

# THE BOOLEAN

Snapshots of Doctoral Research at  
University College Cork

2010



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## Introduction

The key outcome of doctoral research is the generation of new knowledge, and a key measure of the academic output of any doctoral student's thesis is the number and quality of academic publications arising from the work. Hundreds of articles, papers, monographs and books arising from the work of UCC's doctoral students appear in the academic literature each year. However, few outside the academic specialisation involved are likely to read these articles, and hence the knowledge generated by the students is generally accessible to relatively few people within UCC and the outside community.

In recent years, a number of aspects of graduate education in Ireland have changed profoundly. Firstly, an increasing focus is being placed on the structured development of specific skills during doctoral research, particularly the ability to communicate with a range of audiences, including the non-specialist. Secondly, in parallel, there is a growing awareness of the role of doctoral graduates in a wide range of sectors of employment beyond academia, and thus the need for employers and the wider community to understand the type of research in which these students engage. Finally, the importance of research to the development of Ireland's economy is a key factor, and thus initiatives to make stakeholders more aware of the research being undertaken in the universities are necessary.

In the light of all these factors, UCC is launching this publication, *The Boolean*, as a new initiative to share the outcomes of doctoral research to a wider audience. The student authors have been challenged to describe their research in a concise and accessible manner, and have worked with peer-reviewers (from the student Editorial Board) and the academic staff editors to produce articles that successfully achieve these goals. The result is the present volume of 37 articles that describe research from across the complete span of UCC's academic disciplines. We hope the readers will find these articles interesting, illuminating and stimulating, and will generate new opportunities for authors and readers alike.

The team responsible wish to thank, first and foremost, the authors for their contributions and their enthusiasm for the project, and also all involved in the project, listed on the next page. The journal will be available in both hard copy and on-line versions, across UCC and beyond, and will be an annual publication, to continue as a platform for doctoral students to hone their key writing and editing skills while bringing their work to the widest audience possible.

Many thanks for reading this journal, and enjoy!

'The Boolean' team

October 2010

# Investigating the solid-state properties of drug-loaded mesoporous silica

**Robert Ahern**

School of Pharmacy, UCC

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## Introduction

“The drugs don’t always work”: Nearly 40% of new drug compounds developed nowadays have poor water-solubility. Solubility refers to the amount of drug that will dissolve in a liquid. This means that these drugs will not easily dissolve in water; they are a bit like sand. Imagine taking a tablet for a headache that had poor water-solubility; it would take a long time to dissolve in the body and may not relieve the pain. This is a serious problem for the pharmaceutical industry because it is spending a lot of money developing drugs that cannot be brought to market. My work aims to address this challenge and develop a solution to this problem.

## Outline of my Work

In my work, the anti-cholesterol drug fenofibrate will be used as the model poorly-water soluble drug. I will use a carrier material called mesoporous silica to increase the dissolution rate of fenofibrate by combining them together. The dissolution rate refers to how quickly something dissolves in a liquid over a given time; in this case, it refers to how quickly a drug dissolves in the body and works. The addition of mesoporous silica will make the fenofibrate dissolve much faster in water, like sugar in a cup of tea.

Mesoporous silica is a material that has many small pores in its structure, which range in size from 2 to 30 nanometre. The structure of mesoporous silica is highly ordered with long hexagonal pores as seen in Fig. 1. Its structure somewhat resembles the structure of honeycomb Fig. 2. and, as a result, it has a huge surface area. One gram of mesoporous silica has an area equivalent to one tenth of a football pitch. This is one of the reasons why mesoporous silica increases fenofibrate’s dissolution rate, because materials with high surface areas have more contact points at which to dissolve into the liquid.



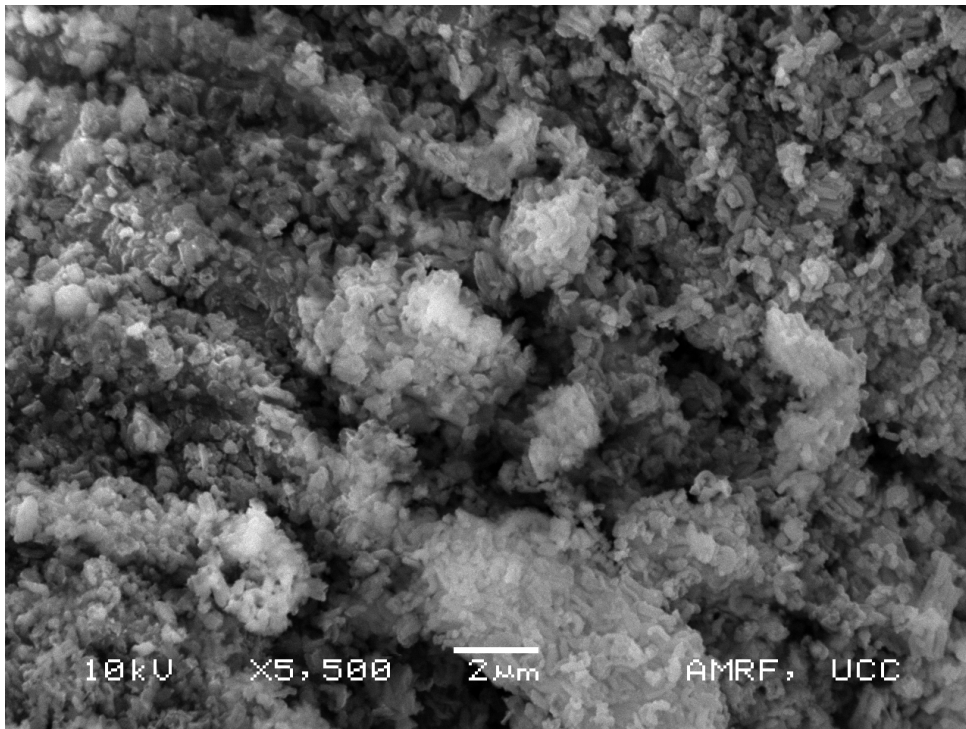


Figure 1: Electronic Microscope Image of Mesoporous Silica

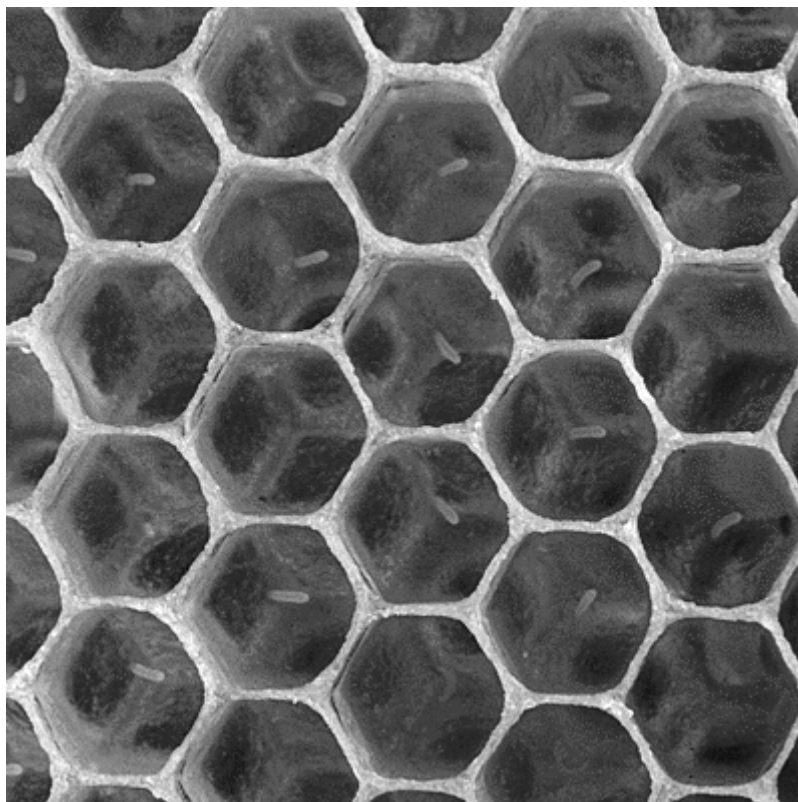


Figure 2: Structure of Honeycomb

## Work Undertaken to Date

Thus far in my work, I have combined mesoporous silica with fenofibrate in different ratios using two different methods to load the drug. The first method investigated involved physically blending them together; the two materials were put in a container and spun around just like clothes in a tumble dryer. These samples are called the physical samples. The second method I used to combine these materials was melting the fenofibrate onto and into mesopores of the silica after the initial blending step. In other words, the two materials were blended, then heated in an oven at 85°C for 24 hours and then cooled for 24 hours. By heating both materials to 85°C, the fenofibrate melted and flowed into the pores and onto the surface of the mesoporous silica. These samples are called the fusion samples.

## Techniques Used to Characterise my Results

Various characterisation techniques were used to determine the effect on fenofibrate of combining it with mesoporous silica. These techniques included DSC, FT-IR, P-XRD and Dissolution Studies. DSC (differential scanning calorimetry) is a thermodynamic technique that works by heating materials, usually up to and beyond their melting points. This is a very useful technique because it provides a great deal of information on a material such as its melting point and enthalpy of fusion (this is the energy required to melt one gram of it) which can be used to determine a material's structural arrangement, crystallinity. The term crystallinity refers to the solid structure of a material; essentially it refers to how structured or ordered definite shape the molecules (the building blocks of the solid material) are. P-XRD (powder x-ray diffraction) provides information on the solid state of a material. The different solid structures of a material can be identified which means that we can see if a material has a structure that is highly ordered (like building blocks of a wall) or if it is disordered. FTIR (Fourier transform infrared spectroscopy) is a technique which provides information on the chemical bonds of a material; FT-IR can be used to determine what interactions are occurring between the two materials. Dissolution studies involve dissolving a known amount of material in a suitable liquid and taking samples of the resulting mixture at different times. These samples are then used to calculate how much of the material has dissolved at each period of time. Essentially, dissolution studies can be used to try and replicate what happens in the human body when a drug is taken by a person.

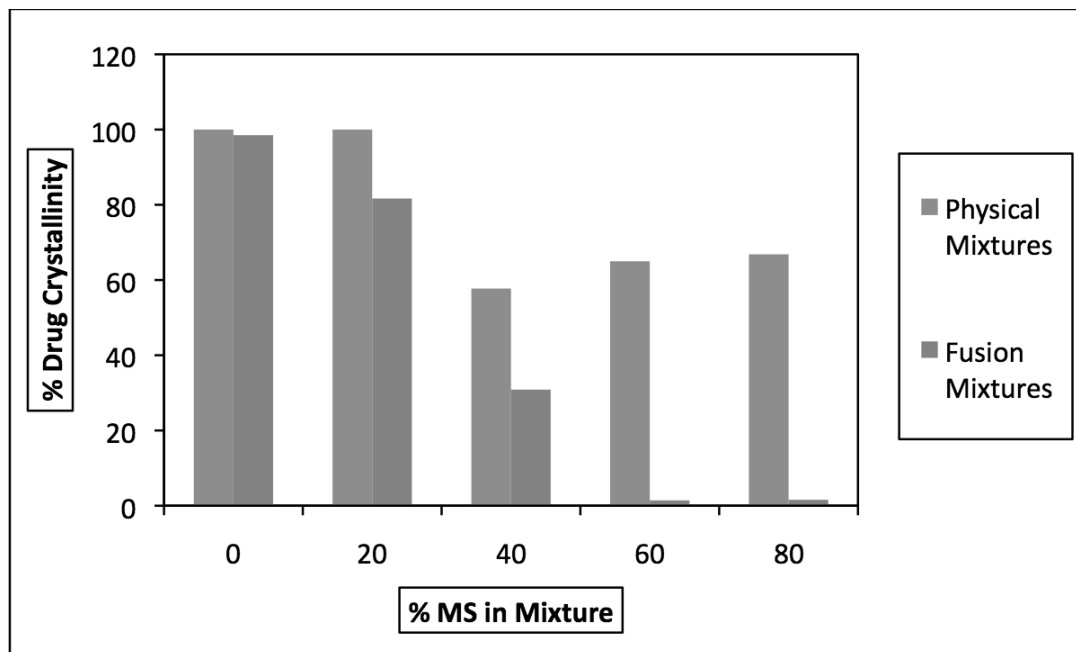


Figure 3: Effect of Addition of Mesoporous Silica on the Crystallinity of Fenofibrate.

