as such is an essential element of maritime culture. It is understood that the seas and oceans make up 70 per cent of the earth's surface and almost 60 per cent of the world's population live in coastal areas. Yet people seem to struggle to comprehend this vast space in which fishers and their families attach meaning and construct their identity. Nevertheless, traditions are inevitably challenged in a globalising world; contemporary fishing families appear to engage in a changing discourse. Therefore, this study explores the cultural life of two fishing communities and their relationship(s) with the sea. It will consider how these relationships have changed over time and the processes that have underpinned these changes. It is essential to acknowledge the productions of identity and sense of place in fishing communities as the lives of inhabitants are very much linked to the complex entity of the sea. Located on the Western fringe of Europe Castletownbere and Le Guilvinec fishery harbours have been chosen for this study. These two communities share similarities however it is of interest to look at differences between both sites and what factors generate these variations.

Remembering the past in order to identify with the present

Fishing is perceived as an ancient practice; traditionally people living in coastal areas often made a livelihood out of this way of life. Certain maritime archaeologists maintain that people have used the sea as a source of identity and belonging for centuries; identity was socially and culturally constructed but also created by the routines of everyday

life. Not only did the physical locality of these coastal communities help forge their local identities, the sea also brought external influences. Historically, cultural values and traditions provided a sense of identity to coastal inhabitants thus shaping these places. A strong sense of identity is frequently observed among fishers which tends to generate a strong sense of place. Society has considerably changed since historical times however many fishers will still argue that they are continually being detached from wider public life due to the amount of time spent at sea. Fishing communities have strong links to the sea that span generations; fishing can best be understood as a way of life rather than a means of economic income and it defines fishers' identities as individuals, households and communities. Below are some of the direct quotations from fishermen and their spouses that I interviewed.

> 'I couldn't live anywhere away from the sea. When you're born and reared near it, it becomes very much part of your life.'
> '. . . it's a way of life without a doubt.'
> 'Fishing is in the blood. It's part of who you are. It's passed on from generation to generation.'
> 'Fishing is what I've always wanted to do . . . I chose my path from a very young age.'
> 'My father and grandfather were fishermen . . . '

Through single interviews and focus groups it became apparent that these coastal residents were attached to their community so much so that they experienced a sense of longing when away from the sea for any length of time. All those whom I interviewed admitted to spending their holidays in coastal locations. Fishermen's spouses confess that even on holidays their husbands tend to seek out the local fishery harbour.

> '. . . I found him mending a net with a local fisherman; neither of them spoke each other's language...'

Fishing communities provide a sense of place that is often steeped in maritime heritage while traditions and local knowledge are intergenerational. Nonetheless, it is important to acknowledge that not all members of the same community share the same sense of place; identities are constantly being renegotiated. Although the physical environment can influence demeanour and shape identity, certain inhabitants admitted to feeling no attachment to fishing or to their environment. In contrast, it appears that fishers' attachment to their physical surroundings provides them with a sense of place and identity. Their daily engagement with the sea connects them with nature thus making them aware of both its bounty and misfortune.

Symbols as part of identity and place attachment

Individual identity is important to the formation of the collective. Many scholars assert that strong individualism sustains collective action. However, community does not auto-

matically mean the same thing to all of its members. Although most fishing communities are dependent on the industry for its existence, fishing families and non-fishing families tend to experience community in very different ways. The lived experiences of each individual inhabitant are shaped by their interaction with other community members. Symbols forge how people experience identity and sense of place. Fishing communities have a multitude of symbols both visible and invisible such as fishing vessels, nets, fishermen's mass, fishy smells and the cawing of gulls. One particular resident remarked that the fishy smell around town signifies that the fishing industry is doing well. Others testified that events united the community and it is the coming together of community members in the various rituals and festivals that shapes one's collective identity and gives meaning to place. Therefore it is in practice that symbolic value is produced and reproduced. Several fishermen that I interviewed would agree that the Fishermen's Mass and the Blessing of the Fleet are two important events in the fisherman's calendar. Some declaring that 'they wouldn't miss it for anything' and others maintaining that they would 'transmit this tradition to their children.' In addition, fishermen discussed the importance of other members of the community attending the Fishermen's Mass as an acknowledgement to their livelihood. Fishing and coastal communities remain quite distinctive to communities inland; a sense of belonging together that strengthens the notion of collective identity. Some academics assert that there is a strong sense of identity and place attachment to coastal areas as place can serve as both a geographical and a social expression. For instance, a fisherman's daughter asserts that 'there's an infinity with other fishing people . . .' Fishermen become acquainted with other fishermen throughout the country. There is a strong sense of shared identity amongst fisher society.

Methodology: An ethnographic approach

Places mean different things for different people; therefore, it is important to acknowledge the depth and complexity with which people construct meaningful relationships to their surroundings. An ethnographic approach accordingly seeks to explore and understand the meanings that people in particular places give to their everyday lived lives. It involves an engagement of the researcher with the people and place of study through immersion over a period of time. This qualitative approach provides a methodology that is highly suited to achieving the objectives of this research project and facilitates an in-depth exploration of both fishing communities. Furthermore, it provides an understanding of individual and collective lived experiences and focuses on direct contact with people therefore it is essential to create respectful relationships with all those involved in the research study. In practice, the concurrent use of qualitative methods such as participant observation will take the form of field notes, diary, photographic and video work. Interviews and focus groups also provide a comprehensive insight into the lives of these coastal inhabitants. Participant observation is central to this process as it allows me to observe, record and

interpret the lived experiences of women and men. The process consists of visits to each site for a period of two to three months to provide an experiential representation. Fieldwork in Castletownbere was conducted over a cumulative period of three months. As per the methodology, this visit involved detailed recordings of the community. The interview phase has been completed with twelve in-depth interviews with active and retired fishers (eight ashore and four at sea) and a further five with non-fishing inhabitants. Two focus groups, each consisting of six participants, were carried out with women from fishing households. It is easier to engage with fishermen on an individual basis rather than through a focus group as their time ashore is precious. Conducting in-depth interviews permits participants to describe their lived experiences in their own words. Participants are recruited via contacts made during fieldwork. Potential participants are fully informed about the research, its aims and the procedures involved prior to making any commitment to an interview. Qualitative research is never linear and therefore overcoming obstacles at the initial stage of the fieldwork will facilitate conducting further investigation.

Conclusion:

The past plays an important role in the construction of both collective and individual identities. While a great deal of research has focused heretofore on the policy and economic impacts on fishing communities this research, using an ethnographic methodological approach, engages the experiential aspects of lived lives of both men and women and should provide a rich source of data to explore fishing communities in a much more in-depth and qualitative way. In some coastal areas fishermen are first generation therefore their identity as fishers gives them and their families a rootedness in their community. The physical environment provides fishing communities with a sense of place and identity moreover fishing is an important part of a town's heritage. It is vital that the younger members of society are aware of the connection fishing has to the past via skills that are handed down through generations; skills that cannot be learned in a textbook, however, training facilities are improving and schools are necessary especially when it comes to safety at sea. Since the arrival of modern technology fishing traditions are becoming part of an inherent past. Young members of society are born into the age of information technology and so the cultural heritage of fishing is on the decline. With the decline of cultural heritage comes the quest for a new sense of identity; individuals and groups alike need to feel a sense of belonging and rootedness thus providing greater self-esteem. Fishing, once a challenging occupation associated with freedom and independence, is becoming part of an industry that is in severe decline and that is frequently linked to stress and pressure. These changes have a negative impact not only on the fishermen still involved in the industry but they have repercussions for the wider community. It is important not to allow these fishing communities to decline. By exploring the cultural geographies of these communities this research sets out to redress a gap in the literature through methods such as participant ob-

servation, individual and group interviews. It is important to capture as much knowledge and archive it for future generations lest it be forgotten.

Special thanks to my supervisors Dr John Crowley and Mr Ray O'Connor and colleagues for their continued support

The Health Benefits of Stress

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Stressed Out

Everyone knows that stress is bad for your health. It causes heart problems and is usually blamed for aging young and, really, who needs wrinkles? We are constantly told to relax and not get stressed (a fine way to stress anyone out!). Experts on television tell us that stress is a major factor in health problems later in life, but what if stress is also the solution to some of the biggest problems with advances in medical device technology?

Motivated

Medical device technology relates to anything from blood pressure cuffs to pacemakers and beyond. I am particularly interested in implantable devices, i.e. any device placed inside the body such as a pacemaker which regulates the heartbeat. These devices have to be as small as possible to fit in the correct location inside the body and they need to be reliable and ideally need to last the lifetime of the person — or as long as the person needs the device. This causes a big problem for electronic systems because battery technology has not advanced dramatically over the last few decades. There have been improvements to batteries such as the move to lithium-ion batteries and thin film batteries, i.e. batteries which are made using very thin materials so that they are not so large. However, these batteries are still new and are used in research. They do have excellent qualities such as a large capacity and many recharge cycles but these batteries still have the typical storage lifetime of the average battery. Using a rechargeable battery with our technology could show a big advancement in current implantable technology.

Another thing we can be proud of is that the batteries in pacemakers these days are not nuclear powered, although some of the earlier models were. Still, there is a major problem. Figure 1 shows a standard pacemaker of today as well as the amount of space taken up by the battery. Evidently, the battery accounts for a significant portion of the size of the pacemaker. This battery typically lasts around 10 years, which was not an issue previously as people did not live as long as they currently do. Now it is not uncommon for people to need pacemakers for decades and replacing this battery in a pacemaker requires additional surgery. This additional surgery comes with both financial costs and risks to the patient.

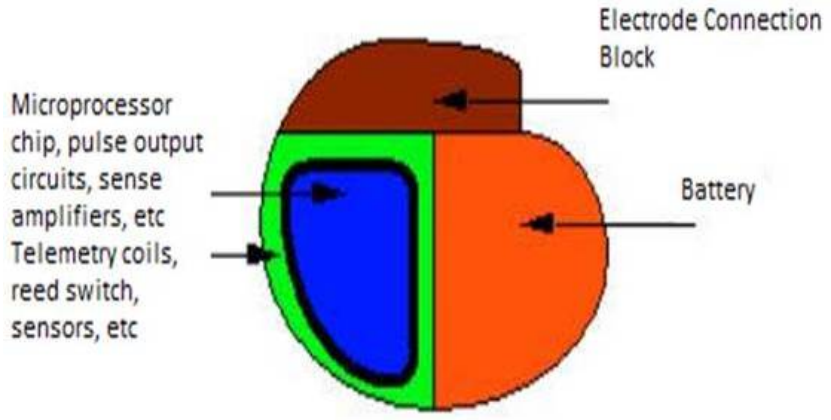

Figure 1: Typical relative size of pacemaker battery. Source: Mallela et al., Indian Pacing and Electrophysiology J. 2001, 4(4): 201-212. Reproduced here under the terms of the Creative Commons Attribution License.

Health through Stress

My research focuses on solving the problem of large battery size and short battery life by looking at ways of recharging the battery. If the battery can be regularly recharged or the device can be powered directly without the need of a battery then space can be saved and surgeries to replace the expiring battery can be avoided; after all, the reliability of the pacemaker battery is extremely important. I use a piezoelectric material in my work. A piezoelectric material is simply a material that responds to any sort of stress — bending, pulling, stretching or crushing — by generating an electric voltage. This means that if the material is stressed, for instance by keeping the edges fixed and pushing on the centre, an electric voltage is created and the electrical energy can then be stored. This stored energy can either be used to power the device directly or to recharge a battery depending on the amount of energy available.

In my work a piece of the material is placed into an artery. The blood flowing through the artery then stresses the material. Since blood flow is pulsating, the material will be moved in different directions over the course of a pulse. This is important because piezoelectric material only generates a voltage as it is being stressed.

There are a number of issues associated with this type of energy harvesting. Firstly, the devices have to be very small to fit into the artery. This means that the amount of piezoelectric material is small and because the power available is dependent on the thickness and size of the material, as well as the amount of stress to which it is subjected, the power output is small. Secondly, the devices cannot interfere too much with the flow of the blood because even a reduction of 5% in flow could prove fatal. This has been a major concern of the research to date. Furthermore, the voltage generated is AC. AC stands for alternating current and is the type of current which is available from the mains electricity supply but most devices, including implantable devices, run from a direct current (DC) supply. For

non-implantable devices a rectifier is used to convert the AC mains to DC to power the device (e.g. computer, phone, and tablet). The battery in a pacemaker provides DC current. For this reason, part of my research is to change the current from AC to DC while using the least amount of power to do this. If less power is wasted converting the current, then more power will be available to supply the pacemaker itself or other implantable devices.

Once the voltage has been generated by the piezoelectric material and rectified (changed from AC to DC) it must then be either stored for future use or sent directly to the pacemaker. Currently the design considered is to send all the power to a battery and then use this battery to power the pacemaker as and when it needs it. This provides more challenges because batteries can only be recharged a maximum number of times before they are no longer usable (this is typically in the region of 1000 cycles). It is also generally considered to be better for battery lifetime to charge it to maximum and then to allow it to discharge to its minimum voltage rather than continually topping up the battery charge before it has reached its minimum voltage. To facilitate this optimum battery management, a super capacitor can be used to hold the generated charge until the battery requires it. A capacitor is a storage device which can be charged and discharged much more often than a battery and a super capacitor has the benefit of having a large capacity and a low leakage current. Leakage current is the current which is lost even when nothing is connected to the capacitor. All laptop users are familiar with the effects of leakage. If a fully charged laptop is left turned off for a few weeks, the laptop will not have full charge (and may even have no charge) when it is turned on again. This is due to the leakage current of the battery.

Don't Stress the Results

Stressed Models

I do a lot of modelling. It is a huge part of my research. This type of modelling does not require a catwalk or extreme dieting, however. I make simulations of what would happen to my devices and what effect they would have on the blood flow. These models have been used to decide which shape the devices should take to give the maximum power for the minimum effect on blood flow. What these models have shown is that using a traditional cantilever device as in figure 2(a) has a much larger effect on the flow than using more unusual designs such as the diaphragm of 4000μm diameter (thin piece of material in a circular shape) with the hole in it, as shown in figure 2(b).

The colours in figure 2 illustrate the stress in the material with blue being low stress and red being high stress. Other models have been created with the devices in a tube which represents the artery. These models give results for the effect on the flow and the power output of the devices. It was decided, based on these results, that the best choice of design

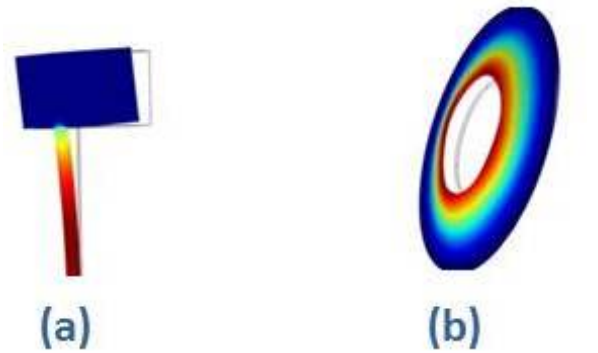

Figure 2: (a) Cantilever (b) Diaphragm with 2000μm hole. COMSOL Images: Rosemary O'Keeffe

was the diaphragm with a hole in the centre. Further models were created to determine what size the hole should be to give the maximum power output with minimum effect on flow. From these results it was determined that a hole of 2000μm diameter gives the best results. The results of the models are summarised in table 1.

Racing Pulse

Models need to be compared to physical devices to prove that they are accurate. Physical devices must also be tested to identify issues which are not apparent in the models or not taken into account due to the limit of the complexity available in the simulator. Simulators solve equations to approximate the real world conditions and the more complex a model the longer it takes to solve and the more likely it is to introduce errors. This means that the simulator makes assumptions to approximate the real world and for this reason all simulation data must be compared to real world data to verify the result. To this end, various devices were fabricated using the fabrication laboratory in Tyndall National Institute. These devices are made by depositing layers of material onto a silicon wafer (i.e. a silicon disc). To make a piezoelectric device, metal is required on both sides of the piezoelectric material to access the induced piezoelectric voltage. These devices use titanium as the bottom metal and aluminium as the top metal and the piezoelectric material is aluminium nitride. This material is particularly interesting as it only develops piezoelectric properties if it is grown in the correct way and part of the work involved

Table 1: Voltage on Device and Fluid Velocity for different hole diameters in diaphragm device

Hole Diameter (μm)	Voltage Output (V)	Fluid velocity (m/s)
2000	0.21	0.44
2500	0.19	0.44
3000	0.11	0.44
Pipe with no device in it	N/A	0.46

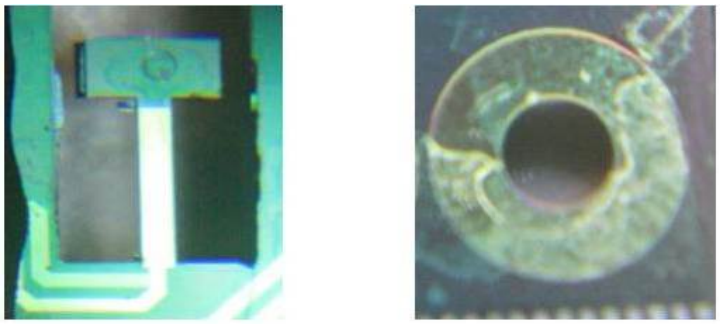

Figure 3: (a) Fabricated Cantilever (b) Fabricated Diaphragm with hole. Images: Rosemary O'Keeffe

in this research was looking at ways to get the best piezoelectric material possible. The fabricated devices are shown in figure 3.