## Results to Date

### DSC Studies

When mesoporous silica was added to fenofibrate, the crystallinity of fenofibrate was reduced. This reduction is most apparent in the fusion/ melting samples compared to the physical blending samples. It is clear that the mesoporous silica has altered the solid structure of the fenofibrate.

### P-XRD Studies

XRD can provide information on the effect of the addition of mesoporous silica on the crystallinity of fenofibrate. Crystallinity refers to how ordered the structure of material is. The characteristic peaks of fenofibrate are clearly displayed.

It can be seen that the addition of mesoporous silica altered the crystallinity of fenofibrate in the physical samples. The characteristic peaks of fenofibrate are reduced and changed in the physical sample. In the fusion sample, the characteristic peak of fenofibrate had disappeared. This is because fenofibrate is now in the amorphous state and therefore has a disordered structure.

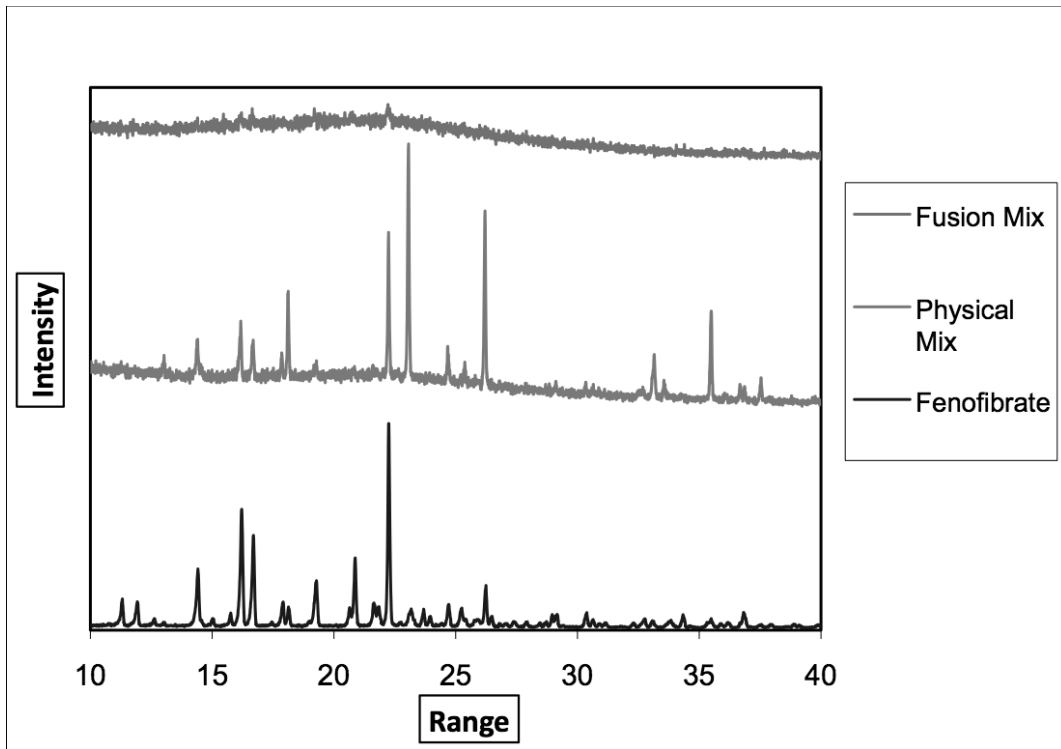


Figure 4: Effect of Addition of Mesoporous Silica on the Crystallinity of Fenofibrate.

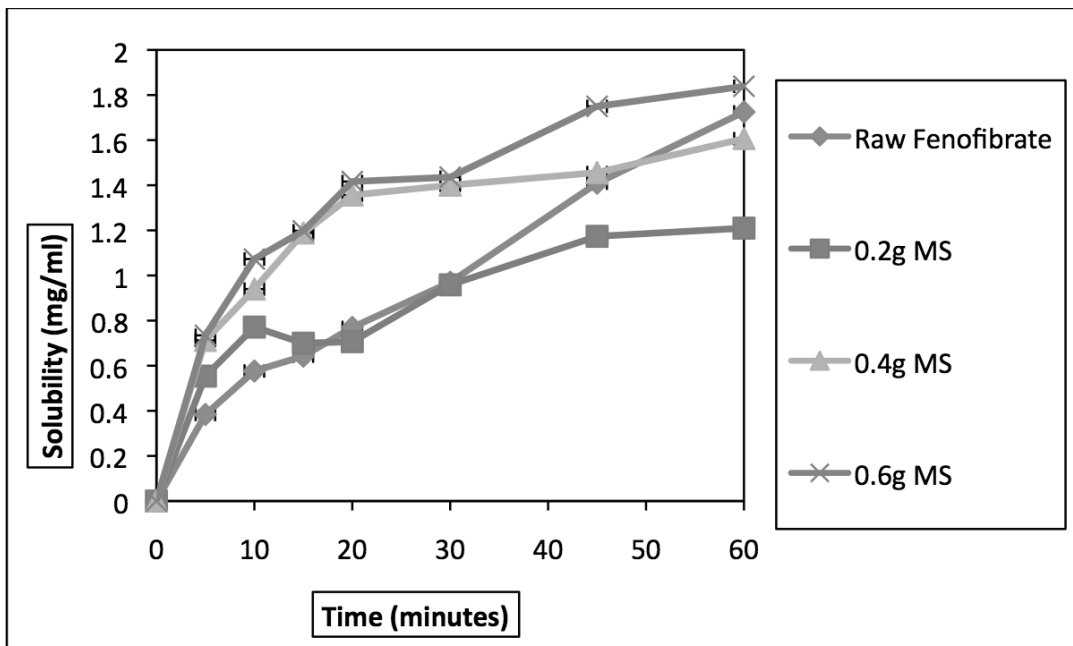
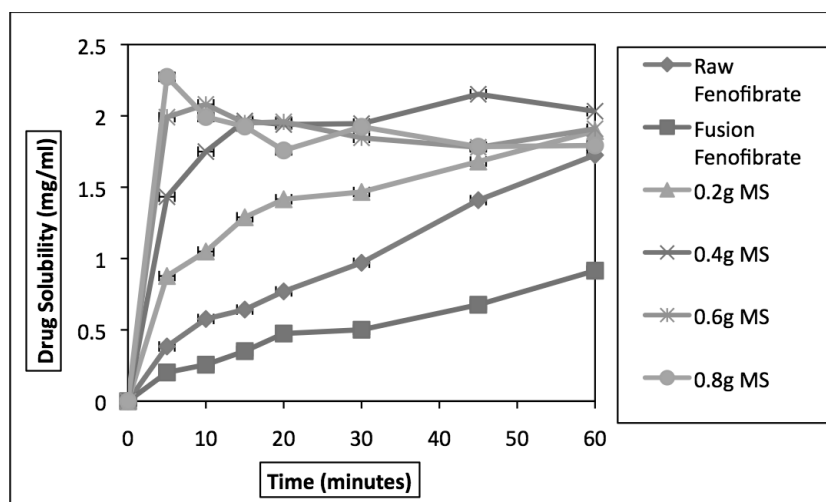


Figure 5: Enhancement of Dissolution Rate of Fenofibrate in Physical Samples.



Note: MS refers to mesoporous silica in 1 g of sample.

Figure 6: Enhancement of Dissolution Rate of Fenofibrate in Fusion Samples.

## Dissolution Studies

The addition of mesoporous silica to fenofibrate enhanced the dissolution rate of fenofibrate. This enhancement was most apparent in the fusion/melting samples and at the higher ratios of silica to drug. Thus, combining mesoporous silica with fenofibrate resulted in faster release of drug over a given time compared to the drug on its own.

## Discussion and Conclusions

It has been reported that the application of mesoporous silica as a carrier for poorly water-soluble drugs enhanced their solubility and dissolution rate (Sanganwar, 2008). The data presented shows that combining mesoporous silica with fenofibrate increased the rate at which fenofibrate dissolves. The results were most pronounced in the fusion mixtures.

It is clear from my work that combining fenofibrate with mesoporous silica altered the solid-state properties of fenofibrate. The crystallinity (ordered structure) of fenofibrate was reduced significantly and in some completely reduced when combined with excess mesoporous silica; this was especially apparent in the fusion/melting samples.

I wish to acknowledge help and support of all the staff of the School of Pharmacy (SOP) and especially my supervisors, Dr. Abina Crean and Dr. Katie Ryan. I would like also to thank the Solid State Pharmaceutical Cluster (SSPC) and Science Foundation Ireland (SFI) for providing funding for my PhD. Robert J. Ahern, Pharmaceutics, School of Pharmacy, UCC; Abina M. Crean, Pharmaceutics, School of Pharmacy and Analytical and Biological Chemistry Research Facility UCC; and Katie Ryan, School of Pharmacy, UCC.

# Chewing the fat about our children's health

**Sinéad Bannon**

School of Food & Nutritional Sciences, UCC

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## Introduction

Popular culture is jammed with TV shows about our health and what we eat, whether it's 'The Health Squad' making people healthy from the inside out or Gillian McKeith telling people 'You Are What You Eat'. Our study, looking extensively at the eating habits of children aged 5-12 years in Ireland, shows us that the extreme picture painted by the media has some basis in fact. Around one in five children are overweight or obese, and many children's diets are lacking in important nutrients and fibre; it is time to find out why and what implications this may have on their future health.

The National Children's Food Survey was a comprehensive survey carried out by researchers in UCC and UCD, investigating the eating habits of children in Ireland between the ages of 5 and 12 years. The survey has provided a valuable insight into the diets of children in this country.

Children from across Ireland kept a food diary for 7 days, recording every item of food and drink they consumed. In addition to collecting dietary data, data on physical activity levels, anthropometric measurements (i.e., weight, height, leg length, waist and hip circumference) and health and lifestyle characteristics of children and their parents/guardians were also collected.

## Results

The results showed that approximately one in five children in Ireland (22%) was overweight or obese with many children's diets also lacking in important nutrients and fibre. With poor diet recognised to play a central role in the development of many of today's "diseases of affluence", including heart disease, obesity, high blood pressure, diabetes, certain cancers and bone disease, the implications for the future health of Irish society are clear. For instance, obesity imposes a significant human burden of morbidity, mortality, social exclusion and discrimination. Along with additional costs to government around social care and health care, obesity also reduces tax revenue.

## **Childhood overweight/obesity**

When the results of the last survey of this age group, in 1990, are compared to the present results, childhood overweight and obesity showed a clear increase from 12% to 22%. This high prevalence of overweight and obesity may be attributed to the fact that over 40% of children exceeded the daily recommendation for fat intake (<35% of total energy intake). The main food groups contributing to the children's fat intakes were 'dairy products', 'confectionery/snacks/biscuits' and 'meat and meat products'. Data from the health and lifestyle questionnaires has shown that children who watched more television (>2 hours per day) were more likely to be overweight than those who watched less television. Furthermore, children were more likely to be overweight or obese if their parents were.

## **Energy**

Where are children getting their energy from? The main food groups contributing to children's energy intake were 'breads and cereals', 'confectionery/snacks/biscuits', 'dairy products', and 'meat and meat products'. While staple foods such as bread and cereals were the greatest contributors, confectionery, snacks and biscuits were also high contributors to their energy intake; this may be one of the reasons why there is such a high proportion of children overweight.

## **Food consumption**

The survey showed that, in general, children are not consuming enough fruit, vegetables and brown/wholegrain breads, and their diets are high in foods of poorer dietary quality, such as confectionery, biscuits, snacks and processed meats. Furthermore, the intake of salt is too high in children, with 60% exceeding the limit, which can put the children at risk of increased blood pressure. The main foods contributing to their salt intake are processed meats and breads. As previously mentioned, 40% of children are exceeding the recommendation for fat, and the main contributors are dairy products, confectionery and processed meats.