The fabricated devices were placed into the flow from a perfusion machine (recognisable from medical shows on TV as the device used to pump blood through the body when doing a heart transplant). This machine produces a pulsating flow with the same characteristics as that which the devices would experience if they were placed in an artery. This provides results on the power and the effect on the flow which is similar to what would be expected in a real system (i.e. implanted in a person).

Conclusions and Future work

To date, the results have been promising and it is possible that an array of these devices will be able to provide enough energy to make them viable as energy harvesting devices. The next step is to look at the circuitry which will be needed to change the current from AC to DC and possibly to boost the output so that the power is larger. This type of device could also be used in other fluid networks besides biological systems such as measuring the water flowing in a pipe. In a non-biological system, the devices would probably be used to power a flow meter or similar device. There is a lot of work still to be done but results have been promising and, hopefully, soon we will have proof that stress can be good for your health!

Thanks to my supervisors, Dr. Alan Mathewson and Dr. Kevin G. McCarthy, and to my colleagues, especially Dr. Nathan Jackson and Finbarr Waldron. This research was carried out in Tyndall National Institute and was supported by the International Centre for Graduate Education in Micro- and Nano- Education (ICGEE).

The "growing" evidence of the bottle and the bump: how does alcohol use during pregnancy affect infant and childhood growth?

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A drink a day keeps the doctor away. . . . . .

"Guinness is good for you!" And it's not just Guinness who, in the past, peddled this message as part of their global advertising campaign! In fact, pregnant women in Ireland were once advised to drink a glass of Guinness a day to fortify themselves and their babies! Although a practice that has been completely abandoned since the 1980s and one which would surely cause a stir today, it is astonishing to ever imagine pregnant women consuming alcohol on the recommendation of their doctor or midwife. Indeed, clinical trials of the potential use of alcohol to prevent preterm birth were on-going up until the 1970s, and some health professionals used alcohol for this purpose in obstetric practice. These days there is a greater focus on the harmful effect of alcohol and media attention on the issue of "moderate" drinking during pregnancy has never been more intense. Today it is estimated that, in countries such as Ireland, the United Kingdom, Denmark and the Netherlands that of 50% of women continue to drink alcohol during pregnancy. But why do so many women continue to drink during pregnancy? Exactly how much are women drinking? Is it safe? And what level of consumption, if any, can women confidently consume without causing harm to their baby?

He said. . . .she said. . . . The problem of conflicting advice!

There are a myriad of reasons why alcohol consumption remains common during pregnancy. While the majority of clinical and government guidelines suggest that pregnant women abstain from alcohol consumption during pregnancy, other guidelines such as National Institute of Health and Care Excellence [NICE] guidelines in the UK suggest that 1-2 drinks up to twice per week may not be harmful to the unborn baby. This contrasts with advice regarding other maternal behaviours during pregnancy such as smoking, about which there is no dispute in relation to its harmful effects on the unborn child. In addition, while many guidelines suggest that abstinence is the safest option for pregnant women,

some evidence suggests that in practice not all healthcare professionals believe it is absolutely necessary to abstain from alcohol once levels of consumption are kept "moderate". However, the exact meaning of "moderate" drinking is highly subjective. Consequently, media or public health messages suggesting "moderate" amounts of alcohol could be safe in pregnancy must be carefully qualified with high quality research due to a significant risk of misinterpretation. This is important to ensure that women do not receive conflicting messages which can easily be mis-understood [see Figure 1].

Figure 1: Drink in moderation. Be merry all you want. Image: www.cartoonstock.com.

Research that captures the truth

The international lack of uniformity in clinical and government guidelines stems from a number of problems that arise at a research level. Firstly, scientists continue to find harmful, beneficial and equivocal effects of alcohol use during pregnancy which can all be independently explained by different biological evidence, thus making the effects of alcohol use during pregnancy difficult to disentangle. For example researchers who have found moderate alcohol use during pregnancy to be protective of preterm birth can substantiate this claim through biological evidence showing that alcohol may inhibit labour through release of hormones that relax the woman's uterus and prevent the baby being born too early. Alternatively, scientists who have found moderate drinking during pregnancy to

increase the risk of preterm birth are able to link the increased risk among drinkers to the production of other hormones called prostaglandins which may mediate the association. Secondly, due to lack of a biological marker which tells us if women have been drinking during pregnancy, research relies on women's self-reported alcohol consumption which may often be underestimated or inaccurately reported. Women may underreport for many reasons, including a desire to answer in a socially acceptable way to avoid stigma or unintentionally under-reporting due to inability to recall consumption accurately. Responding to an interview about drinking during pregnancy in a socially acceptable way is more likely to occur if a woman is interviewed face to face, when responses can often be easily influenced by the way the questions are posed. Under-reporting is also likely in situations where alcohol data are collected after the woman has delivered her baby because alcohol consumption is not always habitual like other health behaviours such as smoking and therefore more likely to be recalled incorrectly. In addition, further problems can arise when a woman has had a negative infant health outcome and is interviewed after pregnancy on her behaviour during pregnancy. In particular, women with a negative experience may be more likely to scrutinize their behaviour during pregnancy and thus report differently to women with a positive infant health outcome. Consequently, it is sometimes difficult to separate what we believe to be a true association explained by some biological mechanism mediated, for example by hormones, or a spurious finding which is in fact a result of reporting biases as mentioned above.

A further problem that arises relates to a concept known as the "healthy drinker" phenomenon. Women who drink low amounts of alcohol during pregnancy may be healthier than women who stop consuming alcohol altogether when they recognize they are pregnant. This results in studies with conflicting results. For example, some studies have found that low to moderate drinking may be beneficial to the infant while others have found a harmful association with health outcomes. In studies where low levels of alcohol are shown to be beneficial, we cannot be sure that the "healthy drinker" effect is not at work. This means that healthier women may already be more likely to have a healthy baby because they are healthier in general and more socially advantaged (educated, older, married) rather than because they consume alcohol during pregnancy. This can often render the results of studies unreliable, inaccurate and even dangerous if misinterpreted by the media or women themselves.

My research aims

The challenges of collecting reliable and accurate data on alcohol use during pregnancy thus far mean that new approaches to measuring alcohol intake in pregnant women are required. In addition, we know very little about women's alcohol consumption patterns during pregnancy in Ireland. Finally, despite the proliferation of studies on the effects

of alcohol use on infant health, we still do not fully understand the effects of alcohol on growth in infants and children.

As part of my PhD I will collect detailed information on alcohol use during pregnancy at Cork University Maternity Hospital (CUMH). I will also compare the use of alcohol reported in CUMH to other available Irish data in order to examine plausible prevalence estimates; this will include the use of the Screening for Pregnancy Endpoints Study (SCOPE) and the Growing up in Ireland (GUI) study. SCOPE is a large multi-centre follow-up study of 5,628 women recruited in Ireland, the United Kingdom, Australia and New Zealand. GUI is Ireland's first cohort study of almost 11,000 children.

In order to examine the potential impacts of low and moderate alcohol use during pregnancy on infant growth, I will use data from SCOPE, GUI and another dataset called the Avon Longitudinal Study of Parents and Children (ALSPAC). ALPSAC is a large British birth study of almost 15,000 women and children whom have been followed up from birth to adulthood. In SCOPE and GUI I will examine the effects of low and moderate alcohol use on growth outcomes at birth using a statistical technique called logistic regression. In ALSPAC I will examine the growth effects of alcohol use during pregnancy in children up to age 10 years using a statistical technique called multilevel modelling.

Impact

The first step in reducing alcohol prevalence during pregnancy and, subsequently, alcohol related harm in infants and children is to achieve coherence in guidelines on safe levels of alcohol during pregnancy by improving the quality of research conducted in this area. Furthermore, it is important that we as researchers communicate responsible and safe public health messages resulting from our work which clearly highlight flaws that may impact the reliability of findings. Taken together, these approaches offer substantial but realistic potential for impact both in Ireland and abroad in relation to maternal and child health.

I would like to thank my primary supervisors Professor Patricia Kearney and Professor Richard Greene as well as my other collaborators. I would also like to acknowledge the Health Research Board (HRB) and National Perinatal Epidemiology Centre (NPEC) for funding my PhD and supporting the collection of my data. Finally I would like to thank the staff of Cork University Maternity Hospital who facilitated my project and the participants of all studies used in my work.

Bundle of Joy: Improving Prenatal Well-being with Gratitude and Mindfulness

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Feeling the weight

Your feet, hands and belly are swollen. Your back is sore and there is almost constant pressure on your bladder. At times you feel absolutely exhausted. That's right, you're pregnant. Your body is doing amazing things; your baby is growing and wriggling about. You are filled with a new sense of expectancy and love, but you have also realised something. Pregnancy is not quite the 9 months of joy and wonder you thought it would be. You can deal with the physical complaints because you believe that they happen to everyone. The stress and sadness you are feeling is quite another thing. At times you feel like crying or giving up. There are many possible reasons for this. Maybe it is because your life has changed more than you are comfortable with. You may receive little or no help and support from your family, or your partner shows little interest in the pregnancy. Work may feel more stressful. You are worried about the future, the birth, your finances, or your life. Maybe for any or for all of these reasons, life has lost some of its colour and joy. You think to yourself, "that's not meant to happen when I'm pregnant, is it?"

For many women, low levels of well-being, characterised by stress, anxiety and unhappiness, are common and pervasive in pregnancy. Well-being involves being healthy and happy; it involves mental and physical aspects. Low levels of well-being are problematic for the expectant mother because they increase her risk of depression and engaging in an unhealthy behaviour, such as smoking. There are also subsequent effects for the developing foetus. For example, low maternal well-being during pregnancy can result in pregnancy complications, low birth weight, and premature birth. These birth outcomes can subsequently impact on infant and child development; so low prenatal well-being goes beyond simply feeling 'a bit down', and can have serious consequences. In Ireland, our maternity services provide high levels of prenatal care to approximately 70,000 expectant mothers each year. These services mainly monitor and foster the mother and baby's physical health and well-being but there is very little focus on fostering and promoting mental health during pregnancy. So, what can you do? How can you maintain or increase your well-being while you're pregnant?

Improving Well-being

As a pregnant woman you can engage in activities to improve your well-being. You can do pregnancy yoga, pregnancy pilates or go for an "expectant mother" spa package. Yes, these activities can boost your mood, but are these activities really that accessible to most women? Firstly they all cost money. A 6 week pregnancy yoga class in Cork city costs €70, while a pregnancy spa package can set you back €155. What if you cannot afford this or you can only afford it once in the 9 months of pregnancy? What if you can afford it but just don't have the time to go? As a working, pregnant mother who already has a toddler running around, being able to go to the local yoga class is not exactly feasible.

This is where my research in health and positive psychology comes in. Health psychology has a long established tradition of examining changes and differences in health and well-being. In this case, my health focus is in the context of pregnancy. Positive psychology is the study of factors that allow us to thrive and live meaningful lives. It is not a *happyology*, as sometimes suggested, with a lot of pop psychologists running around telling everyone to 'smile more, it will make you feel better'. It is a scientific approach, which adopts a positive view of human functioning. The idea that we can foster and improve people's lives, rather than only supporting people in difficulty, is core in positive psychology. This counters the traditional view of pregnancy as a period of vulnerability where women may experience stress or depression and need treatment. A number of positive psychological interventions or exercises have been developed to improve well-being. The two types of interventions I use in my research are based on the positive constructs of gratitude and mindfulness. These constructs have a long history in people's private practice and in research.

Feeling Grateful, Feeling Mindful

Gratitude involves an appreciation of the positive in life. It can involve anything from a delicious home cooked meal to receiving a favour from a friend. The most widely studied gratitude-based intervention is the gratitude diary; this is sometimes referred to as 'counting your blessings'. In this exercise people are asked to think back over their day and write down things they feel grateful for. The main requirement is that they *truly feel* grateful for what they write down.

Mindfulness involves being fully aware of your thoughts, feelings and sensations in the present moment, in a non-judgmental way. In a sense, all internal and external stimuli are acknowledged but are not judged as positive or negative, they are simply accepted. This is not always an easy thing to do and mindfulness is a skill that must be practiced. Mindfulness has its roots in the Buddhist tradition. It shares a focus with positive psychology on cultivating positive aspects within oneself to bring about greater well-being.

Studies examining both gratitude and mindfulness interventions have consistently demonstrated benefits for well-being. Both types of intervention can reduce stress, anxiety, depression and physical symptoms. They can also increase happiness, life satisfaction and physical health. Strangely, despite how much we know about the benefits of gratitude and mindfulness for physical and mental health, their usefulness has yet to be fully examined during pregnancy. As we noted earlier, improvements in well-being would benefit both the mother and child during pregnancy. So we need to find short, easy and cost-effective interventions that are readily accessible to all pregnant women. We then need to prove that they work! My research is focused on these two challenges.

My Research

My research involves two main studies to develop and test the usefulness of gratitude and mindfulness exercises during pregnancy. In the first study I developed two new interventions, one based on mindfulness and one based on gratitude. The gratitude exercise involves writing and thinking about things that you are grateful for. The mindfulness exercise focuses on writing and thinking about your thoughts, feelings and sensations in the present moment. An important part of this mindfulness exercise is that you are thinking but not dwelling or judging anything you think or feel. Both of these exercises can be completed at home in 15 minutes. In the first study non-pregnant women used the interventions 3 to 4 times a week, for 1 month. The women were randomly assigned to one of the intervention groups or a control group. The control group did not do the gratitude or mindfulness exercises during the study. The aim was to see which intervention was most effective before using it with the pregnant group. From this study, I found that combining elements of both exercises has the greatest potential to improve well-being.

The second study examines the effect of a new intervention on prenatal well-being. This exercise combines aspects of *both* gratitude and mindfulness. The impact of the exercise on well-being is examined in comparison to standard prenatal care. Although not yet completed, provisional results suggest that this 15-minute exercise can reduce levels of stress, depression and improve happiness and life satisfaction among pregnant women. This indicates that the exercise has the potential to provide a quick, easy and cost-effective way to maintain and enhance well-being during pregnancy. As there are currently no programs or interventions in place to promote mental well-being during pregnancy this could be especially beneficial for expectant mothers and their developing babies.

I would like to thank my supervisor Dr Samantha Dockray, School of Applied Psychology, for her support and advice, and also The O'Connor Scholarship for funding received. I would also like to thank Dr Mairead O' Riordan, Professor Louise Kenny and Professor John Higgins, Department of Obstetrics and Gynaecology, for support provided in conducting this research.

Reform of the Irish family courts system

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Introduction

Access to the law and to the courts is an essential part of the rule of law in any democratic society. This right must not be 'theoretical or illusory' but rather should be 'practical and effective' as declared by the European Court of Human Rights in *Airey v Ireland* [1979] 2 E.H.R.R. 305.

Ireland's family law courts are in serious need of reform. Delays are problematic, the system is expensive and the courts do not appear to operate efficiently or coherently. Concerns have also been expressed at the continuing use of an adversarial model in this sensitive and complex area of law. Due to concerns that the current family court system is not fit for purpose, the Government has promised reform. The aim of my research is to develop a model of Irish family law courts drawing on international experience with a view to supporting progressive reform in this area.

Why are the family courts in need of reform?

Family law presents enormous challenges. Disputes arising out of family breakdown are as complicated and emotionally charged as they are common. Increasing numbers of people find themselves forced, by financial circumstances, to make their way without legal representation through a process designed for lawyers. A small number of these people go to trial on their own. Many settle, whether or not they have the information and support they need; some walk away, their conflict unresolved and possibly giving up what they need or were entitled to. Others never approach the family court system in the first place, seeing it as inaccessible, unaffordable and unresponsive to their circumstances.

While some people who use the court system to resolve their family law issues are satisfied with the result, the court process itself could be improved. At present, different aspects of a family dispute are sometimes being dealt with at the same time in different courts. This process denies any one court the opportunity to view the problem as a whole. Also, it causes duplicated efforts by judges, lawyers, witnesses, court administrators and the parties themselves and this naturally leads to increased costs.

Another issue that is repeatedly raised is the lack of specialist training that judges receive in dealing with vulnerable parties, in particular children. Judges presiding over family law cases have not necessarily practiced in the field of family law prior to their appointment and are not appointed specifically as family law judges. In contrast, judges in the New Zealand Family Court are specifically chosen because of their aptitude for family law work and only judges that are suitable to deal with matters of family law by reason of their training, experience and personality are appointed to the Family Court in Australia.

In addition, there is an ever increasing volume of cases coming before the courts administering family law. Despite family cases often constituting the highest percentage of cases on the civil calendars, they receive insufficient allocation in the scheduling of court sitting, resulting in long delays in cases being heard. The drafters of the Constitution could never have anticipated the growth in the volume of litigation, its complexity and diversity, throughout the legal system. As Denham J. pointed out in 2012 at the UCD Constitutional Studies Group Conference on "The Irish Constitution: Past, Present and Future":

> "Litigation reflects the radical changes in society which have occurred in Ireland in the last 75 years, especially in the last 25 years. Therefore, the court structure required [now] is different to that of 1937."

In light of the above difficulties, the Programme for Government 2011-2016 commits to the introduction of a constitutional amendment to allow for the establishment of a distinct and separate system of family courts to streamline family law court processes and make them more efficient and less costly, as soon as resources as permit. The specifics of the proposed reforms are as yet unknown. Indeed, the concept of a family court in itself embraces a wide range of ideas. In addition to the physical environment in which a family court is held and how its proceedings are organised, establishment of a family court system requires ancillary services, procedures and supports to be put into place to ensure, for example, the use of alternative methods of dispute resolution outside of the formal court system.

The Aim of my Research

This project will first analyse Irish law (including Constitutional Law) and the obligations under the European Convention on Human Rights associated with family courts and the rights of the parties in family law proceedings. With this legal framework in place, the research will then move on to documenting concerns with the existing courts. This will involve using existing literature and empirical research methodologies (court observation and semi structured interviews with professionals working in the family law area and litigants). It will then use this information to consider what reforms are necessary to enhance the court's accessibility, effectiveness and integration of services in line with international experience and standards. For the purpose of this project: accessibility means simplified

procedures, and services that are affordable and available within a reasonable time and distance. Effectiveness means that appropriate services are matched to family members' needs; that services promote timely, fair and lasting resolution of disputes, and that they foster functional family relationships. Integration means minimizing overlaps and gaps in services and linking those services so users can move easily from one service to another as appropriate. Furthermore, it means that providers of family justice services share common objectives and co-operate in planning and delivering those services.

It will also examine the family courts in other common law jurisdictions, including those currently undertaking similar reforms — notably England and Wales, Australia and New Zealand. The study will examine these family courts in order to identify possible models for achieving accessibility, effectiveness and integration of services in Ireland. Over the past number of years, these jurisdictions have come to the conclusion that the adversarial system is not best suited to family law, and have been exploring alternatives focused on the needs of the children and designed to minimise the conflict between the parties. This has involved greater specialisation in the family law area, including alternative forms of dispute resolution, and, for especially intractable cases, putting in place specialised family courts with specialist judges, supported by trained specialists from other disciplines.

Finally, this information and analysis will be used to develop a family court model consistent with Ireland's legal framework, including the Constitution and the European Convention on Human Rights. The practical realities of setting up such a specialist system in a small jurisdiction will also be explored along with the challenge of changing the culture of the family justice system. In this way, the research will identify key values, standards and principles necessary to underpin the new family court model and how they might be implemented in practice. This project will aim to recommend a family court that will:

- be accessible
- use available resources efficiently and effectively
- integrate service planning and delivery
- ensure children's welfare by adopting a uniform approach and procedure to hearing the child's voice. Facilities for the courts to interview children in family law cases must be provided for those children who have attained a sufficient age and maturity.
- promote early resolution of disputes, and minimize conflict by encouraging early cooperative settlement, refining and enhancing non-adversarial settlement processes, and supporting trials as an appropriate recourse only when other means are not appropriate or effective.

Rosemary O'Sullivan is a PhD student in the Faculty of Law, under the supervision of Professor Ursula Kilkelly. This research has been funded by the UCC Law Graduate School Fellowship

and the Government of Ireland Postgraduate Scholarship, awarded by the Irish Research Council.

Think before you post... Your future employer may be watching

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Figure 1: Shopping with iphone. Commons licensed image from Jason Howie available at http://www.flickr.com/photos/jasonahowie/8585049088/in/photostream/

Introduction

The explosion of social networking sites in recent years has given many Kim Kardashian wannabes an opportunity to display and glamorise their supposed activities and achievements. However, it has also unwittingly given employers an opportunity to pry into the personal (and at times very personal) affairs of their prospective employees through the practice of cyber-vetting. Social media users should take note. They should think very carefully before they post, tweet or upload a photograph as their future employer may be watching and to paraphrase US Chief Judge Alex Kozinski, removing something from the Internet is about as easy as removing urine from a swimming pool!

What is cyber vetting?

Dr Brenda Berkelaar of Purdue University, who completed a PhD on cyber-vetting, described the practice as: "when organizations use information from search engines or social networking communities to evaluate job candidates." In its simplest form, cyber-vetting is the examination by employers of the digital footprint left behind by a prospective employee.

At a basic level, cyber-vetting can involve a candidate being "googled". It can also consist of a more targeted examination of the social networking site(s) such as Facebook and LinkedIn belonging to the person in question. The third and perhaps most alarming stage of cyber-vetting, which for now appears to be limited to the United States, is a request that the prospective employee "volunteers" relevant passwords or enables the employer to "shoulder surf" so that the employer can have unfettered access to the full extent of the candidate's social networking profile(s), warts and all, without being frustrated by any privacy settings.

Why is cyber-vetting carried out?

Employers cyber-vet because they are trying to protect their legitimate business interests and long term reputation by researching what type of person they are hiring to ensure that they are a good fit for their organisation. This vetting provides a cheap, albeit crude, form of human filtration to enable the more promising employment candidates to progress to the next stage of selection, while the "undesirables" will have been eliminated without even realising it. It is also arguable that cyber-vetting could reveal more about the suitability of a candidate than a carefully crafted *curriculum vitae* or, at the very least, verify the information contained therein.

How extensive is cyber-vetting?

Unsurprisingly, given its government's approach to the surveillance of others, the home of cyber-vetting is the United States. A comparison was undertaken in 2010 by Microsoft of human resources professionals in the US, UK, Germany and France. When these professionals were asked whether:

- they reviewed on-line reputational information about a prospective candidate?
- 79% of Americans admitted that they reviewed such information all/most of the time compared with 47% (UK), 59% (Germany) and 23% (France);
- on-line screening was part of a formal hiring process?

- 75% of Americans said yes, compared to 48% (UK), 21% (Germany) and 21% (France);
- they had rejected a candidate as a result of on-line screening?
- 70% of Americans said yes, compared to 41% (UK), 16% (Germany) and 14% (France).

According to this study, nearly 80% of those involved in human resources management in the US admitted to engaging in cyber-vetting and 70% had rejected candidates based on what they had found. However, whilst the Microsoft findings are clear, they are not conclusive. In the US, the Society for Human Resources Management (SHRM) carried out a variety of studies in 2008, 2011 and 2013 on the attitudes of human resources professionals towards social media. Arguably their most important finding was in 2013, when 57% of those surveyed did not have a formal or informal policy towards the screening of social network websites, compared with 56% in 2011 and 72% in 2008.

On first impression the Microsoft findings differ from the SHRM results. The variation in results could partly be attributed to those involved in human resources management adopting a more "professional" approach when being surveyed by their own umbrella organisation when compared to Microsoft. Furthermore, the question asked in the Microsoft study is broader in that it talks about "on-line reputational information", whereas the SHRM survey is far more precise in its questions and talks specifically about social network websites, thus it is inevitable that there will be a difference between the two sets of results. Given its secretive nature, whilst the true extent of cyber-vetting may never be definitively known, it is apparent that it does take place, and employers and employees should be aware of the risks associated with this practice.

Concerns surrounding cyber-vetting

Probably the biggest risk facing employers who cyber-vet is that it may breach the privacy rights of prospective employees. As displayed in the Microsoft study, the country with the lowest incidence of cyber-vetting was France, which has some of the strictest privacy laws on the planet. In addition, if an employer views the social profile(s) of a candidate, they may inadvertently discover so-called "protected characteristics" such as: gender, ethnicity, disability, family/marital information which would not have been apparent from a *curriculum vitae* or application form. It is also possible that negative inferences could be drawn by employers from content indicating addictive tendencies or at the very least a fondness for alcohol, cigarettes or gaming/gambling. Consequently, if the candidate is unsuccessful in their application and can prove that their profile was viewed by an employer who engages in cyber-vetting, then the employer could be facing a very expensive equality and/or privacy claim and the accompanying toxic publicity that surrounds such litigation.

Attempts to curb cyber-vetting

It is perhaps not a surprise to discover that in the land of the free and the home of the brave, attempts have been made to curb cyber-vetting. Whilst nothing can be done to prevent employers reviewing publicly available information on search engines, over 30 States have introduced or have legislation pending that expressly prohibits: the practice of asking for passwords; requesting that privacy settings be changed so access can be obtained; requesting that employers be categorised as "friends"; or shoulder surfing — even during an actual interview. Any adverse treatment as a result of non-compliance is strictly forbidden.

Whilst this legislation aims to prevent employers accessing content that could embarrass and/or humiliate a prospective employee, the State of California has gone a step further and has introduced legislation colloquially known as the "Eraser law" that will enable teenagers to put incriminating photographs beyond the reach of future cyber-vetters in the first place.

Eraser law

In September 2013, the Californian Governor signed a Bill, which will come into legal effect on 1 January 2015, which requires all Internet website operators, online services, online and/or mobile applications to remove, at a minor's request, specific comments and photographs posted by that minor. In essence, it aims to protect teenagers from online baggage they have posted which they may later regret or could affect their ability to gain college admission, employment or both.

This legislation has been hailed as an extension of a minor's privacy rights and has received widespread support from family and community organisations who highlight the impetuosity of teenagers and the permanency of what they publish online. However, others have been less than generous with their support and see this as no more than a populist trick to secure potential votes. Most of the reservations centre on how this Eraser law will practically work, from:

- its complete ineffectiveness if the information has already been shared/uploaded by others;
- its non-applicability to content posted by a third party about a minor;
- how the under-eighteen age requirement will be enforced when many users lie about their age when they register on social networks in the first place;
- the jurisdictional applicability of this law, in that it is unclear whether it applies to organisations with physical operations in California or whether operators around

> the United States will have to comply in case some of their teenage customers reside in California?

The efficacy (or not) of this Eraser law is obviously too soon to tell. It should be emphasised that it will only apply to those who are under the age of eighteen, so for many it is too late and of no use.

Why cyber-vetting does not work

Despite its use, cyber-vetting is a crude, unsophisticated and ineffective tool used by employers in the mistaken belief that it will assist them to protect their interests. The reality is that it may harm those interests by discarding candidates who may be a real asset to their organisation.

Cyber-vetting often relies upon imprecise, incomplete and downright incorrect data and as a result imprecise, incomplete and incorrect conclusions will inevitably be drawn. Even if the information is factually correct, a snippet of information viewed in isolation many months, if not years, after the event cannot accurately reflect the true sentiments of the correspondent at the time the statement was made, particularly if the full exchange of emails/tweets/blogs is not available.

When communicating online, particularly if exchanges are confined to a small pool of friends, correspondents may adopt an alter ego — a more extreme and laughable version of themselves and will deliberately propose controversial ideas. This information may be extracted and isolated by cyber-vetting but the context will not be accurately reflected. Furthermore, people in a formal employment setting do not behave in the same way that they do online with friends, so the reliance by employers on cyber-vetting to provide corporate compatibility is destined to produce inaccurate results.

There is a huge variation in the type and amount of information available online and some prospective employees will have larger digital footprints than others. If cyber-vetting is used by employers as a tool of predicting future behaviour then it is fundamentally flawed as by its very nature it does not provide a completely standardised collection of information across all prospective candidates. In addition, for those employees who regularly self-monitor, artificially enhance and/or massage their online reputation, the results of a trawl of social media information may be distorted, and this consequently may negate any assumptions that can be drawn about their character and personality.

Given the doubts about the veracity of information obtained, combined with a non-standardised treatment of candidates, it is more than arguable that, by its very nature, cyber-vetting is both unfair and ineffective. These inaccurate conclusions are all the more worrying when the individuals concerned are unable to have the opportunity to challenge and/or correct such presumptions.

Whilst cyber-vetting is a cheap and quick method of assessing employees it is by its very nature fundamentally flawed and, for that reason, this practice should be consigned to the trash folder and deleted forever. This research into cyber-vetting forms part of a thesis entitled "Employment law for the digital age: How social media has affected the contract of employment" which examines how the traditional employment relationship has been and continues to be shaped by a variety of legal issues associated with the use of social media.

Elliott Payne is a first year doctoral candidate who would like to acknowledge the support provided by his supervisor Dr Darius Whelan and his colleagues in the UCC Law Department.

The 1979 Energy Crisis: US Foreign Policy and Public Consciousness

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Introduction

It is 1979. Cars wait for hours to get gasoline and fistfights erupt in the long queues. A riot over a lack of diesel fuel for truckers takes place in the centre of a model American middle-class suburb in Pennsylvania. Two years earlier President Jimmy Carter had appeared on national television explaining America's first comprehensive energy policy before submitting it to Congress. Framing the need to reduce dependence on foreign oil as being the "moral equivalent of war", Carter advocated conservation and the development of renewable sources of energy. This research proposes that, despite his efforts, between 1977 and 1979 Carter was unable to produce a grand strategy on energy because of foreign policy developments in the Middle East and their impacts on interconnected US domestic issues in the state of the economy, access to oil, and the public's perception of limits to US power. The foreign policy developments in the Middle East, which included the Iranian Revolution of 1979 and the Soviet invasion of Afghanistan at the end of that same year, affected world oil supplies with the knock on effect of affecting the strength of the US dollar. Without a way of controlling these foreign policy developments, the US was perceived as weak and the President ineffective. Essentially events thousands of miles away held consequences for domestic policies and thus ordinary Americans watched gasoline prices rise through the summer of 1979.

> "Our trade and current account positions have moved into heavy deficit. There are doubts that we will solve our energy problem or control inflation" — Under Secretary for Monetary Affairs to Secretary of the Treasury, July 26, 1977.

While events thousands of miles away influenced US domestic policies, the state of the US economy itself did not exist in a vacuum. With inflation running high OPEC oil producers were receiving less value for their product leading to some pressing for an oil price increase to recover some of that lost value. This was worrying for the US as a higher oil price would feed inflation, creating a vicious circle of continuing price rises and continuing inflation. As shown in the quotation above, the issues of inflation and America's need for oil were very closely linked. Months earlier, on April 18, 1977, President Carter had linked both when announcing the submission of his National Energy Plan (NEP) to Congress. His televised speech began, "tonight I want to have an unpleasant talk with you about a

problem unprecedented in our history", before then announcing that the energy problem was the "moral equivalent of war". He cited the economic and inflationary impacts of a failure to conserve energy, strongly linking his plan with the health of the economy. The NEP, developed over a period of 90 days, was to be Carter's grand strategy to defeat the energy problem. However, how would it solve the issue of inflation? By stemming demand for more energy, prices would stabilise and inflation would drop. In doing so, OPEC were less likely to raise their prices. The promised changes would not occur overnight though as the NEP was submitted to Congress for debate and subsequent approval, modification, or disapproval. In the meantime the US energy problem, and its relationship with inflation and foreign policy, remained very real.