## **Nutrients**

As regards nutrients, children are not getting enough calcium, iron, vitamin D and folate. Calcium and vitamin D are important for bone health, while folate is important for DNA synthesis and growth and development. Iron is important for oxygen transport around the body. Vitamin D is normally synthesised on the skin from the sunshine, but in Ireland we often do not get enough sun in order to make vitamin D and so have to rely on food sources, such as oily fish, eggs, liver and butter, to get our intake. Calcium can be obtained

from dairy products, such as milk, cheese and yogurt, and tinned sardines, folate from liver, fruit and vegetables, while sources of iron include meat, dark green leafy vegetables and eggs. Nowadays, fortified foods, such as breakfast cereals, cereal bars and breads, are also valuable sources of these nutrients.

In relation to fibre, 64% of children are not consuming adequate amounts. Inadequate fibre intakes can lead to constipation and prolonged inadequacy may put the child's future adult health at risk of colon cancer. The greatest contributors to fibre intake in the children were breads, breakfast cereals, fruit and vegetables. Children with higher fibre intakes were eating these foods in greater quantities and/or more frequently than children with lower fibre intakes. Even though most of the children consumed white breads, those with higher fibre intakes were eating more of the brown and wholegrain variety than those with lower fibre intakes.

## **Conclusion**

What can be concluded from this research? Firstly, there is a high rate of overweight and obesity in children in Ireland, with around one in five children either overweight or obese. This can partly be explained by the fact that many children (40%) are exceeding the recommended level of fat in the diet. Children's salt intakes are too high, and processed meats and breads were the main sources. Fibre intakes are also inadequate, as are intakes of vitamin D, calcium, iron and folate.

So what does all of this mean and how can this research be utilised? Surveys like ours highlight nutritional issues that need to be addressed. The data provide an important update for Government agencies on obesity statistics in children in Ireland. The information can be used by the government, its agencies and other interested groups to formulate timely, appropriate and achievable food-based dietary guidelines for healthy eating. It can also provide a basis for public health campaigns to promote a healthier population and reduce the risk of certain diseases. Furthermore, it is widely recognised that dietary habits of people are generally developed in childhood and, as such, it is important to instill good eating practices early on and try and help protect children's future adult health.

Sinéad Bannon is a student in the 'National Nutrition Surveys Group' under the supervision of Professor Albert Flynn. The author would like to acknowledge funding from the Irish Government under the National Development Plan 2000-2006.



# Using waves to generate electricity

**Anne Blavette**

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## Introduction

In less than a century, electricity has become the cornerstone of our modern society. Thanks to it, living conditions have changed more dramatically in 50 years than in two centuries. However, whereas electricity has provided well-being to billions of people over these past few decades, its ever-growing consumption is more and more threatening us. Climate change, fossil fuel depletion, and security of energy supply are crucial issues to be addressed for our “energy society” to be sustainable. Renewables are considered as a major part of the solution. This article deals with the issues related to integrating wave energy into electrical power systems.

## Wave energy grid integration

The major problem associated with wave energy is its variability. Variability can be observed at several time scales: from the range of seconds (wave-to-wave), to minutes (sea-state to sea-state), to days or months (seasonal variations).

However, if wave energy is to be used for generating electricity, electrical networks must be operated so as to cope with this inherent variability. If this is not the case, the effects on electrical grids may range from bulb flicker to total black-outs, which is clearly unacceptable.

The most efficient way to obtain a better understanding of the potential effects of wave electricity on networks is to perform dynamic simulations. These simulations involve a numerical electrical network simulator and generation plant numerical models. The network simulator enables its user to simulate any electrical network (at either a local or a national/international level). The network modelled in this simulator reacts as the real electrical grid would to any disturbance applied to it. Numerical models are implemented in the simulator to represent any power plant, either fuel-fired, hydro-driven or wind farms. However, there is as yet no model available for so-called “wave farms” yet. This lack of models prevents electrical system operators from studying the potential effects of wave electricity on their networks. Consequently, no wave farm is allowed to connect to the grid, apart from small test devices. This represents a major barrier for the development of the wave energy industry on a massive scale and the International Energy Agency has hence included generic modelling as one of its key research topics.

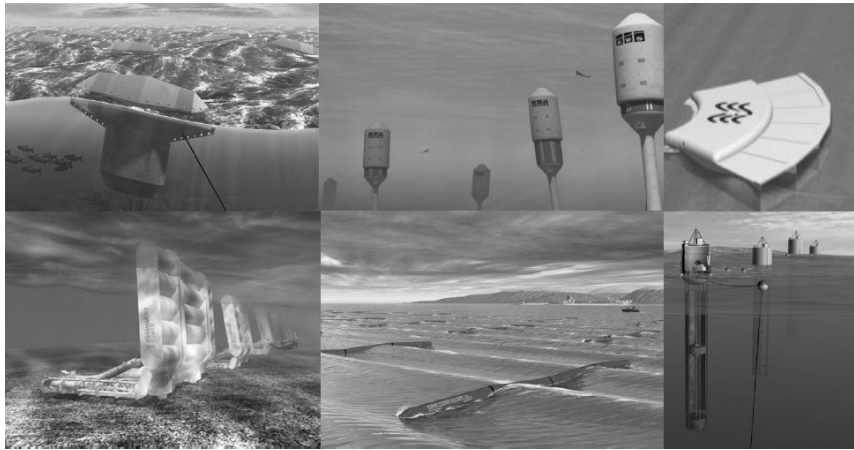


Figure 1: Some device technologies

## Modelling of wave energy converters

The modelling of wave farms and of its individual devices (called wave energy converters) is still in its infancy stage as it is a new field of research. For the purpose of my work, two modelling approaches were considered.

### Technology-specific modelling

The first approach consists in modelling device technologies specifically but was eventually deemed as irrelevant. There are actually a myriad of wave converter technologies (see Figure 1). As of now (July 2010), I have listed almost 170 different devices, none of which can be clearly identified as the leading technology. Besides, modelling entirely and precisely every device requires much time as the device technologies are fundamentally different.

### Generic modelling

The second approach intends to be much more all-encompassing: it is called “generic modelling”. My main topic of research, along with the influence of marine electricity on the grid, is generic modelling. In the course of my PhD work, I intend to create a theoretical generic model and then implement it as a numerical model in a network simulator. From this, I will be able to study the influence of marine electricity on the network as realistically as possible.

A generic model is a model whose structure is constant, but whose internal parameters can be tuned for each device technology. As a result, it is hoped that many devices (as much as possible) could be modelled by means of one single generic model. If an example

is to be given, it may be the one of a train: the structure of the train (its coaches and locomotive) does not change but its passengers do; each journey is hence different.

This model will, of course, have to be as precise as possible and it is intended to check its output against field data obtained from wave energy converters tested at sea or in a wave basin. The first step towards a generic model is the collection of common features among all devices. Each device is currently being fully documented and a general outline classification being extracted.

A generic model will be a major breakthrough and will enable the wave energy industry to avoid some pitfalls encountered by the wind energy industry. Wind turbine developers faced the same problem several years ago as they had to provide numerical models of their machines to electrical grid operators. One of the major issues at this time was that they had little knowledge of electrical network engineering and often subcontracted the modelling to third parties (most often to universities). This situation was very sensitive with respect to commercial confidentiality. Besides, the models were not created at the same level of detail (and hence not for the same time step of simulation): this discrepancy in modelling detail led to implementation difficulties because of undesired interactions between the models. As of now, although the main wind turbine developers have been involved in numerical modelling for years, no realistic wind turbine generic model has been issued yet, but only specific ones. However, it should be stressed (as a matter of comparison) that whereas almost all wind turbines have a similar 3-bladed structure, marine converter technologies (as mentioned earlier) are much more eclectic, increasing the complexity of their modelling.

## Conclusion

To conclude, this paper details how powerful a generic model will be and what a major breakthrough it will represent for the wave energy industry and for the electrical system operators. More generally, this article stresses the necessity of studying the impact of wave electricity on electrical networks. It is hoped as well that this paper illustrates the important opportunities for creativity and innovation that exist in wave energy research.

Anne Blavette is a student at the Hydraulics and Maritime Research Centre (UCC) under the supervision of Dara O'Sullivan, Michael Egan, Hydraulics and Maritime Research Centre UCC and Tony Lewis, Electrical Engineering Department UCC . The author would like to acknowledge them for their always most appreciated help and the Charles Parsons Initiative for funding her research.

# Child surveillance in Ireland

**Aimie Brennan**

School of Sociology and Philosophy, UCC

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## Introduction

*Ten year old James looks out the backseat car window. He's familiar with the views and with speaking to his mom through the gap in the seat. For a moment he wonders what it would be like if it was different. Sometimes he would like to stay at home and play with his dog or cycle his new bike to soccer training. He's used to having his mom drive him. . . but its boring. Then he thinks; what if a car knocks him down? What if a stranger talks to him? What if he gets lost? No, its much better this way, isn't it?*

Could James' experience be a memory from your childhood? Maybe not but my research would suggests that this is becoming a more common experience. The rapid globalisation of Ireland in recent years has hugely impacted many aspects of family life especially the lives of children, for many reasons; the return of women to work, the increase in financial resources, the decrease in public space. International research has shown that in countries which have experienced rapid globalisation like Ireland, children, are experiencing major changes. This paper focuses on just one aspect of these changes that is; freedom and mobility (children's independent movement from place to place). I argue that the current behaviour surrounding children's supervision may be having a negative impact on children and family life.

## What happened in other countries?

In the UK, Amsterdam and the USA researchers have found that children's independent mobility has decreased since the 1970's. In the UK, Valentine (1997) examined children's outdoor play, finding that fewer children were playing outdoors. Fotel and Thomsen supported this, finding that almost 100% of parents admitted to restricting their children's outdoor play. The result was that children's play had become much less street-based and more home-centered. The movement of children from the street to indoors changed the kinds of games that children play.

Valentine (1997) found that children began to take part in more organized activities. Two thirds of the children in the UK participated in some form of organised activity. In urban areas especially, these activities such as horse riding, dancing, rugby etc. take place in



Figure 1: The percentage of time children spend playing indoors and outdoors

locations quite a distance from the child's home, so driving becomes the preferred method of transport. In 1990, Hillman called these children, who were chauffeured from place to place, 'backseat children'. Similar to 'indoor children', the backseat child experienced decreased independent mobility and increased supervision by adults. That is, they rarely used methods of transport such as walking or cycling, which they could do unsupervised. Alder and Alder found that class was a major determinant of children's leisure experiences. For example, the chauffeuring practice of the backseat generation was only relevant to those who own a car, and those who have the time to transport the child. So 'backseat children' were predominantly found to be middle-class children.

### **My research findings:**

In order to examine whether or not middle class children in Ireland were experiencing similar practices to the backseat child and the indoor child I interviewed approximately 75 6 to 10 year-old children and their parents in Cork City. From preliminary analysis, it would seem that Irish middle class children are experiencing similar trends to the UK and USA. Characteristics of both the backseat child and the indoor child have begun to emerge from my data.

### **The indoor child**

Middle class children's play has become much more home centred, either outdoor in a private garden or indoors. The chart below represents how the middle class children I interviewed spend their unstructured time, that is their weekends and after-school time. According to the parents I spoke to, during this unstructured time their children are always supervised by an adult. This includes any time they may spend playing in the street or green.

## **The Backseat child**

The increased involvement of parents in children's after school hours has led to their increased involvement in structured activities. All the parents I interviewed agreed that structured activities are beneficial to children socially and physically and they also keep children safe. They claimed that their children had a busy lifestyle. This applied to children from as young as 6 up to 10 years old. Below is a chart indicating the number of structured activities in which the children participate on a weekly basis.

The high volume of activities in which children participate inevitably brings them all over the city. Over 60% of families indicated that the activities were not local and involved traveling up to 3 kilometers to at least one activity per week. Families who had more than one child attending such activities spent a lot of time in the car.