As the NEP was debated within Congress, the Carter Administration concentrated efforts on improving relations with Saudi Arabia and Iran, the two most important OPEC producers. Knowing that the NEP would take some time to go through Congress, it was important that Carter reassure these key producers that inflation was a key concern of his Administration. In turn he would seek assurances that both nations would not pursue an oil price increase in the coming year. To this end Carter and Saudi Prince Fahd met in late May 1977 where they discussed oil prices , amongst other issues, with Carter attempting to add a key additional block to his grand strategy on energy by gaining a commitment from Fahd not to support a price increase in the coming year. While he did not gain such a commitment, his energy plan, still being debated in Congress, was paying some international dividends. In May an Indonesian oil official stated that Carter's proposed plan had influenced the OPEC nations, Indonesia one of them, to defer a planned July 1977 price increase. However, the positions of Saudi Arabia, Iran, and US inflation, were still liquid. This was shown in an October 1977 briefing memorandum to the Secretary of State which cited continuing US inflation as a key motivator for some OPEC members to seek a price increase for 1978. As testament to this the Treasury Secretary was given the task of explaining how the US planned on combating inflation when he visited Iran in October. In doing so, he would be attempting to convince the Shah of Iran to press for an OPEC price freeze. The final building block in the grand strategy was for Carter himself to meet the Shah and confirm such a freeze. If he could do so, other OPEC nations would follow the Iranian lead and allow the NEP time to get through Congress, and for US inflation to fall. When the Shah visited Carter in November he reminded him that US goods which Iran purchased had quintupled since 1973. Carter was forced to note that this inflation did indeed hurt Iran. Would the Shah freeze Iranian oil prices despite this? Citing Carter's fight against inflation, he did. Saudi Arabia did likewise and OPEC prices were frozen for 1978. Carter's grand strategy on energy was working, a price freeze would assist his fight against inflation and allow time for his domestic energy programs to work. However, events in the Middle East would demolish his project.

> "Continuation of Iranian curtailments beyond the next several months could turn an already tight gasoline market into one of spot shortages this summer" — Secretary of

Energy, James Schlesinger, January 4, 1979.

In September 1978 oil workers in Iran downed tools. Throughout 1978 protests against the rule of the Shah were growing and the oil workers became part of this. By December 1978 Iranian oil production had ceased as the Shah's regime crumbled. This would have profound effects on Carter's energy strategy. Just as he had tentatively constructed his strategy through 1977, he would now see it collapse. In an effort to shore up the remains of his strategy Carter militarised it, linking national security to Middle East oil, through a closer relationship with Saudi Arabia. With the above mentioned spot shortages seeing fuel stations temporarily close throughout the US in the summer of 1979 domestic discontent grew and Carter was blamed. The man who announced the idea of a grand energy strategy would have to take the fall as developments in the Middle East impacted on the US.

As the Iranian Revolution continued, the US saw world oil stocks plunge. The Energy Secretary wrote to Carter on January 4 1979 to explain that if Iranian production did not resume, the normal stock build up that took place to cover the summer and winter months, would not take place. The only nation that could feasibly make up the Iranian shortfall was Saudi Arabia and while it did cover the immediate shortfall no one was sure for how long this would last. Now that Iran was "lost" Washington knew it had to do all it could to bolster Saudi Arabia as the largest oil producer. A US Navy carrier group and jet fighter group was despatched to the Persian Gulf as a show of US resolve. Even still the general uncertainty drove up prices, led to hoarding, shortages and, skyrocketing inflation. Individual OPEC nations were now ignoring official OPEC prices, selling to whoever would buy. It all uncovered how dependent the US was on foreign oil. On January 27 1979 Defence Secretary Harold Brown wrote that the "deteriorating situation in Iran has magnified the serious question of continuing availability of oil from the Persian Gulf in the future...". He was right but Carter's NEP, although passed by Congress in a highly stripped-down form in November 1978, gave the US no immediate alternative. Therefore it had to bolster Saudi Arabia.

Within the US gasoline shortages began to bite. After the embarrassment of Vietnam and the tribulations of Watergate it seemed like this was the final straw, one more sign that the US was no longer omnipotent. The shortages were leading to long queues at filling stations which did have supplies and led to a weekend-long riot in middle-class Pennsylvania suburb. The riot was one result of a trucker's strike over the price of diesel and its effect on the trucking business. It was a perfect example of Carter's failed energy strategy and the effects of foreign policy developments in the Middle East on US domestic issues. With the rioters shouting "cheaper crude or no more food" (aimed at the Middle Eastern nations) it was clear that conservation and the "moral equivalent of war" that Carter had proclaimed in April 1977 was now far from their mindset. Inflation, still high, was frustrating Americans and the lack of access to cheap oil was doing likewise. However this frustration was

not just economic, it was also psychological. The US seemed weak, unable to stem the rising prices and shortages, and the grand strategy offered by Carter had seemed to fail, marking another failure on the dismal score-card of American achievements in the 1970s.

> "An attempt by any outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America" — President Jimmy Carter, January 23 1980.

With no way to solve the energy issue, Washington pressured Saudi Arabia to keep pumping oil. More important still was making sure Saudi Arabia was secure. The Iranian Revolution had shown that even strong monarchies were vulnerable. Would it only be a matter of time before a similar fate awaited the al-Saud family ruling Saudi Arabia? Notwithstanding internal threats there were also perceived external ones. The USSR seemed to be watching events in Iran closely, was actively involved in wars on the Horn of Africa and, according to the Saudis, was looking to gain influence in the Persian Gulf to garner oil supplies there. National Security Advisor Zbigniew Brzezinski, quoted by Time magazine in January 1979, spoke of an "arc of crisis" extending from the Horn of Africa to the Indian Ocean. Both saw the arc as a prime target area for Moscow with the Persian Gulf, from where most of the world's oil was shipped, as a choking point Moscow might someday grip. The careful diplomacy with OPEC members alá 1977 was shelved as Cold War rhetoric heated up throughout 1979 and in December the Soviets invaded Afghanistan, bordering the oil fields of Iran. Energy was now a national security issue under the Cold War umbrella, the grand strategy finished and on January 23 1980 Carter exclaimed the above quotation at an address to Congress in response to the Afghanistan invasion. Clearly the ideas of conservation were no longer to the forefront as oil and the Cold War mixed. Afghanistan was yet another development that scuppered Carter's chances of constructing that planned grand strategy.

However, perhaps Carter was naïve in thinking that such a strategy could ever work, dependent as the US was on resources from such an unstable region. While his goals were admirable, they did not frame the idea of an America without limits and were scuppered by Cold War realities come the end of 1979. Casting our minds to recent years the Persian Gulf region is still one of great interest to the US, the Carter Doctrine (above quote) laying the basis for US involvement in the region ever since the first Gulf War. As such, while this research has yet to reach its conclusions, it is relevant to current realities regarding US relations with energy-rich nations in the region.

Research for this project has taken place at the Jimmy Carter Presidential Library in Atlanta, Georgia, with further research to take place at the US National Archives. The author wishes to thanks his supervisors, Prof David Ryan and Dr David Fitzgerald, for their support.

TV on the move: How the growth in Internet streaming influences the video quality on your mobile device.

Jason Quinlan

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Any sufficiently advanced technology is indistinguishable from Magic (Arthur C. Clark)

Introduction

Every day, millions of people logon to the Internet to view their favorite TV show on Netflix, or similar streaming services, or to watch the latest viral video on YouTube. Two things are paramount, 1) that they receive the best streaming quality available, and 2) the video starts to play as quickly as possible. There is nothing worse than a video that stops and starts, takes forever to view or constantly changes between viewable qualities (resolutions). Due to our limited download speeds (bandwidth), in most houses it is not uncommon to hear "Stop downloading, I'm trying to watch something on Netflix".

When we couple this rise in online streaming with the growing number of portable devices (smart phones, tablets, laptops) we see an ever-increasing demand for high-definition online videos while on the move. This demand for mobile streaming highlights the need for adaptive video streaming schemes that can adjust to available bandwidth, where the cellular or Wi-Fi network can limit the quality of the video streaming, and can provide us with graceful changes in video quality, all while increasing our viewing satisfaction. This is the focus of my research. To date my research colleagues and I have developed three new schemes and have a patent pending.

How far we have come

It is a cold Friday night in December 1983, three weeks before Christmas. In the living room, adults and children are huddled round an impossibly large 21" color television, its soft irradiating glow adding to the festivities. To place the size of the TV in context, it is marginally smaller than a Ford Fiesta. The children are waiting for "The Late Late Toy Show" to begin, while the adults are hoping no new toy will be asked for, which would upset the letter already sent to Santa. Happy happy memories... If you were lucky, or

wealthy enough, you had a second TV in an adjacent room, possible a 14" portable. Again let me also place the 14" portable in context. On average it would take four rather strong children to move this 14" portable, that said it was easier to move the 14" compared to the Ford fiesta in the living room.

In this nostalgic age, there were only two concerns 1) that you did not fall asleep, thus missing the chance to talk with your friends about all the fantastic toys you saw and 2) that the Electrical Supply Board of Ireland was able to cope with 2.5 million kettles being switched on at the same time, during the ad breaks.

Advances in modern Internet and video streaming technologies permitted "The Late Late Toy Show" of 2013 to be streamed live to all corners of the globe. The video received almost 120,000 stream requests in two days as well as over 1.4 million Irish viewers during its broadcast. Meanwhile the benefits of Sky+, TiVo and similar techniques, permit us to pause, record and playback live TV broadcasts. We no longer need to stay awake during the show or overload the national grid during ad breaks. Modern lightweight devices such as smartphones, laptops and tablets now allow us to bring the TV with us as we move, thus introducing an age of mobile video. We can now watch episodes of our favorite TV program when we want, where we want and on what device we want.

But the rise in the number of people using mobile video and the increasing capabilities of mobile devices, soon to reach screen sizes upwards of 13", leads to an ever-growing demand for high quality videos. This equate to large downloads and thus congestion, or blockages, on the network. This ultimately leads to unpleasant video streaming quality. Before we go any further, let's review a little bit of the technology behind video streaming.

Techie bit

Two major technologies assist your device in viewing video streaming. The first is the Internet and associated Wi-Fi networks and the second is the video streaming technology itself.

Internet

The Internet is primarily composed of server computers, connected by a global network of cables and wireless connections, known as links. As the demand on the Internet has increased, the interconnected copper cables have been replaced with super fast fibre optic cables. These cables provide the "backbone" of the Internet and it is these cables that arrive at your home, your business and to the cellular towers you seen strewn over our cities and counties. The wireless links provide the "last hop" from the cable network to

your device. In our homes we use Wi-Fi to connect our devices to the Internet, while we use cellular network technologies like 3G, and soon to be 4G, when we are on the move.

When information or video data is sent from one of the servers to your device, it is normally too large to send all at once. Therefore, the server will cut the data into pieces and each of these pieces will be sent, or transmitted, as a packet. Thus each packet contains a little bit of the information needed by your device to view your requested video. You can think of these packets as dominos. If a domino is missing, then the next domino can't fall until you push it again and it is similar with video packets. If a packet is lost, the information it contains is lost and until your device tells the server to send the packet again, your video will pause and wait until the packet successfully arrives before the video starts to play again.

Finally, like the diesel tank in your car, the number of seats in a plane and the legs on the Christmas turkey, the capacity, or capability, of each of the links on the Internet is limited. Only so many packets can be transmitted on a link at any point in time, which we call the maximum bandwidth of a link. Different links have different capacities. The limit on a copper cable is low, a fibre cable is high, with Wi-Fi and cellular technologies lying in between. Thus, irrespective of the number of servers transmitting packets on a specific link, once the link reaches capacity, known as congestion, the link has no other option than to drop, or discard, packets. If 100 packets will fit on a link at a given point in time, and 110 packets are transmitted, then 10 packets will be lost. Which 10 packets will be lost is unknown, as each link can select the packets to drop at random. Only your device will know if it has lost any packets, as the packets will need to be requested again from the Server.

Video Streaming

Each video clip is nothing more than a collection of images, known as frames, and it is the number of frames per second that provides the illusion of movement. Hence "moving pictures" as it was once know. As we have seen, packets from frames can be lost while being transmitted over the Internet. To counteract the effects of this loss, video streaming introduced the concept of "Group of Pictures" (GOP), which groups a number of adjacent frames together, and treats these as a fixed point in time, such that if one GOP incurs network loss, this loss will not affect any other GOP. This gives your device the option of requesting the lost packets or moving onto the next GOP and ignoring the loss. Neither of these options is beneficial to the person watching the video, as requesting lost packets pauses the video, while moving to the next GOP makes the video very jumpy, plus an important part of the video may be lost. Imagine missing "Luke, I am your . . . .".

My Research

As we have seen the Internet has a finite limit on the bandwidth available to the interconnecting links between servers and devices, while congestion on the links leads to packet loss. The overwhelming growth in video streaming, supported by increasing numbers of portable devices, further exasperates this scenario. Video streaming has introduced a number of mechanisms to recover from the packet loss that occurs, but loss of any kind equals unpleasant video streaming quality. What we need is a way to reduce the quality of a video when loss occurs, thus providing a means of directly reflecting the level of loss in the viewable quality of the video. In addition, when a lot of people are watching the same video clip, as happened with the "Toy Show", we want to transmit only one stream to all the different devices.

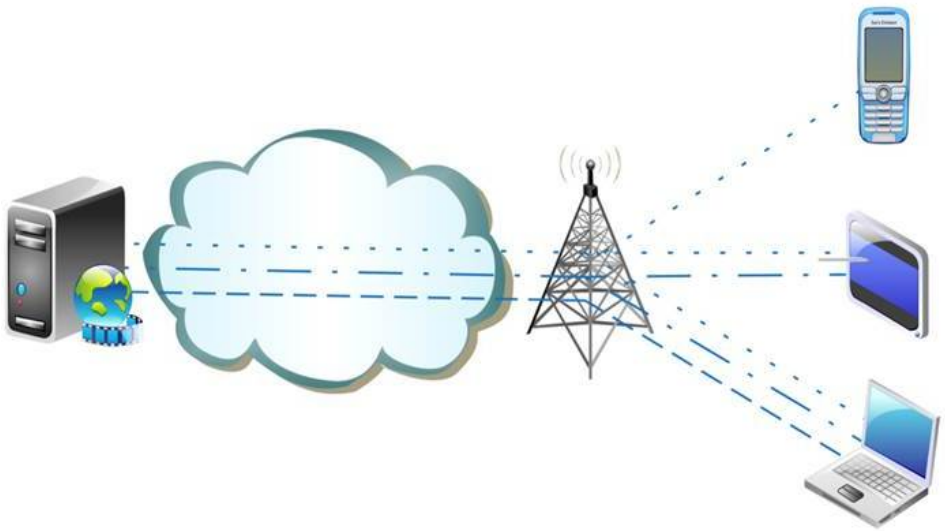

Figure 1: A single SVC stream being transmitted from a celluar tower to three devices each with different capabilities. Image: Jason Quinlan.

To achieve these goals we can use an existing technology called "Scalable Video Coding (SVC)". An SVC stream is composed of layers, where the viewable quality is dependent on the number of layers received at a device. As illustrated in Figure 1 one SVC stream, which contains three layers, is transmitted over the Internet to three devices connected to a cellular tower. Each device selects a different number of layers dependent on the capabilities of the device or the capacity of their respective link. This will allow each device select the correct quality for both the device and the link, plus it reduces congestion on the network as only one stream is transmitted for all devices rather than one stream for each device.

Unfortunately SVC does not cope very well with packet loss. With the exception of the lowest quality in the stream, called the "base layer", each of the layers in SVC is dependent on at least one other layer. Thus to increase viewable quality, a device needs to receive a number of layers with no packet loss. As I explained in the Internet section, at present

packet loss occurs randomly and because of this there is no guarantee that a complete layer will arrive at a device.

This is where my research begins. I like all the benefits that SVC provided, but it had a few flaws. As part of my work, I proposed a few changes that better reflected what I saw as the underlying goal of SVC. I changed the way the server cut the data into pieces. In my design each packet would contain a piece of information from every SVC layer and every frame per GOP, thus reducing loss to a little bit from every layer rather than all of the loss from one layer or GOP. I also created a new technique where I added a little bit of data to every layer, which would help us to recover from packet loss. The size of the helper data per layer would be dependent on how important the layer was, i.e. the base layer would have the biggest amount of helper data. This allows viewable quality to be dependent on the quantity of packets lost and not on what was lost.

I hope that these small steps, as well as my other research, will help companies design future streaming technologies that will provide all of us with better quality streaming videos for years to come.

Jason J. Quinlan is a PhD student in the Mobile and Internet Systems Laboratory (MISL), Department of Computer Science under the supervision of Prof. Cormac J. Sreenan and Dr. Ahmed H. Zahran. He would like to acknowledge the support provided by the Science Foundation Ireland (SFI) and by the National Telecommunication Regulation Authority (NTRA) of Egypt. He is forever indetted to his supervisors, Cormac Sreenan and Ahmed Zahran, his MISL colleagues, Ilias, Tony, Nashid, Lau, Paul, Mary, Lanny, Dapong, Hazzaa, Thuy, Xiuchao, Neil, to name but a few, and his family, Teresa and Jack, for their help and support during his journey.

Potential new drug for leukaemia

Eileen Russell

Department of Biochemistry, UCC

It's 1963 and the parents of Edward Burke try to make their child as comfortable as possible. It is a difficult task given that the 4 year olds pale body is covered in melon sized bruises. His bleeding gums briefly distract them from his persistent coughing and fever. The fair-haired boys meek voice complains of pain all over his swollen belly. This is leukaemia, for which there was no cure.

What is leukaemia?

Leukaemia is a cancer of the blood. Cancer is a group of diseases characterized by unregulated cell growth. There are over 200 different types of cancer, each classified by the type of cell that is affected. Blood is composed of red cells, white cells, platelets and plasma. These components are marked in figure 1. White blood cells play a vital role in fighting infection. In leukaemia, there is an unregulated increase in abnormal white blood cells. This explains where the term 'leukaemia' originated as it comes from the Greek words "leukos" and "heima," also meaning "white blood". These abnormal white blood cells, or leukaemic cells, grow rapidly and crowd out the normal cells that the body requires to function properly. In addition, leukaemic cells can move from the blood to other parts of the body. This movement, known as metastasis, allows the cancer to spread.

Factors that may affect the development of leukaemia are unclear but are thought to include family history and exposure to certain chemicals and radiation. Symptoms of the disease include tiredness, bruising, regular infections, fever and pain.

Leukaemia as a model for other cancers

Although leukaemia develops far less frequently than many other cancers, research in this disease has been some of the most productive of all cancer research. Virtually all of the major advances in cancer were first made in blood-related cancers, and subsequently transferred to other diseases. For example, the first chemotherapy was developed in leukaemia patients. The main reason that leukemia has been so productive for scientific discovery is that the blood provides great flexibility for researchers. Blood cells can easily be obtained from patients, and continue to be studied once outside the body. Cancerous blood cells can be drawn regularly from a patient receiving treatment with very little pain to the patient.

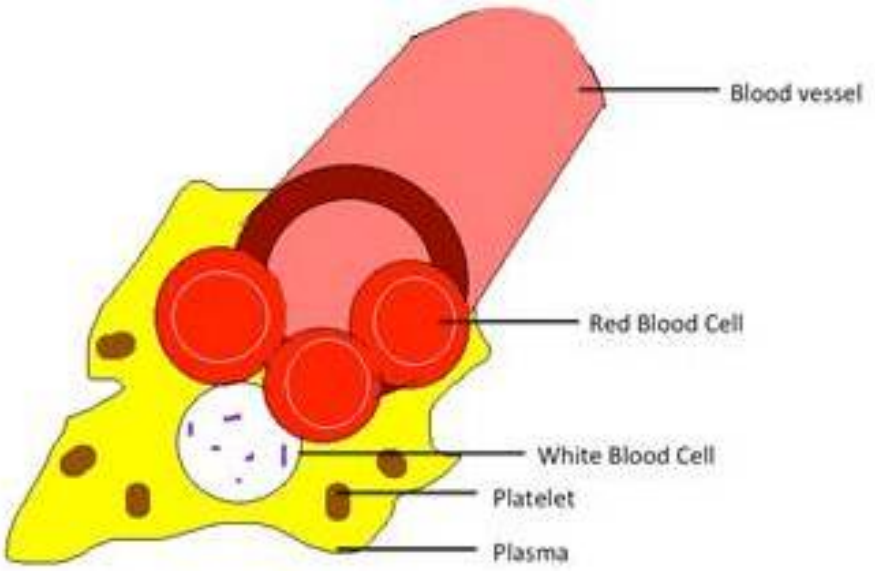

Figure 1: Components of the blood. Image: Eileen Russell.

Treatment of Leukaemia

Chemotherapy is the main treatment approach for leukaemia. The aim of chemotherapy is to kill the cancer cells while doing the least possible damage to normal cells. Figure 2 shows a cancer cell undergoing cell death. The image was captured by my supervisor, Professor Tom Cotter. A combination of chemotherapeutic drugs is often given to a patient. There are a number of chemotherapy drugs available, however, their effects are not always long lasting. The effects are usually so short lived due to a phenomenon called 'resistance'. Resistance occurs when cancer cells resist the effects of chemotherapy, all it takes is a few drug-defiant cells to thrive. Undoubtedly, leukaemia treatment has come a long way since it was first observed in 1845, but there is clear need to develop better drugs for this disease.

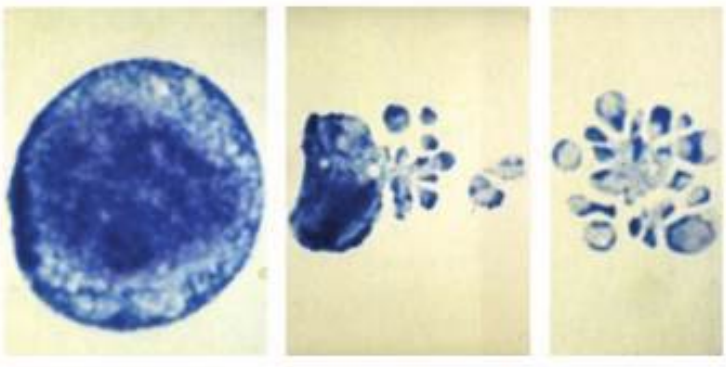

Figure 2: A cancer cell undergoing cell death. Image: Prof. Tom Cotter.

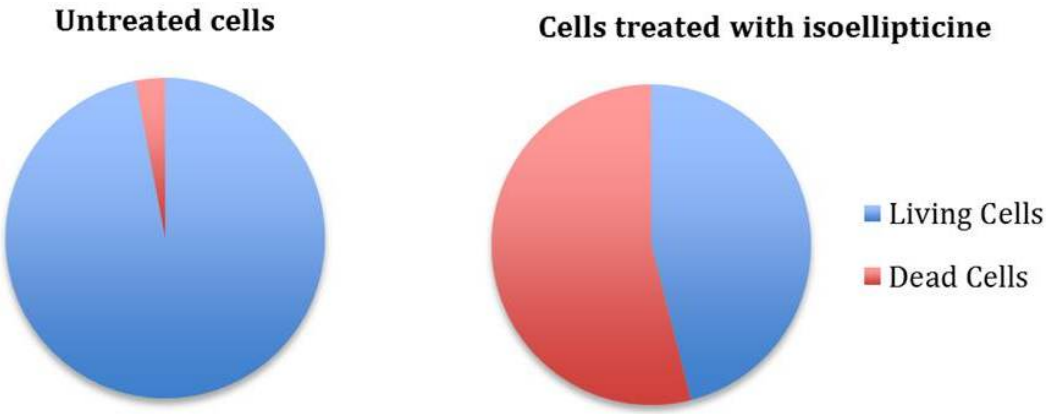

Figure 3: DIfference in health of treated and untreated cells. Image: Eileen Russell.

My Research

My project aims to improve ellipticine, an existing drug whose anti-cancer properties are already well known and characterized.

Ellipticine was first isolated from the leaf of *Ochrosia elliptica* Labill by Goodwin in 1959. Ellipticine was found to display strong anticancer activity. Unfortunately, ellipticine's use is limited as only a small fraction of the drug enters the blood. However, making a small structural change to ellipticine rectifies this problem. The modified ellipticine is called isoellipticine. My project is a partnership between our cancer biology laboratory and a chemistry laboratory in UCC. The chemistry group perform experiments on the drug to alter it before passing it over to us. We examine how good the altered drug is at killing leukaemia cells. So far, results show that the changes we have made to the structure of ellipticine have made it more effective at killing leukaemia cells. This is demonstrated in figure 3 which shows that cells treated with isoellipticine show 20 times more of a response than those not treated. Excitingly, preliminary data also suggests that isoellipticine has beneficial effects when used with an existing chemotherapeutic drug. Research is also being carried out to discover the best dose and how often the drug should be administered. All of the experiments in my project work with cells derived from leukaemia patients. These cells are now grown outside of the body in controlled conditions. This technique is known as cell culture. Cell culture involves the growth of cells in an environment composed of nutrient solutions and ideal conditions of temperature, humidity and gaseous atmosphere. This system allows a researcher to measure the response of the cell's alterations in prospective drugs. The advantage of these kind of experiments is that they permit simplification of a system. Armed with the knowledge gained from cell culture experiments, scientists can move forward to other experiments with isoellipticine.

What next?

The drug discovery process is lengthy. If a drug is found to be effective in cells outside of the body, it must then be used in experiments in cells that are in a living body. Following successful completion of this process the drug will move into trials in patients. Regulatory bodies must then review the drug's performance. Even after the approval of a drug, post-marketing surveillance takes place. While most drugs don't make it to the end of the process, research on these drugs can still be constructive. For example, if a drug fails to work, it may still tell us something new about the disease and work can begin on designing a drug overcoming this. The process can be tedious but patient safety is priority. It is laboratory experiments such as those carried out in my project, which lay the foundation in the drug discovery process.

Summary

Since Edward Burke's death in 1964, survival rates for leukaemia have quadrupled. A diagnosis of leukaemia is life changing but is no longer a death sentence thanks to advances in research. There is still an urgent need for a drug to combat leukaemia to further increase the survival of patients. It is hoped that data obtained from our research can simultaneously contribute to the knowledge about the disease and lead to the development of a new drug. Such a drug would improve the survival chances, and quality of life of people with the disease. This may be beneficial to sufferers of other types of cancer as many leukaemia phenomenona are applicable across to many categories of the disease.

Thanks to my supervisor Professor Tom Cotter, Dr. Florence McCarthy, my colleagues and my funding body, PRTLI.

Getting a sense of what is in your beverage

Shauna Scanlon

Tyndall National Institute and the Department of Chemistry , UCC

Introduction

When you drink a soft drink, probably the last thing that crosses your mind is how the taste is the exact same as the one you had before that, and the one before that. But how do the manufacturers ensure that the taste and quality of these beverages are consistent from one bottle to the next? Throughout the production process, food and beverage manufacturers must continuously ensure that their product meets the highest standards. In order to do this, a number of steps must be carried out. These begin with the analysts removing a sample of the product from the process line. Next, the product is taken from the processing plant and brought to the lab, where various quality control tests must be carried out. Here, it is the job of one or more analytical chemists to determine if the sample meets the standards expected by not only the quality control managers but also by the consumers who will buy the final product. The experiments carried out by the chemists include determining the pH of the sample, measuring the colour of the product, analysing the particle sizes within the sample, determining its viscosity and many more. Some of these experiments are quick, and simply involve placing a recording device into the sample and getting a reading. Others, however, are more complex and use very large instruments that may take almost an hour to provide a reading. The fact that the chemists must use each of these instruments repeatedly at regular intervals throughout the day, means that the current method of determining product quality is cumbersome, costly and laborious, where one cycle of testing may take up to two hours. Despite this, the analysis of product quality is a critical part of production and, therefore, manufacturers have had to accept these time-consuming methods as necessary steps to be carried out multiple times a day. What the food and beverage industry needs is new methods of measuring the quality of their products, which are easy to use, cost effective and use state-of-the-art technology.

Outline of my research

Process Analytical Technology

Consumers have increasingly high expectations when it comes to the quality of their food products and are looking for quality seals and trust marks on food and beverages, expecting manufacturers to produce these products to the highest standards. In order to

achieve this, the implementation of Process Analytical Technology (PAT) in the food and beverage industry has become increasingly desirable. PAT can be described as a system for analysing, and controlling manufacturing through regular measurements of the critical parameters that contribute to the quality of in-process materials. This is done through the application of a variety of different analytical methodologies, such as the ones mentioned previously, either directly within the process line, or externally. In this way quality is built into the product rather than determined through end-product testing.

My research aims to develop a system which integrates all of the technologies required to carry out the necessary quality control experiments into a single device for use with PAT in the food and beverage industry. This system will consist of two separate devices. The first device will be used to detect temperature, pH and conductivity while the second device will be used to detect specific gravity, particle size and caffeine concentration.

So how can instruments of such a large size be integrated into a device measuring a few centimetres? The answer can be found in the emerging technological area of Micro-Electro-Mechanical Systems, or MEMS.

MEMS

MEMS can simply be described as miniaturised devices and structures that are made using the technique of micro-fabrication, the most notable elements being microsensors. MEMS involve the integration of complete systems and technologies onto a single silicon chip whose dimensions can vary from a few micrometres to several millimetres. To give an indication of the size of this, the width of a single human hair ranges from 17 to 181 micrometres. As the name suggests, MEMS are devices that consist of at least some elements that have mechanical functionality. This does not mean to say that the elements necessarily have to move and therefore MEMS can vary from relatively simple structures having no moving elements, to extremely complex electromechanical systems with multiple moving elements under the control of integrated microelectronics.

It is these microsensors which will form the main part of my research. By replacing the currently used analytical instruments with microsensors, a multi-parameter sensing system can be developed.

Device components

An example of a microsensor that will be integrated into the device is an Ion-Sensitive Field Effect Transistor (ISFET). ISFETs are sensors used to determine the pH of a substance. They differ from the traditionally used glass electrodes in that they do not have an external glass structure, which means that they are more robust. This is an advantage, especially in

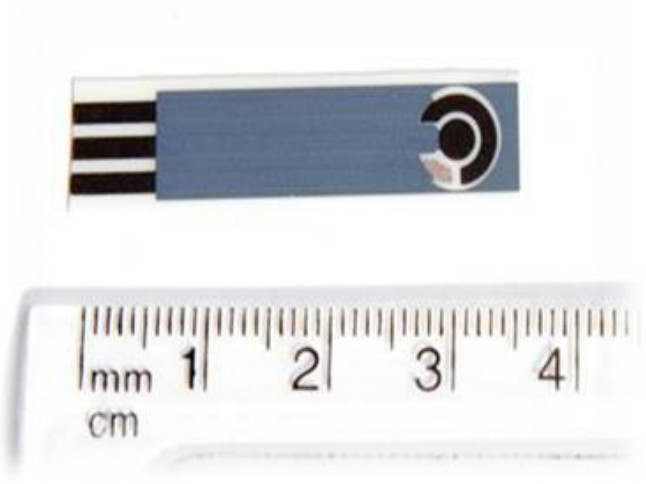

Figure 1: A Screen Printed Carbon Electrode for Caffeine detection. Image: Shauna Scanlon.

the food industry, where a glass breakage can bring the whole process to stop, no matter how small the glass fragments.

By using ISFETs instead of the currently used glass electrodes many other advantages will also be introduced such as their small size, rapid response and low cost.

Another example of a microsensor that will be used in the device is a conductivity sensor. This sensor gives an indication of, among other things, the consistency of the dissolved solids in the sample.

A planar sensor will be used to replace the traditional conductivity probe. An example of the dimensions of the sensor to be used, such as the one in Figure 3, is 15 mm x 5.5 mm x 0.65 mm, which is approximately half the size of a postage stamp.

Figure 2: Comparison of a traditional pH glass electrode (above) and an ISFET pH probe with the ISFET sensor on the probe tip (below). Image: Shauna Scanlon.

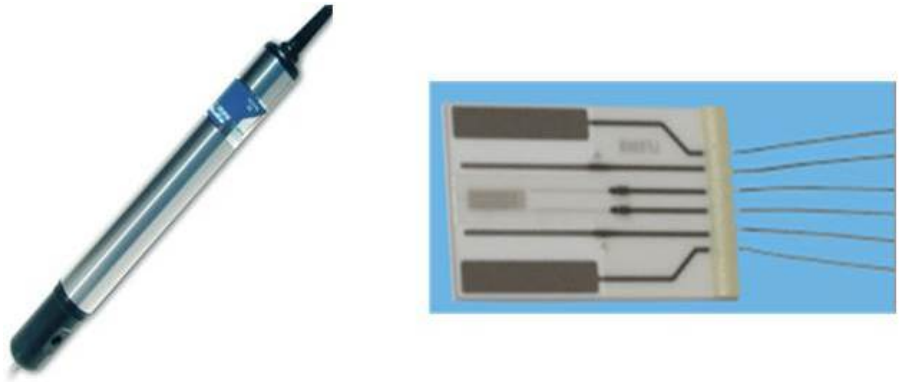

Figure 3: Traditional Conductivity probe (left), Planar, combined temperature and conductivity sensor (right). Image: IST AG.