## **Why have we increased supervision?**

It is understandable that parents are anxious about their child's safety. However, the issue of safety and risk has changed. New global risks are circulated by the media on a daily basis which increase parental anxiety amongst the middle-classes. Stories like that of Madeline McCann have become common knowledge. One method of negotiating these risks is to increase supervision. Parents feel less anxious if they know where their child is, or if they are with a responsible adult. Parents make more of an effort to create situations where their child is in this position. There is no question that their intentions are good. The problem arises when children are in adult care all of the time. It is adults' over-involvement in children's leisure activities that has led to the creation of these new 'childhoods'; the indoor child and backseat child.

## **Possible consequences of increased supervision**

Although there are positive elements to attending structured activities and it is safer to drive children long distances, the extent to which some children are being supervised is excessive. Parents are taking full responsibility for protecting their children all of time. This is stressful and almost impossible. I presented the children with the following scenarios

- What would you do if you were at home alone and there was a knock on the door?
- How do you cross the road safely?
- What would you do if you were walking to school and a stranger started talking to you?

There was a sense of nervousness and an initial response of 'I don't know'. Subsequently, I received one of two responses. Some children recited contrived answers they had learned in school. The others, mostly the younger ones, created a plan of action whereby they would badly injure the stranger, or escape in a very elaborate way. While I can appreciate that some of these scenarios would be quite frightening, their answers didn't fill me with confidence. It is possible that many of the children really couldn't handle facing these risks.

I also asked them if they would like to spend more time at home alone, playing in their room or outside and, unexpectedly, 85% of them said no. They explained that they would be too frightened. Afraid of the phone ringing or a knock on the door, afraid of the kettle or the oven and more seriously afraid of robbers or stalkers! Some parents even told me that children would panic if they were left alone for too long. It seems to be the case that the risks and anxieties of their parents, and society at large, are being absorbed by these middle-class children. Will these children always be nervous? Will they be able to negotiate risks later in life or will they remain dependant on others?

Some psychologists suggest that the over-involvement of parents in children's lives has detrimental effects on children's development. The French psychologist Piaget accredits a child's intelligence to its participation with its environment. Outdoor play presents children with the opportunity to be creative and to interact with their environment. I can remember making up games, changing the rules or inventing new ones. When children have to decide on a location for their game, at time to meet, a type of game and a set of rules which will be used they are developing many skills such as problem-solving. As early as the 1970s, it was noted that children's spontaneous play encouraged the development of interpersonal skills. Unfortunately these new highly supervised, structured childhoods of the backseat child and the indoor child deter this kind of play in the interest of child safety.

## Conclusion

This paper has highlighted children's need for space, freedom and independent mobility. The new childhoods which I have found to exist in Ireland are not providing for this need and, as a result, Irish children are experiencing problems similar to other globalized countries such as the USA and the UK. It has been suggested that these behaviours are class-based; therefore, in order to understand the causes and consequences of this behaviour in greater depth, my research will be expanded to examine supervisory patterns of both advantaged and disadvantaged families in Ireland.

Aimie Brennan is a Student in the School of Sociology and Philosophy under the supervision of Dr. N. Hourigan. The author would like to acknowledge funding from the College of Arts, Celtic Studies and Social Science in UCC.

# Are unborn children rights-holders under the United Nations Convention on the Rights of the Child?

**Fiona Broughton**

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## Introduction

In September 1992, Ireland ratified the United Nations Convention on the Rights of the Child (CRC), committing itself to the promotion, protection and fulfilment of the rights of all children on a non-discriminatory basis as outlined in the Convention. But just who is a child under the wording of the CRC? Article 1 of the CRC defines the child as “every human being below the age of eighteen years, unless under the law applicable to that child majority is attained earlier”. So the CRC is clear on a maximum age limit for one to qualify as a ‘child’ and thus gain rights under the CRC. It makes no mention, however, of a minimum age limit for a human being to qualify as a ‘child’ under the Convention. Does a child gain rights under the Convention from the moment of his existence, i.e., immediately following conception, or from the moment of birth, or at some point in between? Ostensibly, the Convention is silent on the matter.

This issue of whether or not the CRC applies to pre-natal children is not one that was simply over-looked during the drafting process. Quite the converse - it was an extremely contentious issue. There were fears that states would not ratify the Convention if it explicitly afforded rights to unborn children because of the effects it might have on those states’ abortion laws. On the other hand, stipulating that the CRC would only protect children ‘from the moment of birth,’ would make a clear statement allowing for abortion practices under a Convention whose purpose was to protect and vindicate the rights of *all* children on a non-discriminatory basis.

It seems that it was in an effort to facilitate ratification by as many states as possible, that the Working Group (which was responsible for drafting the text of the CRC) attempted to leave the matter of whether or not the CRC applies to the child before birth purposefully ambiguous. That way, states could decide for themselves from what point of human development a child would be protected in their jurisdiction and therefore would ratify the Convention, regardless of what their abortion laws stated. This begs the question of what possible value international human rights laws are to a child, if the state in which that child lives can decide for itself which children are entitled to those rights.



Many of the rights enumerated in the CRC are pertinent to pre-natal children. The rights which are most overtly linked to children before birth are the rights to life, survival and development and the right to pre-natal health care. Also relevant to these children are rights to non-discrimination, the right to freedom from violence, the right to be protected from harmful acts and substances and the right to an adequate standard of living, to name but a few. Are children in the womb entitled to such rights under the CRC?

To answer this question, it must be established whether or not pre-natal children come within the scope of Article 1 of the CRC (i.e., the definition of a child). This requires an honest and accurate interpretation of Article 1. There are vastly differing academic opinions on this matter. Philip Alston (a prominent U.S. human rights practitioner), for example, argues that the pre-natal child is not and was never intended to be included in the definition of a child in the CRC. Bruce Abramson (a human rights attorney specialising in the CRC) on the other hand, contends that the definition of a child in the CRC is and was indeed intended to be broad enough to encompass the child before birth.

The Vienna Convention on the Law of Treaties, 1969 (Vienna Convention) offers rules to aid interpretation of international treaties. Article 31.1 of the Vienna Convention states that a treaty should be interpreted (a) in good faith; (b) in accordance with the ordinary meaning of the terms of the treaty; (c) in light of the treaty's context; and (d) in light of the treaty's object and purpose. In addition, it is stated that the context in which the treaty is to be interpreted shall include its preamble (a statement of the motivation and context of the treaty). These criteria must be followed to discern whether or not the pre-natal child is included in the definition of a child under the CRC.

#### **a) The 'good faith' requirement**

Recall that Article 1 of the CRC states that "a child is every *human being* below the age of eighteen years unless, under the law applicable to that child, majority is attained earlier" (emphasis mine). If this statement is to be interpreted 'in good faith,' as is required by the Vienna Convention, the term which must be examined – the operative term – is in fact 'human being' rather than 'child'. The term 'child' is to be construed throughout each provision of the Convention as *every human being below the age of 18* (unless in that state, the age of majority is attained earlier). Alston, in his argument that the definition of a child under the CRC does not extend to pre-natal children, focuses on terms such as 'child,' 'foetus' and 'embryo'. He avoids the term 'human being'. Abramson, on the other hand, does deal with the operative term of the Convention and uses a diagram of a set, to show that children before birth are as a matter of fact included in the term 'human being' and thereby included in the CRC.

Abramson illustrates this by way of two concentric circles (see below). The outer circle A consists of all human beings within the jurisdiction of the state while the inner circle B consists of all of those human beings who are under the age of 18 or the age of majority,

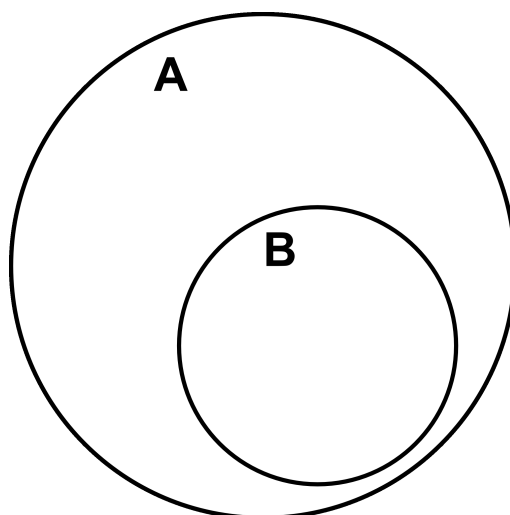


Figure 1: Outer Circle A: All human beings within jurisdiction of state; Inner Circle B: All of those human being under age of 18

whichever occurs first. Every individual within the inner circle (set B) is a child (whether pre or post-natal) and therefore a rights holder under the Convention.

The fact that Alston focuses on the term ‘child’ instead of ‘human being’ makes his argument an easier one – it is much simpler to argue that the pre-natal human being is not a ‘child’ than it is to argue that the pre-natal human being is not a ‘human being’. However, as the Vienna Convention instructs that interpretation of Article 1 is to be conducted ‘in good faith,’ then the operative term of the Convention ‘human being’ must be discussed and not avoided.

#### **b) The ‘ordinary meaning’ rule**

The term ‘human being’ is expansive and perhaps the most all-inclusive term that could have possibly been chosen by the drafters. According to the Oxford English Dictionary, a human being is “a member of the human race”. Other dictionary definitions are more specific, for example “any individual of the genus *Homo*, esp[ecially] a member of the species *Homo sapiens*” (Random House Dictionary of the English Language). Abramson rightly comments that to be a member of a species “does not call for any age or developmental test”. We acquire human rights simply by virtue of being part of the human species. Therefore, it seems that the ordinary meaning of the term ‘human being,’ chosen by the drafters of the Convention, is inclusive enough to apply to a human being who is under 18 (or the age of majority) during the pre-natal stage of existence as well as the post-natal stage.

This assertion is lent weight by the fact that states themselves, who are party to the CRC, have interpreted the term ‘human being’ to refer to the developing child during the pre-natal stages of existence as well as the post-natal stages. For example, a report by Argentina states that Article 1 “must be interpreted to the effect that a child means every

human being from the moment of conception up to the age of 18". A report by Brazil refers to the special "vulnerability of the human being from conception up to approximately six years". Indeed, Abramson records that 128 out of the first 176 states to file reports with the Committee on the Rights of the Child either expressed or inferred that children before birth are 'human beings' and therefore rights holders under the Convention. It appears that the *ordinary meaning* of the term 'human being' does include the child in pre-natal stages of development.

### **c) To be interpreted 'in their context'**

The Vienna Convention requires that the term 'human being' in Article 1 is interpreted in the context of the CRC as a whole. Therefore, if Article 1 is to be interpreted in accordance with the Vienna Convention, it must be read in light of other Convention provisions including, for example, the right to pre-natal care under Article 24. Article 24 recognises the right of the child to "the highest attainable standard of health" and as part of this right, recognises the right to "appropriate pre-natal care for mothers".

Health care before birth is recognised here as a *child's* right, notwithstanding the fact that such a child is not yet born. Although the recipient of the care is the mother, the rights holder is the child. Abramson explains that "[a]s a post-natal child's right to clean water must be directed to the water supply, a pre-natal child's right to health care must be directed to his pre-eminent environment — his mother". As this right is specific to pre-natal care, it must follow that the child is not yet born. If the rest of the Convention is to be interpreted in the context of this provision, each provision of the CRC will apply to the pre-natal child just as it does to the post-natal child.

### **d) The 'object and purpose' rule**

The Vienna Convention states that treaty provisions should be interpreted in the light of that Treaty's 'object and purpose'. It is well established that the fundamental aim of the CRC is to develop and encourage the promotion of children's rights. It must follow from this that a retreat on existing standards of protection afforded to the rights of children would go against the CRC's object and purpose. As human rights treaties prior to the CRC already explicitly or implicitly recognise the pre-natal child as a rights holder, (for example the American Convention on Human Rights, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights), to suggest that the CRC does not protect the rights of the pre-natal child would in fact be reneging on existing standards of protection afforded to that child under existing human rights treaties and therefore would go against the object and purpose of the Convention.

### **e) The Preamble**

The Preamble to the CRC states that "the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before

as well as after birth” (emphasis mine). This clearly states that a child is to be considered a ‘child’ before birth and that a pre-natal child is entitled to legal protection.

The Vienna Convention specifies that “meaning [is] to be given to the terms of the treaty in their context... [which includes]... its preamble...”. Therefore, the definition of a child in Article 1 must be interpreted in the light of the statement in the preamble recognising explicit protection for the child before birth.

The relevant paragraph in the Preamble states that ‘*appropriate*’ legal protection must be given to children ‘before as well as after birth’. What then exactly is ‘*appropriate*’ legal protection for the human rights of children? Alston asserts that what constitutes ‘*appropriate*’ protection for the human rights of pre and post-natal children is a question for each state to decide for itself. This assertion flies in the face of the underlying function and values of an international human rights instrument. Rita Joseph in *Human Rights and the Unborn Child*, seems to be more in tune with the very nature of human rights when, in a compelling argument, she concludes that ‘*appropriate*’ legal protection for human rights is non-discriminatory, without arbitrary interference, universal, objective and non-selective; it is protection that meets the requirements of morality, public order and the general welfare, and protection which is in line with the purposes and principles of the United Nations. Thus, it is suggested that inclusion of pre-natal children in the definition of a child under the CRC ensures that ‘*appropriate*’ legal protection is afforded to all children, without discrimination of any kind, irrespective of the child’s birth or other status and irrespective of or his or her parent’s political or other opinion, as is indeed required by the CRC itself.

## Conclusion

At the nub of this research lies a very basic question – who is the subject of human rights? This is a vital question and not one which should be left up to each state to decide the answer for itself through arbitrary court judgments, piecemeal legislation, or as Angela Shanahan has put it “accidents of precedent”. It is a question which needs to be (and is) answered explicitly in international human rights instruments themselves such as the CRC. The answer can indeed be found in an honest and accurate interpretation of the CRC, which stipulates that all children should be afforded rights on a non-discriminatory basis. The child before birth too, has a recognised place in the framework of international human rights law, and whether such a human being is termed ‘embryo,’ ‘foetus,’ or ‘unborn child,’ the individual in question is the very same – an immature human being at the most vulnerable and fragile stages of human development.

Fiona Broughton is a student in the Department & Faculty of Law under the supervision of Dr. Ursula Kilkelly. The author would like to acknowledge funding from the Department & Faculty of Law, University College Cork.

# Wave farm modelling: harnessing Ireland's greatest energy resource

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## Introduction

Wave Energy Converters are being developed worldwide, including by a number of Irish companies, as a sustainable and environmentally-friendly means of generating electricity using the power of the ocean. By 2020 it is envisaged that hundreds of these devices will be deployed off the West Coast of Ireland in arrays known as Wave Farms and connected to the national electricity grid. The focus of my Ph.D. project, being carried out at the Hydraulics and Maritime Research Centre (HMRC) in UCC, is to create realistic models of these Wave Farms so that we can better understand their behaviour and ultimately optimise their performance.

## Why Wave Energy?

Nearly 95% of the electricity consumed in Ireland is generated from fossil fuels such as gas, coal and oil. As reserves of these resources begin to dry up, leading to scarcity of supply and increases in cost, and the environmental concerns about carbon dioxide emissions become more pronounced, Ireland will need to develop more sustainable sources of energy to light our homes and keep our myriad of electrical appliances running. While we are already utilising renewable forms of electricity generation such as wind turbines and hydroelectric plants, our greatest natural energy resource resides in the waves that lash our coast, especially on the western seaboard.

Ireland is ideally located to capture Wave Energy. The prevailing South-West wind blowing across the Atlantic Ocean, generating waves, means that we are situated at the end of a vast, natural transmission line for wave power. A 2005 report by ESB International estimated that the theoretical Wave Energy resource off the Irish coast amounts to 525 terawatt hours (TWh) annually. In comparison, our total electricity requirement for the year 2008 came to 27.8 TWh. Harnessing even a tiny fraction of our natural power would go a long way to meeting our electricity needs.

## WEC Arrays

The devices that will be used to capture this energy are commonly known as Wave Energy Converters (WECs). To date there is no universally accepted design for a WEC. A quick internet search will provide examples of dozens of different devices with radically different shapes, sizes and operating principles. All these competing designs must be deployed in arrays to form Wave Farms. The reason for this is that when compared to a traditional power plant a typical WEC, operating in isolation is small, with the capacity to provide power for approximately 1,500 homes. As a result multiple devices will have to be placed at sea in close proximity to each other to produce a grid scale generation plant. This will present many challenges as it is likely that within an array the WECs will interact with each other by radiating waves outwards or by absorbing the energy destined for a neighbouring device. The aim of my research is to develop an understanding of this behaviour so that wave farms can be designed to extract the maximum amount of energy.

## Wave Field Modelling

In order to investigate the performance of WEC arrays it is necessary to be able to describe the ocean waves that drive the operation of these devices. An integral part of my research involves the simulation of wave fields through computer modelling. Initially the ocean surface seems to be a chaotic place that would be difficult to model, with waves of varying size appearing to come from a range of angles at random intervals. However it is possible to recreate realistic, irregular wave profiles by simply adding together the correct combination of simple regular waves of different height, length and direction. This combination can be derived from previously developed mathematical formulae, or from the data provided by wave measurement buoys located offshore. This allows wave profiles to be generated for the all potential device locations within a Wave Farm, even when these points are separated by several kilometres. An example of this can be seen in Fig. 1 which illustrates the evolution of the water surface profile in a 50m x 50m wave field at intervals of 10 seconds.

## Power Smoothing from WEC Arrays

Investigating the power smoothing effect when WECs are placed in arrays is one application of ocean surface modelling at Wave Farm scale. Because of the irregular nature of real sea waves the incoming energy at any point is not steady. Significant fluctuations can be seen — the power generated by a device can go from practically zero to a dramatic spike several times larger than the average value in a matter of seconds, as seen with the red line in Fig. 2 (a) on p.24. These fluctuations are unacceptable if the power captured from waves is to be fed into the electricity grid and methods of smoothing out the supply from WECs must be developed. To date a number of solutions to this problem have

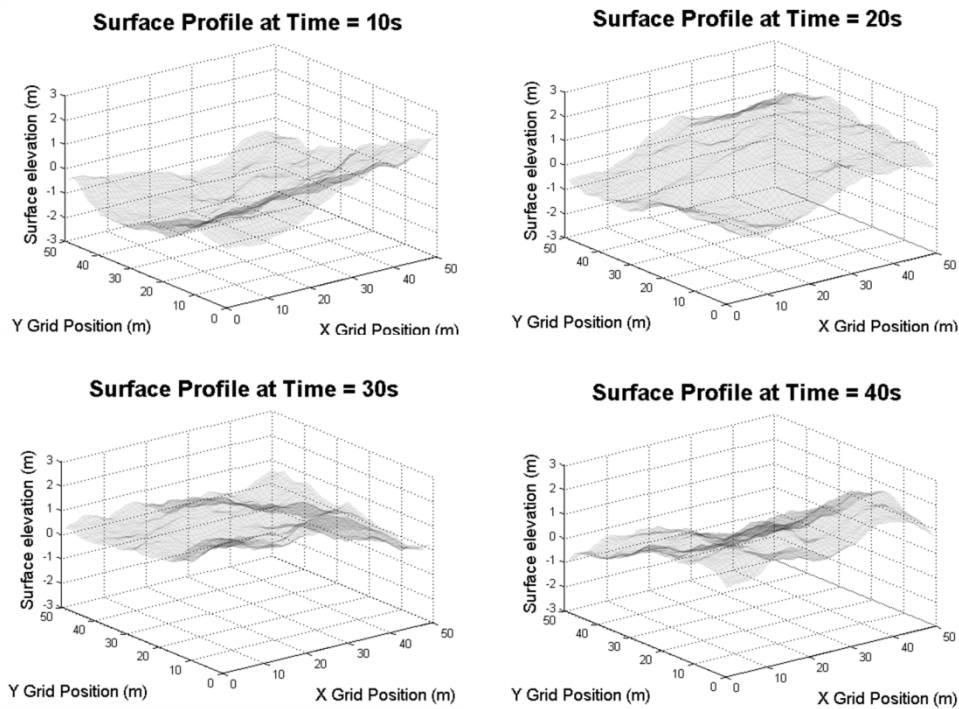


Figure 1: Simulated Wave Field at 10 second intervals

been suggested. It may be possible to temporarily store the energy generated by WECs using batteries or flywheels, allowing the output power to be regulated, while the motion of devices can be controlled so that the resulting output power is less intermittent. The approach I've taken is to examine if the inherent variability of the wave fields where farms will be situated can be utilised so that the total power output from the array is smoother, i.e., will the power peaks of a portion of the devices be cancelled out by the troughs of others?

## Results

Surprisingly, neither changing the distance between the individual devices nor changing the overall layout of the array had much effect on the smoothness of the output power, which can be quantified by calculating the standard deviation of the total power produced by the farm over the time period being investigated. Of greater influence is the number of WECs in a farm. In Fig. 2 (b) it can be seen that the total output from an array of 25 devices showed approximately one-fifth of the variability of a device operating in isolation in similar wave conditions. It is also worth noting that the very severe peaks and troughs in output for a single WEC have been eliminated, see Fig. 1 (a). This result is a promising one in terms of the future deployment of large scale, commercial farms. It is envisaged that the first WEC arrays will be of a similar size, or possibly even larger, than the farms assessed in this work. The outputs from this study indicate that a level of smoothing will

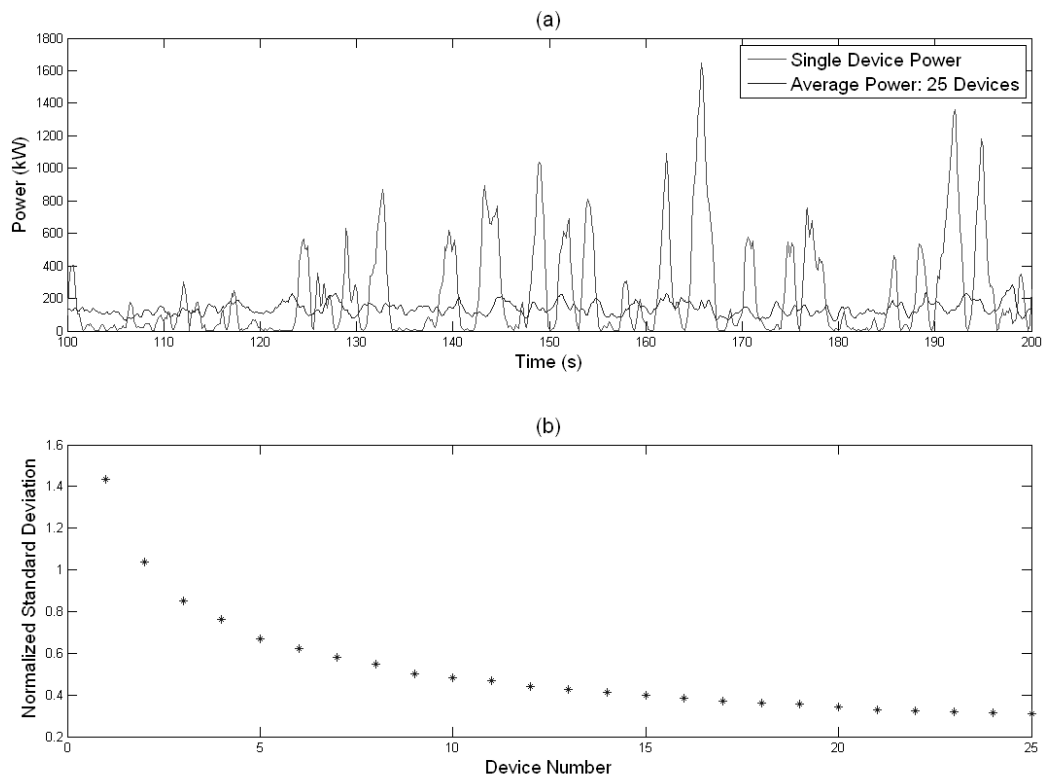


Figure 2: (a) Power output from a single device (red) and average device output from a farm of 25 WECs (blue); (b) Decreasing variability with increasing number of devices in a Wave Farm.

be inbuilt in these developments, as the total aggregate power will be far less intermittent than the yield from a single device. This inherent smoothing effect will ensure that the power produced by Wave Farms will be much more grid-friendly and should reduce the need for incorporating methods of short-term energy storage into WEC array designs.