Integration of devices

My multi-parameter sensing system will be integrated directly into the manufacturing process allowing for quality of the product to be continuously monitored, while avoiding disruption of manufacturing.

There are two methods by which the devices can be included in the manufacturing process. The first way is to fabricate a single probe that contains all of the sensors together on the probe tip. This could be integrated into the process line directly, with measurements being taken of the sample as it flows past during production.

The second method for integrating the devices would be through the use of an external sample cell that houses the sensors outside the process tank. In this case, small lines would be used to bring a sample from the main process line to the device, with another bringing the small amount of analysed sample to a waste area.

Either of these techniques enables all of the required tests of the sample to be carried out, while the quality of the product is continuously monitored. This will allow for manufacturers to receive the data they need, while avoiding the cost and time spent carrying out experiments in the laboratory.

Data from the sensors will be transmitted to the laboratory via a data aquisition system. This can then be analysed, trended and alarms points can be set up, which will be used to monitor any parameter that falls outside of the desired specification.

The approach to quality control, which I will be developing in my research, will open up further possibilities to exploit the technology in other relevant application sectors such as pharmaceutical and bioprocessing industries.

So, next time you have a soft drink, you can be happy in the knowledge that manufacturers are using state-of-the-art technology to assure the highest standards of taste and quality for you.

I would like to thank Dr Eric Moore, my supervisor, in Tyndall National Institute and Dr Damien Browne and Dr Sharon Rothwell, my co-supervisors, in PepsiCo for their support and advice. I would also like to acknowledge the Irish Research Council and PepsiCo for funding my research through the Enterprise Partnership Scheme.

Barefoot and Rosary-in-Hand: A Geography of Pilgrimage in Ireland

Richard Scriven

Department of Geography, UCC

> Pilgrimage is one of the fundamental structures a journey can take — the quest in search of something, if only one's own transformation, the journey toward a goal. - Rebecca Solnit, *Wanderlust: A History of Walking*

Departure

Bare feet treaded carefully on gravel. Staves sounded rhythmically against the path. Backpacks, filled with diluted orange drinks and sandwiches, were tightened on backs. The pilgrimage had begun. Just after dawn on 'Reek Sunday', the last Sunday in July 2012, I had started my climb of Croagh Patrick along with thousands of other pilgrims from across Ireland and further afield. Toddlers and octogenarians, whole families and groups of friends, youth clubs and lone walkers, all merged into one in the ascent of this conical peak in Co Mayo. We were participating in the continuation of ancient customs stretching back millennia, although the modern pilgrimage centres on the belief that St Patrick spent 40 days in prayer on the summit. As each person embarked on the journey up the mountain, they became a 'pilgrim'. Simultaneously, their beliefs, emotions and performances imbued the mountain with significance and sacredness. The place defines the people and the people define the place: people becoming pilgrims, a mountain becoming a sacred space. My research is about pilgrimage and this dynamic process that shapes the people and places involved.

Understanding Pilgrimage

From the car park at Murrisk, a well-established path winds its way up the ridge on the southern shore of Clew Bay towards the 'Reek', as Croagh Patrick is known locally. As the path stretches out before me, I paused to take in the crowds flowing up and down the hillside: children holding on to their parents, rosary beads swinging gently in hands, weary pilgrims leaning on their staves for support.

Croagh Patrick, recognised as being one of the best examples of large scale traditional pilgrimage in Western Europe, reminds us of the continuing role of pilgrimage in the contemporary world. In recent decades, with improved transport systems and increased

Figure 1: Pilgrims looking back at Croagh Patrick on Reek Sunday 2012. The long line of hundreds of pilgrims climbing and descending the mountain can clearly be seen. Image: Richard Scriven.

living standards, this practice has witnessed a revitalisation. This year up to 5 million Muslims will make the Hajj to Mecca, 20 million Catholics will go to Guadalupe in Mexico, and over 30 million Hindu pilgrims will travel to the River Ganges. In Ireland, Christian pilgrims will visit other major sites across Ireland, such as Knock and Lough Derg, and a range of regional and local shrines, especially holy wells.

Why is this ancient practice still attracting millions of people? What is its continuing appeal? In its essence, pilgrimage is a journey. Physically, it involves travelling and undertaking challenges, such as walking certain routes, prayer patterns and fasting or keeping vigil. Spiritually and emotionally, the journey offers a chance to take a break from the hustle and bustle of the everyday world and reflect on the more meaningful things in life. In particular, there is a strong desire to go in search of authentic experiences in specific sacred or special sites. The totality of the journey can be a transformative event, with the pilgrim returning home renewed, with a new outlook on life. All of these elements combine, to continually draw people to leave their homes and go on pilgrimage.

Approaching Pilgrimage

Before going on pilgrimage, the pilgrim must make preparations, select clothing and equipment. Similarly, the researcher must prepare a toolkit. This 'toolkit' consists of concepts and methods. I study pilgrimage as a geographer. Human geography investigates how people, through their actions and ideas, shape the world around them and how environments influence and define people. Therefore, I am interested in pilgrimage as an activity that shapes the way people and places interact.

An ethnographic methodology is the way I conduct my research. It involves observer participation and interviews with pilgrims. By being present at the pilgrimages and participating with and alongside other people, I can get a first-hand appreciation of all that is involved. I use cameras and camcorders to capture the performances and events of the pilgrimage. This observer participation is complemented by interviews. Discussions with people about their motivations and experiences, allows for explorations of the meanings and significance of pilgrimage. During my conversations with pilgrims we talk about why they go on pilgrimage, how they find the experience and what it means to them. In combining my geographical concepts and the rich audio-visual materials produced in fieldwork, I can provide new insights and appreciations of the role of pilgrimage in Irish society.

Journeys and Paths

The path up the Reek is a steep climb over loose rocks and gravel (see Figure 2). It is often said that, on the Reek, for every one step forward you slip back two. During my research, I stop to watch and photograph the progress of the pilgrims. I can see determination, doubt and exhaustion. The multitude of motivations and feelings are matched only by the countless steps taken up and down the mountain that day.

Traditionally, pilgrimage was about the desire to encounter the divine, to do penance or to gain some favour. It is now appreciated that these religious reasons are complemented by a vast array of spiritual, emotional and personal motivations. Pilgrims bring all manner of concerns, sentiments and feelings to the pilgrimage. Sick people, departed loved ones and current hardships have been all mentioned as reasons for climbing.

Several of the pilgrims expressed a strong connection between the physical journey and their intentions for being there. Turlough, a middle-aged man, explained that he thought of "family, friends and those in need while walking, often reciting simple prayers of childhood for their intentions". A comparable sentiment was expressed by Lily, a young woman who went with her family: "I've always found that praying while I walk helps so much. It keeps my mind off the hard task and reminds me of why I am doing it." The greater mean-

Figure 2: The steep path and loose rocks make the trek up 'the Reek' particularly challenging for pilgrims. Each pilgrim struggles up the path bringing their own intentions and concerns with them. Image: Richard Scriven.

ing of the route and the trek was mentioned by Ciarán, an older man, who commented that "[the path] tells you that anyone that wants to do the climb must do it the hard way and some people suffer because of it each year."

The trail up the side of the Reek is alive: alive with movement and activity, but equally with purpose and feeling. By going on pilgrimage, each person participates in and becomes embedded in this process. Each pilgrim weaves her or his own path. With every step the physical exertions of the climb are blended with the very personal intentions and emotions of the pilgrimage.

Barefoot Pilgrims

One of the customs most associated with Croagh Patrick is climbing barefoot. Only a small minority now undertake this challenge. It is most common to find people doing it because they feel it is in the spirit of the pilgrimage; however, some are doing it for specific reasons, such as a charitable cause or religious concerns. The barefoot pilgrims frequently make reference to the kind words and support from fellow pilgrims. Kate, a middle aged woman, explained that such encouragement made a significant difference to her on her climb: "There's a great sense of camaraderie and kindness, it's been really

Figure 3: A barefoot pilgrim kneels among those praying by the chapel after mass on the summit. Image: Richard Scriven.

fantastic, because it's the hardest physical thing I have ever done".

The Reek: A place apart

"We're there!" a woman announced triumphantly to her companions. They were relieved and delighted to have reached the summit of the Reek. For many pilgrims, there are other observances to be followed. Large crowds attend the frequent open-air masses and go to confession, some say the rosary while circling the mountain-top chapel. Pilgrims then take a well-earned break with the packed lunch and maybe a cup of tea or soup from one of the stalls set up for the day. There is a festive atmosphere. This is a special occasion where something unique happens in many different ways each year.

It is important to acknowledge the role of the location and the people in constructing this event. Firstly, the peak top sitting at 764 metres (2,507 ft) creates a feeling of being separate from the rest of the world. It was this feature that is thought to have brought St Patrick here, so that he could withdraw in prayer and meditate. Indeed, it still resonates today, with one pilgrim, Anthony saying that for him "travelling to a sacred place, is so important because it allows me to be connected spiritually with my God". Secondly, the large gathering and the chapel on the mountain-top site are most unusual, especially in an Irish context where most elevations are largely devoid of people and human-made

features. In addition, there is a distinct convivial character with many of the normal social barriers being removed. All pilgrims, friends and strangers alike, swap stories and even share food.

Return

The descent marks a slow return to the everyday world. Pilgrims are jubilant: the most arduous part of the day is behind them, they have filled up on lunch and, some, have attended mass and got confession. The breaks on the way down are not breathless pauses, but stops to take in the view or to offer a few words of encouragement to those coming up. As we leave the Reek, we are returning to normal life and shedding the role of pilgrims. However, we have been part of something which has left marks both on us and on the mountain.

By performing the pilgrimage, observing events and talking with people, I explore the rich and multifaceted relationships that exist between people and places. I also tell these people's stories and tell the story of this special mountain. This contributes to our understandings and appreciations of places such as Croagh Patrick and the customs involved. Furthermore, it presents a distinct way of valuing the experiences of each individual and our continuing role in shaping and preserving our cultural heritage and natural landscape.

Thanks to my supervisors John Crowley and Ray O'Connor, and the staff and fellow research postgraduates in the Department of Geography. Also, thanks to my family and friends for their support. My research is funded by the Irish Research Council Government of Ireland Postgraduate Scholarship and was previously funded under the Department of Geography PhD Studentship Scheme. Some of my fieldwork was funded by the Geographical Society of Ireland Postgraduate Fieldwork/Travel Award 2013. All the images were taken during my fieldwork on Reek Sunday 2012 and 2013.

Stable Ships for Smooth Servicing of Offshore Wind Farms

Matthew Shanley

Civil and Environmental Engineering, UCC

> "Man cannot discover new oceans unless he has the courage to lose sight of the shore."
> (Andre Gide)

Introduction

There is a rapid increase in the number of offshore wind farms in European waters to help meet renewable energy targets. Wind turbines are being installed in progressively more exposed areas of the North Sea and the Irish Sea, with the eventual aim of placing them in the Atlantic Ocean. As offshore wind farms require regular maintenance, being able to access the wind turbines during rough sea conditions is a key issue for profitable operation.

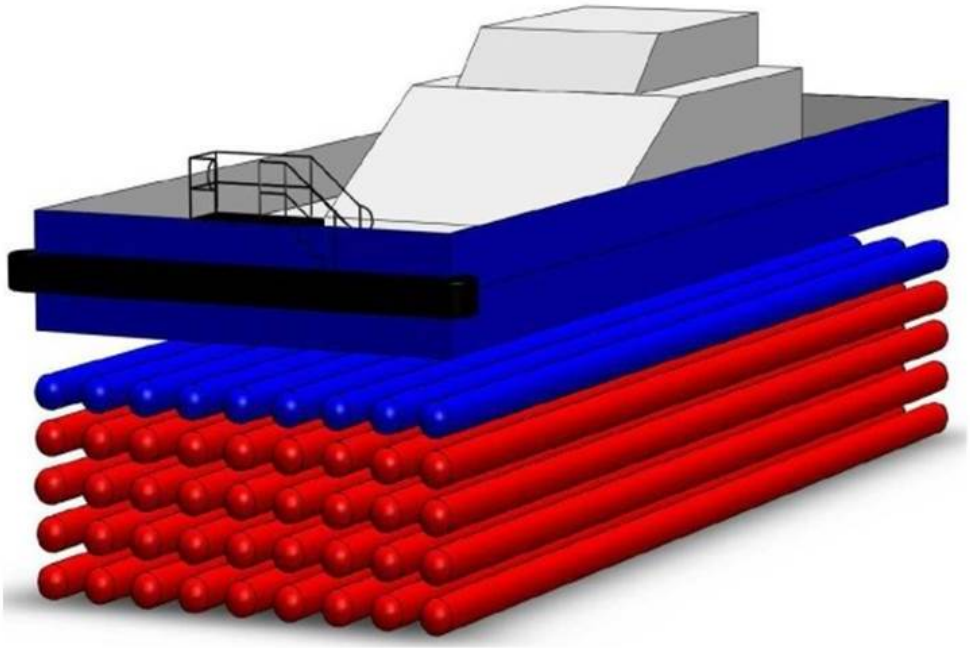

Figure 1: Artists Impression of the Concept Ship Design, Consisting of a Large Number of Buoyant Tubes. Image: Matthew Shanley.

The operation involves transferring personnel from the service ship to the wind turbine. The current wave height limit for this is 1.5 m, slightly less than 5 feet, increasing this results in significant savings over the lifetime of the wind farm. Each wind farm service

ship has 12 maintenance crew. Imagine you are one waiting on port for the sea and weather conditions to be right so that you can head out to the wind turbine. You've been waiting for two weeks, you can see the wind turbine from land but the sea is so rough that stepping from the ship to the turbine is impossible. The only way to transfer the maintenance crew to the turbines is from the front (bow) of the ship, out at the wind farm this is the best way for the ship to maintain position. Standing at the bow of a ship is much like standing on the end of a seesaw; which means that accessing the wind turbine can only occur during reasonably calm conditions. Quantitatively, this results in the average of the highest one-third waves being 1.5 m, which is described as a sea state code of slight to moderate. This research aims to develop designs that can operate in the sea state code of rough, with an average height of the highest one-third of the waves being 3 metres or more.

What We Hope To Do

I will address the issue of wind turbine access by examining a concept hull design for an offshore wind farm service ship as shown above in Figure 1. The ship's unique hull design is composed of buoyant tubes that give the ship buoyancy, and allow water to flow around them. The effect of this on the proposed design minimises the ships motions, by reducing its response to the wave motion. The design was first analysed using specialist software and then physical model testing was carried out. The physical model testing took place in a large, 25 m long tank of water capable of generating ocean waves.

Ship Design

The ship is intended to be a wind farm service provider, 24 m long, with a capacity for 12 passengers. These specifications come from Det Norske Veritas (DNV), regulations, a leading regulatory body for wind turbine operation. Their rules for classification of ships 'Offshore Service Ships, Tugs and Special Ships', specify the requirements of ships for windfarm maintenance.