## Future Work

I hope to build on this work by creating more realistic models of WEC operation and include interactions between the devices in an array. It would also be interesting to use this approach to study geographical smoothing; i.e., distributing the locations of potential Wave Farm sites along the coast so that fluctuations in local meteorological conditions have less influence on overall power production. Finally, I will investigate the accuracy of these numerical models by carrying out testing of small scale models in the 25m x 18m wave tank at the HMRC.

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# Characterization of new materials for capacitor formation in integrated circuit technology

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## Introduction

There have been tremendous developments in electronic technology in the last 40 years as evidenced by the widespread availability of computers, mobile phones and electronic entertainment systems and their continued shrinking in size and cost.

Much of the improvement in the performance of electronic systems can be traced to developments in Integrated Circuits (ICs) (“microchips”) which form the fundamental building blocks of modern electronics technology. Within an IC, the most important electronic component is the transistor and it is the transistor that is used to implement the operations associated with computer logic. With each generation of technology, the size of the transistors is reduced and more of them can fit on a single IC, which allows more powerful devices to be made that take up the same or even smaller space and draw less power from the battery. This trend regarding the scaling down in size of the transistors was first noticed by Gordon Moore, the co-founder of Intel, in 1965 and has since come to be known as Moore’s law. This states that “the number of transistors that can be placed on an integrated circuit (of a given area) doubles approximately every two years”. This law is expected to hold until at least the year 2015 if not longer.

While it is the transistors on an IC that implement the computer logic and other functions, they are not enough by themselves to form a complete system. Several other types of electronic components must also be placed on an IC to make the overall system perform a useful function. One of these components is known as the capacitor. A capacitor is similar to a battery in the sense that it can store electrical charge. Capacitors are widely used in electronic systems to help maintain a constant high-quality power supply to the rest of the electronics, as part of the tuning elements in radios and other wireless devices and for a variety of other purposes. With each new generation of IC technology, capacitors have to shrink in size, just like the transistors, so that the benefits of scaling can continue to be exploited. The research presented in this paper supports the continued scaling of capacitor components by developing techniques to characterize the performance of advanced

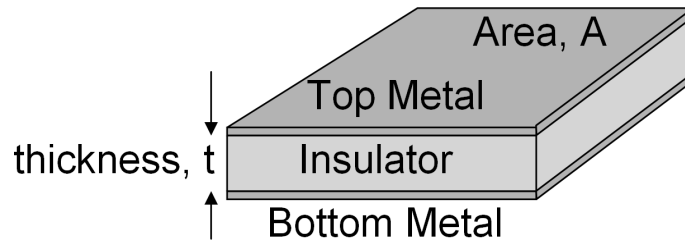


Figure 1: MIM capacitor

new materials that can be used to make small, high performance capacitors for future generations of IC technology.

## Integrated Circuit Capacitors

Most of the high performance capacitors on an IC are made using a simple 3-layer sandwich structure like that illustrated in Figure 1.

The two outer layers of the capacitor sandwich are made of a metal such as copper (Cu) or aluminium (Au). Copper is a very good conductor, i.e. it allows electrical current to pass along it easily, which is why it is used extensively for electrical wiring in buildings. Aluminium is also a very good conductor and has some properties which make it easier to use for IC fabrication than copper. The middle layer of the 3-layer sandwich is made of an insulator material. The insulator, also commonly known as the dielectric, acts as a barrier to the flow of electrical current between the two metal layers and the combination of the three layers gives rise to the charge storage properties of the capacitor structure. This type of capacitor is commonly referred to as a parallel-plate MIM capacitor because of the Metal-Insulator-Metal arrangement of the layers. Until recently, silicon dioxide (chemical symbol  $\text{SiO}_2$ ) has been the most widely used material for making insulator layers in integrated circuits. The  $\text{SiO}_2$  layers on an IC are of extremely high purity and are made under precisely controlled temperature and pressure conditions during the IC manufacturing process.  $\text{SiO}_2$  also occurs in nature where it is commonly called silica and occurs as sand and quartz.

A very important characteristic of a capacitor is its capacitance which is a measure of how much electrical charge it can store for a given voltage applied across the two metal layers. The capacitance of a parallel-plate MIM capacitor such as that shown in Figure 1 is given by Equation 1:

$$C = \frac{\epsilon_0 \epsilon_r}{t} A \quad (1)$$

Equation 1 shows that the capacitance depends on the dimensions of the capacitor and the properties of the insulator material. The important dimensions are the area of the capacitor ( $A$ ) and the thickness of the insulator layer ( $t$ ). The capacitance increases if

the area,  $A$ , is increased or if the insulator thickness,  $t$ , is reduced. The capacitance also depends on a physical constant,  $\epsilon_0$ , which does not change with technology, and a property of the insulator material called the dielectric constant,  $\epsilon_r$ . The value of  $\epsilon_r$  for the most commonly used dielectric, silicon dioxide, is approximately 3.9. With each new generation of technology there is a demand to reduce the size of the components to fit more of them into a single IC; thus, there is a demand to reduce the capacitor area,  $A$ . For many applications, the value of capacitance,  $C$ , must still be relatively large, however, if the area,  $A$ , has to be small, a large capacitance,  $C$ , can still be achieved by making the insulator layer thinner, i.e., by reducing the value of  $t$ . In present generation technologies, the area,  $A$ , can vary from several square microns to thousands of square microns (one micron is one millionth of a metre; for comparison purposes a micron is approximately equal to 1/100 of the diameter of a human hair), while the thickness,  $t$ , can vary from several nanometres to several hundred nanometres, where a nanometre (nm) is equal to one billionth (1/1,000,000,000) of a metre. Unfortunately, if the thickness,  $t$ , is too small, leakage current can flow across the dielectric layer and the dielectric no longer has perfect insulation. This can cause the integrated circuit to operate incorrectly or to consume too much battery power and, therefore, there is a limit to how thin the dielectric layers can be made.

Looking again at Equation 1, if a large value of capacitance,  $C$ , is required but if the area,  $A$ , must be kept small and there is also a limit to how small the thickness,  $t$ , can be made, then the only available option is to increase the value of the dielectric constant,  $\epsilon_r$ . Therefore, in recent years, there has been extensive research into developing new types of materials that could be used to form the insulator layers of capacitors on integrated circuits and that would have a value of the dielectric constant,  $\epsilon_r$ , higher than that of silicon dioxide. These new materials are commonly called “high-k” materials because the symbols “k” and “ $\epsilon_r$ ” are often used interchangeably.

## High-k Materials

Many new materials have been proposed to meet the challenges of high-quality insulator layers for capacitors in IC technology over the next decade. To meet these challenges, any new material must meet stringent performance specifications such as being a very good insulator, having a high value of the dielectric constant ( $k$ ,  $\epsilon_r$ ), and being compatible with all the other steps of the integrated circuit manufacturing process. The development of new materials therefore involves extensive research on all aspects of the material such as the chemical composition, the physical structure, the methods used to process the material during IC fabrication and the characterization of the electrical properties of the material such as the dielectric constant. Over the last 4 years, a team of scientists and engineers at the Tyndall National Institute in collaboration with partners from other

European organizations have developed processing techniques and measurement (characterization) methods to explore a promising new type of material suitable for capacitors known as PMNT. PMNT is a ceramic-type material made from a compound of the elements lead, magnesium, niobium, titanium and oxygen with a chemical composition given by  $\text{Pb}(\text{Mg}_{0.33}\text{Nb}_{0.67})_{0.65}\text{Ti}_{0.35}\text{O}_3$ . It has been demonstrated that PMNT can yield an extremely high dielectric constant of over 1000 (compared to 3.9 for silicon dioxide) and therefore has great potential for making large-value capacitors for IC technology.

Most integrated circuits used in modern electronic devices are made from silicon (Si) and are usually processed as thin wafers (that look similar to pizzas) with a thickness of 0.5 mm or less and a diameter ranging from 8 inches to 12 inches. The manufacturing process begins with wafers of high purity silicon and in each step of the manufacturing process new layers are grown on top of the original wafer to gradually build up all the components needed to form the desired electronic circuit. For the PMNT processes developed in this research, the PMNT layer is created on the silicon wafers in a multi-step process. First, the PMNT material is prepared in the form of a liquid gel. A droplet of this gel is dropped onto the centre of the silicon wafer and then the wafer is spun at very high speeds to cause the droplet to spread out over the surface of the wafer in a very thin layer. At this stage, the PMNT is still in a liquid form and must now be transformed into a strong solid layer. This is achieved by a process called annealing, where the wafer is heated to a high temperature (hundreds of degrees Celsius) at which the final chemical reactions occur and the material changes to a solid form. In IC manufacture, each of the steps of the process must be carried out at a precisely controlled temperature to ensure that the layers grown will have the desired chemical composition and physical structure. There is also a constraint that, as each layer is processed, the layers created earlier should not be physically damaged or changed in chemical composition. One of the most common ways of damaging a layer created earlier is to use too high a temperature in a subsequent step; therefore, the temperatures needed for the annealing step during the creation of the PMNT layers is of critical importance and is one of the main aspects investigated in the research. To determine the influence of temperature, samples were prepared using different annealing temperatures and the samples were then analysed to determine the influence of temperature on the electrical performance, especially the dielectric constant.

## Electrical Performance of PMNT Capacitors

A set of special test structures were designed to allow sample capacitors to be made with the new material PMNT as the dielectric layer. To investigate the effect of annealing temperature, two sets of samples were processed. The first set of samples used an annealing temperature of 450°C for the PMNT layer and the second set of samples using a temperature of 750°C — these samples are labelled as PMNT\_450 and PMNT\_750, respectively.

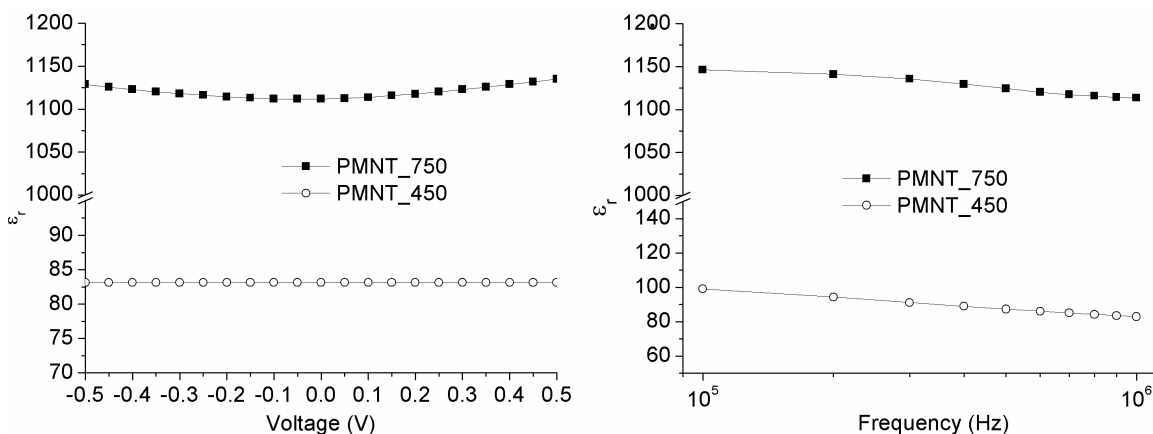


Figure 2: (a) The dielectric constant of the PMNT MIM capacitors as a function of voltage; (b) The dielectric constant of the PMNT MIM capacitors as a function of frequency.

When processing was complete, the capacitance of the capacitors was measured using a standard high-quality capacitance measurement system and the measured capacitance was used to determine the value of the dielectric constant,  $\epsilon_r$ , of the PMNT layers, by a suitable rearrangement of Equation 1.

Apart from the having a high dielectric constant,  $\epsilon_r$ , there are many other desirable attributes for the material making up the middle insulator layer of MIM capacitors, but two attributes are especially important; first, the value of the dielectric constant should not change with the voltage applied to the capacitor, and, second, the value of the dielectric constant should not change with the frequency of the electronic signal applied to the capacitor. Both of these attributes have been analysed for the PMNT samples developed in this research and are shown in graphical format in Figure 2.

Figure 2 illustrates the most important characteristics of the PMNT layers for the purposes of making high-quality capacitors. The most important aspect to notice from the figure is the difference between the samples annealed at 450°C and 750°C. It is seen that the dielectric constant of the samples processed at 750°C is much higher (approximately 1000) than the samples processed at 450°C (approximately 100). This indicates that for high-value capacitors, the PMNT material needs to be annealed at the higher temperature. The other important aspect to notice from the graph is that the dielectric constant of the PMNT does not vary significantly with either the voltage applied to the capacitor or the frequency of the signal used. Both these aspects indicate good performance and point to the good potential of the PMNT material to be used for capacitors in future generation integrated circuits.

## Conclusion

This research has focused on the development of measurement strategies for a new type of material known as PMNT for use in future generations of integrated circuit technology as the insulator layer of high-performance Metal-Insulator-Metal capacitor devices. A set of capacitor test structures have been designed and samples have been processed under different conditions to determine the effect of annealing temperature on the electrical characteristics of the final capacitors. It has been shown that the PMNT material displays a very high dielectric constant (high-k) (approximately 1000, compared to 3.9 for SiO<sub>2</sub>, the most commonly used dielectric in the current generation of IC technology), but in order to achieve this very high value, a high annealing temperature is necessary. Thus, PMNT is a very promising material for future use in ICs, especially if the annealing temperatures needed to give the high-k performance can be reduced.

Wenbin Chen is a student at the Tyndall National Institute under the supervision of Dr. Kevin G. McCarthy and Dr. Alan Mathewson. Co-authors Alan Mathewson, Mehmet Çopurođlu, Shane O'Brien, and Richard Winfield are based at the Tyndall National Institute and Kevin McCarthy is a lecturer in the Department of Electrical and Electronic Engineering. The authors would like to acknowledge the European Union Sixth Framework Programme for funding this research through STREP Project 033103 (CAMELIA). Wenbin Chen also receives support from the PRTL1 4 project NEMBES.

# Alzheimer's disease: a fatal 'lack of communication' in the brain

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## Alzheimer's disease

Alzheimer's disease is a progressive, incurable disorder of the brain, first described by Dr. Alois Alzheimer in 1906. In Alzheimer's disease, brain regions critical for memory and understanding are slowly obliterated. This results in impairment of these functions, more commonly referred to as *dementia*. It is widely recognized that, while Alzheimer's is the most common cause of dementia, it is actually a disease of the brain and is not a result of the normal aging process.

Approximately 24 million people worldwide suffer from Alzheimer's disease, with age as the primary risk factor. It is estimated that up to half of people over the age of 85 suffer from Alzheimer's. Because age is the greatest risk factor for developing Alzheimer's, the upward trend in prolonged life span across the globe means that an ever-increasing number of aging people will be at risk of developing the disease. In addition, there are social and economic consequences to the growing prevalence of Alzheimer's disease, as the stress on family members, carers, medical care providers and the State can be overwhelming. For these reasons, thousands of researchers across the globe are racing to find a cure for this devastating disease.

## Alzheimer's treatment and research

Current treatments for Alzheimer's only address the *symptoms* of memory loss, but are unable to stop the advancing onslaught of brain deterioration. Over the last 100 years, huge advances in medical and scientific technology have vastly increased our understanding of the effect of Alzheimer's disease on the brain. In addition to age, several genetic and environmental risk factors have been identified; however the true 'smoking gun' – a specific neurological event – has yet to be discovered. Thus, it is important not only to develop effective treatments for symptoms, but ultimately to identify the real cause and help successfully combat and prevent Alzheimer's in the future.

Alzheimer's disease is specific to humans and, because the brain cannot be safely biopsied, it is thus difficult to study the disease at early stages. However, over the last 15 years,

scientists have been able to make use of genetic mutations to better comprehend the disease. These genetic mutations are the cause of Alzheimer's disease in a small minority of patients (around five percent). This *familial*, or hereditary, form of the disease results from genetic mutations which may be passed down by either one or both parents. By inserting these mutated human disease-causing genes into mice, scientists have been able to create transgenic mice which develop Alzheimer's when they normally would never do so. This allows researchers to look at Alzheimer's disease in the brain as it develops over time, a feat impossible to do in the human brain. This work has had a significant impact on Alzheimer's research and continues to shed light on the development of Alzheimer's in the brain and improve our understanding of the disease, which will greatly accelerate the search for a cure.

### **Neurons relay information throughout the brain**

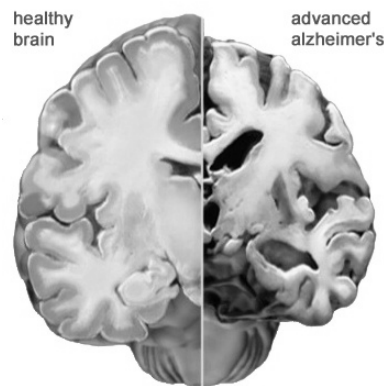
The healthy brain contains around 100 billion *neurons*, the important cells which relay messages throughout the brain and are lost in Alzheimer's disease. These neurons connect to each other at points called synapses and form a complex network of neuronal connections. In all, there are approximately 100 trillion synapses in your brain, where chemical and electrical signals are transmitted which allow you to move, think, learn, and interpret the world around you through sight, sound, touch, etc. Every bodily function and ability is controlled by the brain and, on a minute level, neurons.

### **The Alzheimer's brain**

The two main characteristic features, or pathologies, of Alzheimer's disease are *amyloid plaques*, which are deposits of a small protein called *amyloid- $\beta$  ( $A\beta$ )*, along with *neurofibrillary tangles*, made up of clumps of an abnormal form of tau protein. Normally  $A\beta$  and tau function within neurons to control creation of neuronal connections, along with other tasks. However, abnormal forms of these proteins become sticky and cluster inside and between neurons. These aggregations of protein can then physically 'get in the way' of normal neuronal processes.

The large clumps of  $A\beta$  and tau occur specifically in regions of the brain designated for memory storage, learning, understanding, behaviour and personality. Ultimately, this leads to the destruction of synapses and neurons in these critical parts of the brain (Fig. 1). Essentially, Alzheimer's attacks the very part of the brain that defines *you* as you.





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Figure 1: The brain of a patient with Alzheimer's disease is severely damaged compared to the brain of a healthy patient.

## Cellular communication in the brain

### Messenger molecules

Within all cells, including neurons, there are hundreds of different proteins which act as 'messenger molecules' to transmit instructions or signals inside the cell and to surrounding cells. These messenger molecules have complex pathways – orders of signalling where messenger A 'tells' messenger B, which signals to messenger C, and so on, over many steps, in what is described as a *signalling cascade*, or *pathway* (Fig. 2). We can describe messenger A as 'upstream' of messenger B, and messenger C as 'downstream' of both A and B. Turning one messenger 'on' or 'off' can have several effects throughout the entire signalling cascade, meaning that the actions of only one messenger molecule can affect numerous neuronal functions.



Figure 2: Normal signalling cascade (left) compared to defective signalling cascade (right), where blocking the actions of messenger molecule A' has downstream effects on messengers B and C.

### Alzheimer's disease and molecular 'miscommunication'

Why do neurons die in Alzheimer's disease? The answer to this question is not simple, as many factors come into play on a microscopic and molecular level, and we still do not know the primary causative factor in Alzheimer's disease. Scientists have been able to study the pathology which builds up in the brain and causes neuronal death, but it is still

unclear what initiates this accumulation. However, we do know that the process which makes neurons become 'sick' and die involves abnormal relaying of messages between neurons, and within the neuron itself.

The sticky proteins  $A\beta$  and tau clump together inside and outside neurons, preventing normal trafficking of messenger molecules inside neurons and across synapses. They are also able to turn essential messenger molecules 'on' or 'off', which can have drastic effects upstream and downstream in the signalling cascade. Research on brain tissue from patients who had Alzheimer's disease has identified several messenger molecules which are defective in Alzheimer's disease, but it is unclear if the resulting faulty communication is a cause or an effect of Alzheimer's pathology.

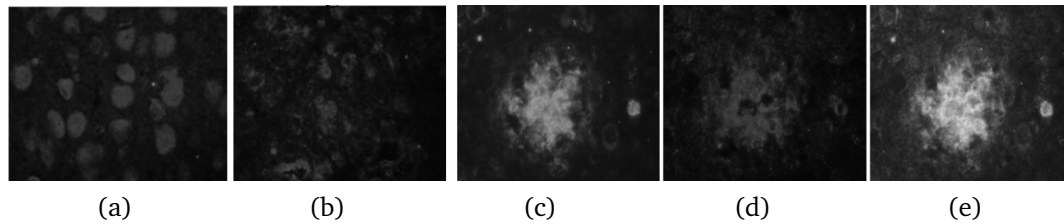
### **The insulin signalling cascade**

*Insulin* is a type of molecular messenger in the body called a hormone, and one of its functions is to regulate levels of sugar in the blood. It may be familiar to many readers as a treatment for diabetes. Insulin also has a key role in the brain, and is especially involved in memory and learning – the brain functions which are impaired in Alzheimer's disease. Several studies, including work from our lab, have shown deficiencies in the insulin signalling pathway in the human Alzheimer's disease brain. However, the exact relationship between insulin and the abnormal  $A\beta$  and tau remains obscure.

### **Results from my doctoral research**

Transgenic animals have been instrumental in enhancing the understanding of Alzheimer's, particularly a mouse named the '3xTg-AD' model, in which  $A\beta$  and tau pathology closely mimic that found in the human brain. Thus, the focus of my doctoral work has been to utilize this mouse model of Alzheimer's to examine certain molecular messengers in relation to the disease.

It was already known that insulin signalling was altered in Alzheimer's, but my work set out to investigate if this defect was perhaps a cause of Alzheimer's disease, or if it was a result of  $A\beta$  and/or tau pathology in the brain, and how these three relate to each other. One of the ways I did this was to use a technique called *immunofluorescence*, which allowed me to look at sections, or slices, of a mouse brain and 'tag' the messenger molecules with different colours. Using a microscope I then photographed the tagged proteins to examine where and at what levels they were present in the 3xTg-AD mouse brain in comparison to normal mice, and if they located near the clumps of sticky  $A\beta$  or tangled tau.



Insulin receptor (red) is found in neurons of a normal mouse (a), but is decreased in mice with Alzheimer's pathology (b). Clusters of sticky A $\beta$  (green, c) draw insulin receptor (red, d) out of the neurons. By merging these images (e), it is possible to see that A $\beta$  and insulin receptor occur in the same place (yellow), providing evidence of a direct relationship between the two proteins.

Figure 3: Changes in the insulin receptor in the brains of mice with Alzheimer's disease.

### Insulin signalling is defective in transgenic Alzheimer's mice

What I found throughout the course of my work is that the *insulin receptor* (IR), the protein to which insulin binds, is changed in the 3xTg-AD mouse. It is lost in the specific areas of the brain which have sticky A $\beta$  and tau (Fig. 3a, b). The receptor also sticks to A $\beta$  itself, and gets drawn into the large clusters of sticky A $\beta$  known as amyloid plaques (Fig. 3c-e). What this means for the 3xTg-AD mouse is that there are fewer IRs to which the insulin hormone can bind. This has serious consequences for the affected neurons, as it means that other messenger molecules 'downstream' of the receptor may not be in their correct 'on' or 'off' state. This interferes with the ability of the neurons to carry out normal functions for survival. In addition, this deficit can impact the neurons' ability to signal to other cells through damage to the synapses, the important connections between neurons, and ultimately results in neuronal death. Loss of synapses and the neurons themselves are the cause of impaired memory and other symptoms of Alzheimer's disease.