Numerical Analysis

The numerical modelling of the concept hull design was carried out using a specialist software, in order to better understand the dynamics of the design. The software used was a computational fluid dynamics (CFD) package that calculates the movement of water and the movement of a floating bod. The design was modelled using symmetry; hence, only

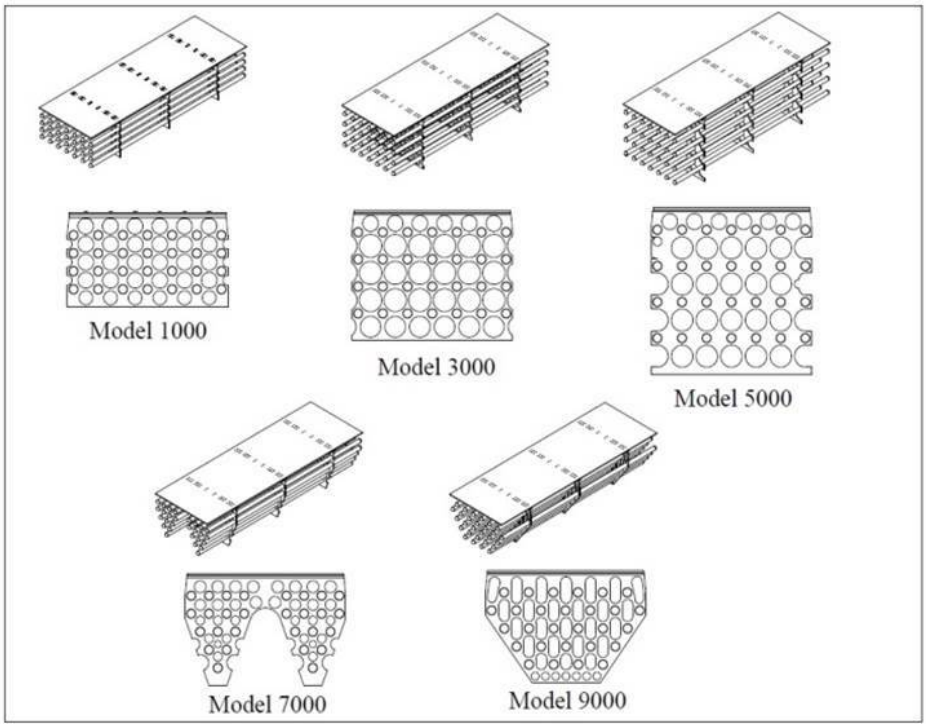

Figure 2: Model Configurations tested during the Physical Modelling Analysis. Image: Matthew Shanley.

a “slice” of the design was modelled; this reduced the computer power required to carry out the simulations.

Physical Analysis

The physical modelling of the concept hull design was carried out at 1:25 scale, and took place in the wave tank at Beaufort Research in University College Cork. The entire hull was constructed and a number of variations of the concept were tested; the vertical spacing between the tubes was altered, the overall layout of the tubes was also altered from the box layout in Figure 1 to a catamaran style layout and a staggered layout. Figure 2 below shows the model configurations in more detail. Each of the designs was tested also with a “heave plate”, a large flat piece that resists the ships vertical motion.

The variations in design included;

- Changing the spacing of the buoyant tubes
- Changing the horizontal spacing of the tubes but keeping the overall width constant
- Adding a “heave plate”, a large flat piece that resists the ships vertical motion

I used the wave tank to generate a range of waves to interact with the model and I then recorded the models motions. From these measurements I was able to calculate the ships

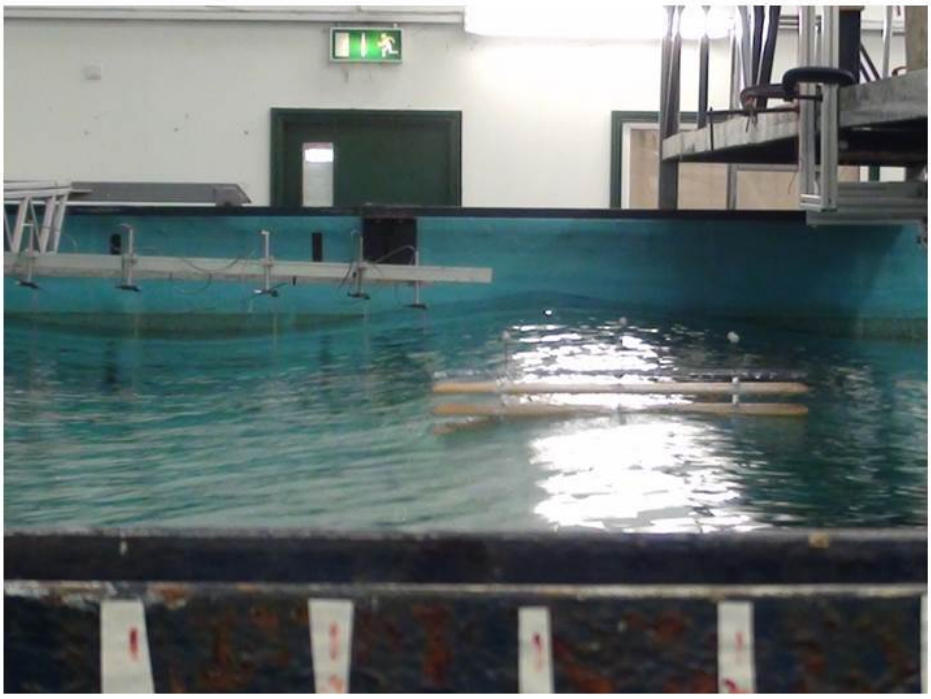

Figure 3: Physical Modelling of the Hull Form in a 1 m Deep Wave Tank. Image: Matthew Shanley.

Response Amplitude Operators (RAO). RAO is a measure of how much a wave moves a ship up and down (heave) or tilts the ship backward and forwards (pitch), relative to the wave height.

The model is shown below in Figure 3 at the crest of a wave. The model was tested in the Beaufort-HMRC wave tank. The tank is 25m long and 18m wide with a depth of 1m. The waves are generated by forty bottom-hinged (at 0.7m depth) flap-type paddles with active absorption and at the opposing end of the tank, there is a wave absorbing beach. The model was constructed primarily from 4mm polycarbonate, balsa wood coated with Original Yacht Varnish, 4mm stainless steel bolts and lead ballast. The model was slack moored to maintain position and avoid additional forces being imparted on the model.

Results

The results from my work show that some parts of the design work well. The deeper the ships structure extended below the waterline the better and the ships with a heave plate performed very well. However the tubes at any spacing or configuration added very little to reducing the ships response to waves.

Comparison Response Amplitude Operators (RAO) from the results of the numerical and physical analysis show close agreement. RAO as explained earlier is a measure of how much a wave moves a ship up and down or tilts the ship backward and forwards.

The close agreement between numerical and physical model testing reinforces the accuracy of the type of numerical analysis carried out (computational fluid dynamics) which is gaining a significant amount of positive press from similar validation studies related to floating bodies. This result is a validation of using a numerical wave tank set up in CFD for testing novel hull forms. Unfortunately, it took longer to do fewer simulations with the numerical method than the physical one.

Conclusion

This article has described a design that was analysed as part of my Ph.D. in order to develop a ship that allows maintenance crews to access offshore wind turbines in rough seas. This will address the rapid increase in the number of offshore wind farms in European waters, and the maintenance requirements that these have.

The model testing showed little improvement over a conventional ship of the same size. Although the results from the work carried out show that some parts of the design work well, such as a deep draft and a heave plate, the tubes themselves had very little effect.

An important conclusion from the testing carried out is the dependability of CFD numerical wave tank modelling. This illustrates that a CFD numerical wave tank is a powerful tool in accurately modelling unusual shapes.

The concept tested was not an improvement on the conventional ships but some aspects of the ship showed potential for significant improvement if developed. Further work will focus on these features and the development of them for an advanced design. However, any one of the twelve maintenance crew mentioned earlier would probably not trust such strange ships at first, but they shall warm to them when they work and make their lives easier.

The author wishes to thank Dr Jimmy Murphy and Prof Tony Lewis for their supervision and to acknowledge the Graduate Research Education Program in Engineering and the Beaufort-HMRC research centre for the financial support of the project.

Water — the new oil!

Brendan Patrick Walsh

School of Engineering, UCC

> When the well's dry, we know the worth of water. (Benjamin Franklin)

You're at home in the kitchen, it's warm outside, your mouth feels dry, you take your favourite glass, all clean and glistening in the glowing sunshine; you turn on the tap to get some cool, clear, refreshing sparkling water .... but nothing happens. Welcome to the future .... unless we change the way we manage our water.

The management of all our limited natural resources is becoming increasingly critical. Freshwater is available in abundance in some regions of the world, but is becoming increasingly scarce in others.

Ban Ki-moon, Secretary General of the United Nations, recently stated that water links the local to the regional, and brings together global questions of food security, public health, urbanization and energy. Addressing how we use and manage water resources is central to setting the world on a more sustainable and equitable path.

Traditionally in Ireland, we have been blessed with a plentiful supply of freshwater; indeed, in some cases, excesses have been responsible for tremendous damage and sadly the loss of life. Ireland even exports drinking water around the world; who would have thought that was possible thirty years ago?

But do we in Ireland, or even globally as a population, really manage our water usage? The answer is "No". Therefore, this research aims to develop novel, software based models to integrate and interpret data on water usage. The software shall be capable of providing a clear understanding of this area, both domestically and industrially and shall be suitable for optimisation in order to identify the most efficient means of utilising water within the facility being studied and hence lead to reduced water consumption.

Energy Crises and Energy Management

Historically, there have been several crises associated with natural resources, the most significant of which being those associated with oil. This has resulted in the development of systems to control the utilisation of oil, through the management of energy consumption. Typically, standards are developed to assist with these management systems, most recently a worldwide standard ISO50001 for Energy Management was released.

Adoption of a standard means that the organisation undertakes to perform its activities in a responsible and efficient manner as described in its relevant certification documentation. An initial audit is executed in order to grant certification, with follow-up audits carried out routinely. Any non-compliance is identified and corrected. Typically, this results in a well-managed, predictable and improved performance in the area covered by the standard.

Water as Energy

Now it is the turn of water, which is often referred to as "The New Oil", in a guarded and prudent manner, to take the limelight. Indeed many organisations have adopted water as a form of energy and managed it using ISO50001 the Energy Management standard, University College Cork (UCC) being one such example. UCC was awarded certification to ISO50001 late in 2011 and was the first third level institution worldwide to achieve certification, along with being the first public sector body in Ireland to be certified.

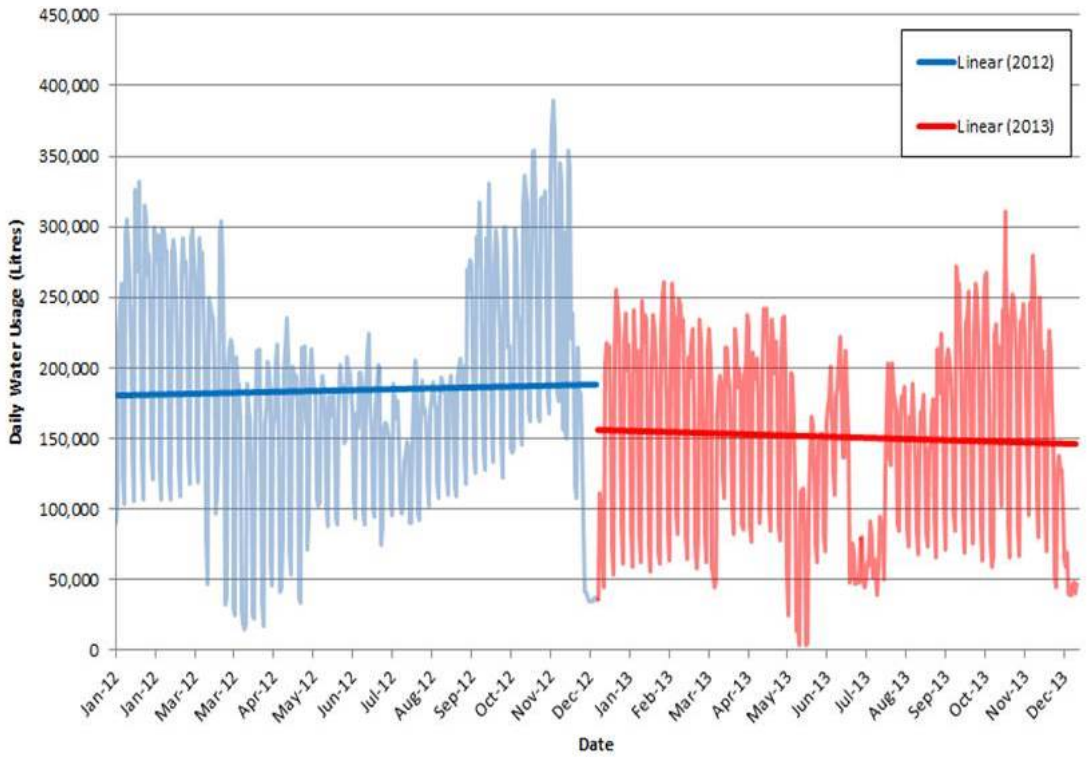

Figure 1: Water Consumption in UCC.

The graph in figure 1 illustrates the daily and linear average water consumption by the main campus of UCC since certification to ISO50001. The data shown is for the calendar years of 2012 and 2013 and includes the major consumers such as the heating boilers and sanitary facilities. The benefits of following the program have been realised through the 18% reduction in total annual consumption from 67,433,977 to 54,966,464 litres/year.

The Water-Energy Nexus

A nexus is defined as a means of connection or a link. Typically, on a worldwide basis, water, energy and food are considered as one nexus, with the water-energy link being a subsidiary of that. Aspects of the nexus include the strong interdependencies between water and energy generation and distribution, with water being required to generate electricity and electricity being required to distribute water. The excess consumption of both has had effects on climate change and subsequently on the environment. Both are undergoing a rapidly growing demand worldwide, while also serving as resource constraints. Both are subject to regional quality variability with variations in supply and demand. Internationally, energy has been included in regulated markets for a long time, while water has been added more recently. Within Ireland, Irish Water has been formed within the energy company Bord Gais and is being regulated by the Commission for Energy Regulation. Globally, and even between states in the US, water and energy supplies have been the subject of trade and security disputes, with certain regions depriving others of what they consider to be their entitlement.

Many countries have provisions made for a clean energy future, however they must also now plan for water scarcity and the two programs need to be incorporated. Energy and Water consumption are inextricably linked and the Energy-Water nexus needs to be understood and managed. In order to assist with this, the United Nations has revised its publications protocol, and the inaugural annual World Water Development Report, to be published in 2014, is themed upon “Water and Energy”.

Industrial Water Consumption

The neglect of one area of either energy supply or water supply, both internationally and indeed industrially, can have a significant impact on the other and lead to shortages with consequential effects.

Instinctively for water, quality would be the initial consideration; however, just as for a goldfish, the quantity available is also critical!

Many multi-national companies now require measures of both the quality and quantity of supply of both energy and water. Quantitative metrics are being developed in order to allow comparison between proposed locations and are being used by multi-nationals as an aid in the selection of the location for future facilities and also as an aid to the determination of which facilities to close down. One such metric is water usage effectiveness (WUE), a metric that looks at how many litres of water go into running and cooling equipment. For example, Facebook even began highlighting the WUE measure by publishing real-time dashboards on the internet that display how its data centres in the US are performing

against these metrics.

The carbon footprint of an organisation is defined as being the total of all the green-house gasses caused by the organisation. Presently, companies calculate their carbon footprint and strive to improve it by reducing their emissions. In the not-so-distant future, companies are also expected to declare a water-footprint, in a similar manner to the declaration of a carbon footprint presently. This footprint will be applicable to products, processes and organizations and will be based on life cycle assessments. It will be necessary to accurately quantify the water consumed, in a verifiable and consistent manner. In order to facilitate this, a new international standard, entitled ISO14046 Water Footprint, is being developed.

As well as efficiency, other factors such as wastage through ageing distribution networks, conservation measures and waste water treatment developments to facilitate recycling also need to be considered.

Software and the Research Topic

All management systems utilise the data that is made available to them. The constant introduction of additional meters within systems has resulted in large quantities of data being generated, with readings being taken every second if required. Virtual meters are also being employed, where real meter readings are subtracted from an overall total, in order to yield a reading for a supply which does not have a meter.

In order to receive, collate and manipulate this data, software systems are required. In my PhD research, I will develop software models to increase efficiency and thus reduce the consumption of water. It is proposed to consider water as a utility resource in a similar manner to other environmental energy streams and create a software model of the water utilisation in a large industrial manufacturing facility. Typically in a sterile manufacturing facility, mains water is taken in and treated by equipment and chemicals to provide several different water streams, such as De-ionised water, Purified water, Water for injection, Boiler feed water, Potable water etc. I propose to assign categories and values to each of the different forms of treated/processed streams based on the inherent environmental and economic impact of the stream. The model optimisation shall then identify potential changes to the existing practices of water treatment and consumption within the facility. These changes are expected to highlight and reduce the use of high value treated water and increase the use of low value water streams. The changes will also identify large consumers, which when targeted, will lead to a reduction in overall consumption. The model will be optimised using appropriate data analytic methods and novel optimisation techniques with a view to the best possible utilisation of each water stream, thus reducing the cost of water supply, the cost of water treatment, the overall

volume of water consumed and hence saving the facility money whilst also benefiting the environment.

The incoming ISO14046 Water standard and the existing ISO50001 Energy standard both require the monitoring of existing performance and also the demonstration of improvement. The software being developed as part of this research will satisfy these requirements for organisations, thus ensuring compliance with the standards which will ultimately lead to improved efficiency and reduced consumption.

Software has already been shown to be beneficial in the management of water consumption. In California, one software company has harnessed the information made available to it from the electricity meters installed on the motors driving the pumps on a large farm's irrigation system. The electricity measured by these meters represents a set of data, that when analysed correctly can be turned into a profile of when and where water is being lost in the irrigation system. Thus, without the addition of extra water meters, the existing information can be analysed to assist with water conservation. Indeed many water efficiency improvements similar to this can actually save as much energy as energy efficiency measures and at a much lower cost.

Conclusion

The UN estimates that presently one fifth of the world's population is challenged by water scarcity and that, by 2025, one quarter of the population will be affected. Water availability will become a major consideration in residential occupation and business operation around the world.

The metered cost of water is also expected to rise. In the US, commercial water rates have risen by an average of 30% over the last four years. All indicators point to the cost continuing to increase in all parts of the world.

Concerns regarding the future availability and cost of water have now stimulated interest in the management of this valuable resource. The EU Research Program Horizon 2020, commencing in 2014, predicts €500 million per year EU public investment in Water research in Europe.

Water consumption domestically, commercially and industrially needs to be managed in an effective manner analogous to that of Energy. My research will assist in this challenge by providing the software required to optimise water consumption industrially and hence contribute to the reduction in water consumption globally.

Brendan Walsh is a student in the School of Engineering under the supervision of Dr. Dominic O'Sullivan. The author would like to acknowledge the support of the Irish Research Council under the Enterprise Partnership Scheme along with ENMS Ltd.

The virtually extended self: searching for meaning in online worlds

Steve Warren

School of Applied Psychology, UCC

> The technology we use becomes part of our mind, extending our minds, and indeed ourselves, into the world. (David Chalmers)

The Search for Meaning in Life

Denton

A man wakes to the same world that has greeted him every morning for the past 29 years. It's a world he isn't very fond of, and it's a world that hasn't given him much opportunity to change. He lives in practical isolation, caring for his house bound mother, a duty left to him after an abusive father finally left a few years back. He doesn't have a job, nor has he ever. He doesn't have friends in the real world, although he would like some, and he doesn't have a normal life, although this is something he also desires. This is a man who lives with depression and anxiety, in a world where his needs and wants go largely unfulfilled. One day a seemingly insignificant decision, based on his underlying desire for improvement in life, had an outcome that would impact his life as much as, if not more than, any of those forced upon him previously; he purchased World of Warcraft, a massively multiplayer online role-playing game (MMORPG). Suddenly this online world opens up to him, he plays the game from dusk to dawn, and well beyond. He makes friends, starts participating in a community, gets a feeling of accomplishment, gets to express himself, and has control over his life in this world; he begins to grow and experience all the meaningful things life can offer for the first time. This is the story of Denton, and it isn't a unique one.

Decisions

The decision Denton made, whether he knew it or not, was all part of his own personal search for meaning. Every day we make decisions, small or large, which can either be based on the past or based on the future. If I decide to stay home tonight, I am choosing the past; I know it's comfy, I have done it many times, I liked it before, and so on. It's the safe option. But if I decide to go to the ballet on a whim I am choosing the future; it is a new experience for me, and so previously unknown opportunities arise, and so

on. Each decision we make each day builds up until an underlying direction is formed, what Sartre called *a fundamental project*. An underlying direction pointed at the past leads to stagnation, boredom and a sense that life is meaningless. An underlying direction pointed at the future leads to excitement, fulfilment and a sense that life may have some meaning. This time Denton, for whatever reason, decided to choose the future. His search for meaning in life had turned a corner.

Meaning in Life

So what exactly is meaning in life? Meaning in life is, according to Schnell, '*a fundamental sense of meaning based on the appraisal of one's life as coherent, significant, directed and belonging*'. The literature holds that there are the three pillars of meaning in life: 1) that your life has personal significance, that you feel your life is worth something, 2) that your life makes sense, that it has a sense of order, and 3) that your life has a direction, that you feel your life has a definite purpose.

So what exactly is involved in the search for meaning? The search for meaning has been found to be an ever-present facet of our lives, and regardless of the level of presence of meaning in life the search is always ticking over. After reading the paragraph on decisions you shouldn't be surprised to hear that curiosity is a predictor for the extraction of meaning from any given situation or on any given day. Exploration of the self, the world, and the expansion of skills and knowledge lead to a greater chance of meaning being found.

But how do you extract meaning from the world around you? There are what the literature calls *sources of meaning*, these are the cognitive and emotional resources that an individual draws upon to obtain meaning in life. Some examples of these would be; *knowledge, challenge, individualism, achievement,* and *creativity*. These are only five of a potential thirty plus sources that can be used to give you that feeling of significance, purpose or order, a feeling of meaning in life. However, there are also *domains*, or areas of life, that allow you access to these sources. Online gaming is one such domain. It is at this point in the literature where my research aims to make a contribution by finding which of these sources are specific to online gaming, and what the relationship is between online gaming and meaning in life.

Online Games

Popularity

Video games in general have permeated our everyday lives, as demonstrated by the fact that it is claimed in 2013 that 67% of US households play them and that $66 billion dollars were spent on gaming. Figures now claim that 72% of gamers now in 2014 play online,

with 17 billion hours invested in Xbox Live alone in a single year. Games, and in particular online games, are no insignificant thing.

Extended Minds and Extended Selves

In the field of philosophy of mind, Clark and Chalmers have discussed the idea of *The Extended Mind.* This is the idea that some mental processes are extended into the organism's environment; that the mind does not end at the same place your neurons do. So we manipulate, exploit, and transform external structures to use them as extensions of our minds. In a thought experiment, Inga and Otto are trying to recall where the museum is. Otto has Alzheimer's so he writes down as many memories as he can on his notepad. Otto recalls by consulting his notepad, which he has used as an extension of his mind. As humans we do this all the time, from counting on our hands to using an iPhone for memory, navigation, calculations, etc. According to Chalmers, the technology we use *"becomes part of our mind, extending our minds, and indeed ourselves, into the world"*

Ng and Wiemer-Hastings found that even if certain MMORPG players could not play in a game. For whatever reason, they would look for social interaction elsewhere online. Some people just prefer the interactions online. Yee discovered that 40% of males and 54% of females found their online friends *comparable or better* that their real life friends. This is not an insignificant number, and shows how important and influential the online world can be.

In one paper, compellingly named *The Ideal Elf,* it was shown that players who have low self-esteem or depression create characters in online games that are closer to resembling their ideal selves over their real selves. This is based on a theory called *self-discrepancy,* where a person's happiness is related to the gap between their real self and their ideal self. Therefore, by creating a character online they are filling this gap.

The Virtually Extended Self

Method

Based on the literature discussed above, the current study set out to discover the potential relationship between meaning in life and online gaming. This research employed a qualitative approach, by interviews with MMORPG players. Ages ranged between 18 and 42, with both male and females interviewed. Grounded theory was employed to analyse the interviews, chosen because of its systematic methods in discovering a theory that would describe the relationship which was the goal of the research.

Tools for Meaning

The theory constructed in the study describes the relationship between a gamer's offline life and their online life. Players of online games, in this case MMORPGs, will use the game to obtain differing amounts of meaning in life through the activity of participating in the online world. However, it is only a temporary benefit, as they understand that the real world is the most important reality. The players seem to use the game as a stepping stone. It was shown that players use the game to get what they want, and do the things they want. The theory then reads:

> Players use online games as temporary tools to obtain missing meaning in life

This theory has two important facets; 1) the game/online world (the distinction being blurred here) used as a vehicle to obtain meaning in life, whether inadvertently or otherwise, and 2) that this process is ultimately temporary, and is used as a stepping stone. The online world is a bubble, and in the long run participants say they want the sources of meaning to come from the real world. Booker sums up this idea that the game is used as an extension of the real world:

> "The real world is always where the most valuable and deepest experiences will take place.. In conjunction with the real world, then it [gaming] adds a considerable amount."

Elizabeth has an interesting story to tell when it comes to meaning that is missing in life and the potential to replace it. She now lives in a small community, where she is completing her MSc in Clinical Psychology. Unfortunately for her, she feels that she has to be very careful with how she appears in public, in case it affects her professional reputation. She must dress a certain way, speak a certain way, and behave a certain way. She continues:

> "... it's very tiring, so WoW let's me be me really".

Her life has taken a turn that, while she is happy with it in one sense, has significant setbacks in another. Her life is now artificially constricted, and she is missing aspects of life which are important to her, such as the ability to be herself. Asked if she felt that the game may help with that issue, she replied:

> "Uh yes, it allows me to pull into my life those people I want in it, and leave out those whom I can do without".

Elizabeth uses the game as a tool to *do* and *get* the things she wants. The online world is a place where she can be herself and get an important form of personal meaning in life.

Another participant, Manderley, replies to a question about the feeling of accomplishment with the following:

> "At the moment, I'm unemployed (and job hunting), so it's definitely happening in WoW more often :) When I was at work, though, I could count on several times a week feeling more accomplished and useful."

For Manderley, being out of work has meant that he is not getting that feeling of accomplishment and self-worth in the real world he would like, and the game is helping fill that gap. He continues:

> "I would say it's a means to interact from home when I don't have the ability to 'get out' — I'm a single dad so my ability to go shoot billiards or have a night out is pretty limited."

For Manderley, just like Elizabeth and many others in the current study, the online world is a way to *get* and *do* the things they are unable to do in the real world.

Six Online Sources of Meaning

The current study found six sources of meaning that an individual has the potential to obtain through participation in the online world. The six factors are: *social participation, sense of community, accomplishment, expression, agency,* and *personal growth*. These factors are the sources of meaning that players can obtain from playing online games, and in turn influence the theory discussed above. It is these six factors that players of online games will look to replace by participating in the game, consciously or unconsciously.

Notepads, Computers and Meaning

Just as Otto used his notepad as an extension of his mind, as an external structure manipulated to extend his mind's abilities, Denton uses the character he has created in the online world as an extension of not only his mind, but his self. William James talked about how we extend into our environments, how our identity is defined by not only the inner self, but also the outer self; our clothes, our car, etc. Chalmers and Clark talk about how we extend our minds into the environment, and use them as tools to improve our "holistic minds."

And for Denton, these both apply. He extends himself into this *online* world, a relational world, a social world, full of dialogues that spring from and create that world. It is here he searches for missing meaning, using his extended online self to enrich what we might call his "holistic self."

The current study has shown that people who participate in these online worlds consider them, consciously or unconsciously, an enhancer of their whole (or holistic) life experience. People will obtain differing sources of meaning from their participation in the online world, with the strength of attainment depending on what they are missing in the real world. It can be something as simple as fun or social activity, to as complex as agency or expression. They use the online world as a tool to obtain missing meaning in life.

However, it is important to note that the online world is not used as a replacement for the real world, but rather as an enhancement. People who involve themselves in these online worlds believe that the real world is still the most important arena, but due to circumstances, often out of their control, they must expand their search. This is a salient point, as it has been argued many times that spending time in online worlds is a waste of time, and people who use them should be made interact in the real world. That online worlds are unhealthy and objectively inferior to the real world, but these arguments miss the point. The online world is different to the real world. At present, the online world can be viewed as something like a crutch; it is something we rely on when our preference for the real is unavailable. You don't walk up to someone using a crutch and demand they throw it away and walk on their broken leg. The crutch, just like an online world, is an enhancer of our holistic life experience. But as access to and advancements in the online world continue, this idea that the online world can be used to enhance experience will become even more important, maybe even to the point where the online world may not be regarded as a crutch at all, where the difference between the online world and the real world is practically indistinguishable because of the tight integration between the two.

I would like to thank my supervisor, Dr. Jurek Kirakowski, as well as all the participants who kindly agreed to take part in my study.

The Overweight Challenge and Perceptions of Weight

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Background

Obesity is the most important health challenge faced at a global level and represents a rapidly growing problem to the health of populations. The prevalence of obesity is increasing worldwide and is an emerging healthcare epidemic affecting all populations. The World Health Organisation predicts that by 2015, 2.3 billion individuals will be overweight, and more than 700 million will be obese. Obesity is a relatively new phenomenon that has increased dramatically over the past three decades. In Ireland, adults are becoming overweight and obese at an alarming rate mirroring international patterns which signals a spiralling public health issue. Changing diets, consumption of high fat and high energy foods and increasingly sedentary lifestyles, have contributed to the generalised increase in body weight.

Obesity is a chronic disease and is characterised by an accumulation of excess body fat caused by increased caloric intake and decreased energy expenditure. Obesity is associated with complications that have a significant impact on health, psychosocial well-being, longevity, and quality of life for those affected. The rise in obesity rates have been accompanied by an increase in preventable chronic diseases. Eighty per cent of obese adults have at least one, and 40% have two, or more associated diseases such as diabetes, heart disease, gallbladder disease, breathing problems and certain forms of cancers (endometrial, breast, colon). Obesity appears to be responsible for a substantial economic burden and has a substantial impact on health care spending.

The increasing prevalence of obesity in Ireland has led to the normalisation of obesity within society. Recognition of the problem is a key component of obesity management and it remains especially crucial to address this issue. Reducing obesity is one of the greatest global public health challenges of the 21st century. Health care professionals have a key role to play in the prevention, treatment and management of obesity. Obesity cannot be cured, but effective prevention and treatment strategies are required and creating a lifestyle transformation for overweight and obese people must now become a major priority.

Perceptions of Weight

As individuals become overweight or obese, they experience an increase in body image dissatisfaction which relates to an individual's ability to accurately perceive their body weight. Many people misperceive their weight and do not recognise their own overweight status. Inaccurate recognition of weight status by individuals is a threat to their health. The acceptance of higher body weights has led to individuals being unaware of the reality of their weight status and gravity of this situation. As individuals have become more tolerant of higher body weights, the need to perceive their weight status is delayed thus impeding recognition of obesity.

The decision to lose weight is heavily based on the perceptions of one's weight. Weight misperceptions among overweight and obese individuals may preclude adoption of healthy attitudes and behaviours. Awareness of personal weight status may be an important first step to avoid further weight gain. Having an adequate perception and interpretation of one's own body weight is the first step in maintaining a healthy body weight and prevention of being overweight. Encouraging behavioural changes can be difficult if an individual does not perceive that they are overweight or obese. The Health Belief Model represents a useful framework for understanding how individual's forms decisions that influence health behaviours and this framework will be used in the study to gain a deeper understanding of factors influencing weight loss.

Given the escalating global health problem of obesity, the need to re-appraise its management is more compelling than ever. It is widely accepted that the causes of obesity are complex and multi-factorial, therefore prevention demands an approach that enables a change of culture, attitudes and behaviour. In view of Ireland's increasing prevalence of obesity rates, a study to measure factors relating to motivation to change behaviour focusing on weight perceptions is timely.

Aim

The aim of the research was to determine factors relating to motivation to change behaviour in overweight individuals and to determine if the constructs of the Health Belief Model helped to explain motivation to change behaviour.

Methods

Following ethical approval, a descriptive, cross sectional, correlation study was undertaken. A sample of 202 men and women who perceived themselves to be overweight participated in the study. Data were collected using an online questionnaire.

Findings

Results indicated a significant discrepancy between individual's perceptions of their body weight and their BMI-determined weight category. The findings showed that the majority of respondents (81%) accurately perceived themselves to be overweight. Weight misperception was found in those who were obese with only 17% of respondents who were obese perceiving themselves to be obese. Over 60% of obese participants perceived themselves to be overweight and 21% perceived themselves to be very overweight. In contrast, most overweight respondents correctly perceived themselves to be overweight. The study results clearly show that the largest misperception was found in those who were obese.

Conclusion and Recommendations

The findings in this study offer insight into the need to examine the role of body weight perception in weight management strategies. Weight misperceptions are potentially modifiable, therefore public health strategies that promote physical activity and healthy eating behaviours need to focus on overcoming weight misperception. Greater routine monitoring and interpretation of body weight is required and could present an important step in managing the obesity epidemic. It is anticipated that the findings of this research will prompt health care professionals to focus on inaccurate weight perceptions in targeting weight loss effort among overweight and obese individuals. This should include routine monitoring and interpretation of body weight followed with education on enhanced benefits of modest weight loss and healthy lifestyles.

The finding draws attention to the need for health messages that challenge people to think about their weight as having an accurate perception on one's level of body weight can be a valuable first step in an individual's awareness of their weight status.

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