My work has also addressed a similar receptor called *insulin-like growth factor-1 receptor* (IGF-1R), which, as its name suggests, signals in a similar way to IR. IGF-1R is also changed in the 3xTg-AD mice, along with several other important messenger molecules downstream of both receptors.

Interestingly, defects in IR and IGF-1R associated more with A $\beta$ , rather than tau pathology. This has allowed me to narrow the focus to possible interactions between A $\beta$  and these receptors and the messenger molecules downstream in the pathways. What's more, I have been able to extend my research beyond the 3xTg-AD mouse and look at neurons grown in the laboratory. These neurons were treated with A $\beta$  and I was able to observe changes in IR and IGF-1R to provide further evidence of a relationship between A $\beta$  and these signalling cascades in neurons.

## Conclusion

The conclusion of this work is that over time, accumulation of  $A\beta$  in Alzheimer's mice negatively impacts IR and IGF-1R signalling and their target proteins. Malfunction of these signalling pathways then has far-reaching consequences within neurons and how they communicate with other cells. Thus I have shown that the defects in several of the messenger molecules are actually a *result*, not a *cause*, of the disease, providing more information about how  $A\beta$  and tau affect the brain, an understanding which is essential to finding a cure. This work is the first to show such defects in an animal model of Alzheimer's, supporting the hypothesis that insulin signalling plays a major role in Alzheimer's, and should be taken into consideration when exploring new treatments.

Thanks to my supervisor Dr. Cora O'Neill, my colleagues in the lab and our collaborators, Dr. Dominic Walsh, University College Dublin and Prof. Frank LaFerla, University of California. Meghan Coakley is a student in the Neurobiology and Alzheimer's Disease Laboratory under the supervision of Dr. Cora O'Neill. The author would like to acknowledge funding from the Science Foundation Ireland Research Frontiers Programme and the Health Research Board. All animals used in this study were treated humanely and in accordance with guidelines issued by the Irish Department of Health and Children.

# Islamism and nationalism in the Palestinian territories: 'The Palestinian experience'

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## Introduction

The Palestinian question has remained one of the most continually debated topics in the world today. More than any time in the past a solution to the Palestinian/Israeli conflict seems more distant than ever when Palestinians and Israelis themselves, academics, analysts and peacemakers do not hold much optimism for the future in achieving peace between the Palestinians and the Israelis and a settlement to the issue of Palestinian nationhood. A key factor in the struggle with Israel and in Palestinian efforts to achieve a Palestinian state has been the internal ideological battle between Islamism and Nationalism in defining the Ideological direction of the Palestinian struggle. The Islamist Hamas believes, through what it has formulated as an Islamist nationalist perspective by fusing together Islam and nationalism, that only through Islam can the Palestinians succeed in achieving their rights. Moreover, Hamas considers that the demise of Israel can only be brought about by returning to Islam within Palestinian society. Islamic Jihad similarly believes that liberation of Palestine can only be successful if it is Islamic. Although the religion of Islam does play a significant role in a conservative Palestinian society, Hamas' arch foe Fatah is ideologically a secular organisation. This ideological struggle within the Palestinian territories is represented by the current ideological divide existing in the West Bank governed by the secular Palestinian Authority and in Gaza governed by the Islamist Hamas. Hamas and other Islamist movements have an ideological world view of a Palestinian state which is at odds from that of more secularist and leftist parties such as Fatah. Complicating this picture is the fact that Israel, the EU and the U.S. are key actors in Palestinian politics and ideology demonstrated by their support for Fatah and the Palestinian Authority in the West Bank and the isolation of Hamas and the blockade in the Gaza Strip. In turn, Hamas is supported by Hizbullah in Lebanon, Syria and Iran, as all actors look to further their interests in the region. This Ideological struggle within the Palestinian territories between Islamist and secular Nationalists forms the basis for my research.

## Previous Research

There is a significant amount of research published on the Palestinians and Palestinian identity, much of which charts the formation of a Palestinian Identity before and after World War 1. There is also an abundance of research focusing on Islamic politics in the Palestinian territories and on Islamic movements such as Hamas. Very little of this research, however, has concentrated on the reasons why Palestinians support either the Islamist or secular nationalist milieus within the Palestinian territories. However, in recent years, Loren Lybarger has undertaken research focusing on Islamism and secularism in the occupied territories (Lybarger 2007). His research relied on extensive field work in the West Bank and Gaza during the first and second Intifada in 1987 and 2000 and interviews carried out during time spent in both areas. What was different in Lybarger's research was that he gained an insight into the lives of ordinary Palestinians, their experiences and reasons for supporting either Islamist or secular parties, whether Christian or Muslim. One of his conclusions is that "Palestinian society does not fall neatly into two camps, Islamist or secular nationalist" (Lybarger 2007). There have been significant changes in the Palestinian arena since Lybarger's research, including Hamas winning the 2006 parliamentary elections and its takeover of Gaza in 2007. Since then, Gaza has been under blockade and the West Bank and Palestinian Authority have been further supported by Israel, the EU and the U.S. in efforts to isolate Hamas and move forward with the peace process. As evidenced by Hamas' election victory in 2006, Palestinian political loyalties and ideological allegiances have shifted more towards the Islamist perspective over the last decade due to Hamas' ability to capitalise on the failure of the peace process, corruption within Fatah and the Palestinian Authority, and no improvement in the daily lives of the Palestinian people.

## Research Questions

What are the reasons then for Palestinians supporting Islamist nationalist groups such as Hamas and Islamic Jihad or more secular nationalist groups such as Fatah in contemporary Palestinian society? How significant is religion, ideology and politics in Palestinians voting for Islamist or secular parties? How has the prospects/failure of the peace process affected/alterd Palestinian allegiance to either the Islamist or secular milieu? How have Israeli actions such as the assassination of Hamas leaders, daily checkpoints, curfews and settlement expansion affected and shifted Palestinian allegiance to the Islamist nationalist camp? These are some of the questions I intend to answer by living and studying amongst Palestinians in the West Bank, Ramallah in 2011. Through carrying out in-depth and focus group interviews with Palestinian activists, students and academics, I will gain a further insight into the 'Palestinian Experience'.

## Palestinian Collective Identity

How Palestinians identify themselves is crucial in understanding the choices they make, whether a Muslim or a Christian living in Israel, the West Bank, Gaza or in a refugee camp in Lebanon. Although Palestinian identity emerged during the years before the outbreak of World War 1, Palestinian identity was also formulated in reaction to the decline in pan-Arabism, Zionism and occupation (Khalidi 1998). The Israeli occupation which has been seen as constituting a threat to both the Arab identity of Palestine and its Islamic character has been an important factor in the rise of the Islamic movement (Abu-Amr 1994). Due to the separateness of the Palestinian people from one region to another, their individual experiences and identity have evolved differently, which impacts on the ideological choices they make. Palestinian Muslim youths growing up in Gaza have a somewhat different life experience than a Palestinian Christian living in the more secular city of Ramallah in the West Bank. Gaza today is blockaded by Israel and is governed by the Islamist movement Hamas.

Living conditions, where most Palestinians live in absolute poverty, are significantly worse than in the West Bank which is supported politically and economically by Israel and the West. Moreover, the West Bank is governed by the secular Palestinian Authority where the religion of Islam does not play a role in the politics of the West Bank, unlike in Gaza. In the Palestinian realm, the absence of national state institutions and structures representing all Palestinians living in the Palestinian territories, signified by the current split between Gaza and the West Bank, mean that Palestinian identity continues to evolve along numerous trajectories.

Hamas have an Islamic nationalist vision for Palestinian society which is ideologically at odds with that of the more western secular national Palestinian forces within the PLO. As Hamas became more predominant within Palestinian society, specifically during and after the first Intifada, Palestinian Identity became more Islamised, in what Meir Litvak refers to as "the Islamisation of Palestinian Identity" which led in turn to "the Islamisation of the Palestinian Israeli conflict" (Litvak 1998). Hamas presented a religious and national alternative to the secular PLO leadership by incorporating Palestinian nationalist elements and rhetoric into its Islamic Ideology.

In response, Fatah adopted Islamic symbols and rhetoric into its discourse, as both Hamas and Fatah vied for the support of the Palestinian people. Palestinian secular nationalist and Islamic identities have thus over time become intertwined. The failure of the PLO nationalist peace process and the Oslo Accords in the early 1990's enabled Hamas to capitalize and make further gains in the Islamisation of the Palestinian struggle with Israel. Similarly, Hamas will seek to benefit from what it sees as the inevitable failure of the current peace process in galvanising support for its Religious Nationalist solution to the Israeli/Palestinian conflict.

## **Islamist Nationalist or Secular Nationalist**

Since the creation of the state of Israel in 1948, there have been three separate and distinct Palestinian movements, with different ideologies, Arab Nationalism, Palestinian Nationalism expressed by Fatah which dominated Palestinian politics in the 50's and 60's, and Palestinian Religious Nationalism which Hamas embodies and has become more dominant in the last few decades (Baumgarten 2005). After the decline in Arab Nationalism, the main struggle in contemporary Palestinian society is between what Lybarger refers to as the 'Islamist milieu' represented by the dominant Hamas and the secular-nationalist milieu represented by Fatah, which is the dominant faction in the Palestinian Liberation Organization (Lybarger 2007). Lybarger discovered that, due to competition and division between the Islamist and secular, activists integrated elements from both the Islamist and secular milieus in reformulating new political identities (ibid). The boundaries between Islamism and secularism in the Palestinian setting have become blurred as both secularists and Islamists use both secular and Islamist symbols to further their agenda in securing the Palestinian vote. Palestinian allegiance to either the secular or Islamist faction can be governed by many factors, including the social and political affects of living in either the West Bank or Gaza. Many Palestinians voted for Hamas in the 2006 elections due to rampant corruption within the Fatah leadership, divisiveness within Fatah and a poor election campaign whereas Hamas were considered to be honest, well organized and united. ADDIN ZOTERO\_BIBL Susser argues convincingly that Hamas' victory was also due to a crisis of secularism in the Arab world where Islamist politics is on the rise (Susser 2010). However, despite increased support for Islamist movements such as Hamas, Palestinians have been much less committed to Hamas' ideology (Shikaki 2004). Palestinians may have voted for Hamas not because of its ideology but because of its political program and the absence of any other alternative to Fatah. Ideological affiliation amongst Palestinians has also been influenced by the success or failure of the peace process as Hamas continued to score low in opinion polls during the Oslo years throughout the 1990s. However, support for Hamas and suicide bombings increased from 20 per cent to 40 per cent in the late 1990s due to disillusionment with the Oslo peace process (Gunning 2007). Although the political climate has certainly changed in the Palestinian Territories since then, understanding how and why the Islamists reacted to the peace process in the 1990's is vital in analysing their political and armed actions during the current peace talks.

## **Conclusion**

Palestinian Islamist and secular political Identity continues to evolve in response to the ability of Palestinian political players to attract Palestinians to supporting the goals of an Islamist or secular led nationalist cause. The peace process will play a significant role as Palestinian support for either Hamas or Fatah, regardless of their ideological preference,



is dependent on progress or failure in the current peace process. Hamas believes it will benefit from what it sees as the inevitable failure of the current peace talks in convincing Palestinians that the only solution to the conflict is one which relies on the political Ideology of Islamism. However, in a society which has a long experience with secularism, supporting the Islamist Hamas does not mean that Palestinians believe in or will support a strict Islamist ideology. Palestinian Islamists though, such as Hamas, have developed an ideological position that reflects the concerns of the Palestinian community (Milton-Edwards 1999). Hamas and the Islamist alternative challenges the notions of nation and nationalism previously held in secular Palestinian politics. This alternative of Islamist nationalism will continue to be shaped by the unique 'Palestinian Experience' as Palestinians strive to attain a nation of their own. The future of Islamism and nationalism in the Palestinian Territories will depend on the ability of political actors throughout the Palestinian territories to unite and reflect the hopes of the Palestinian population as a whole. It will also depend on Israeli, U.S. and International actors in dealing with Islamist movements such as Hamas and the outcome of the current peace process. It will also be contingent on the ability of Hamas to moderate further and integrate into Palestinian institutions alongside more secular parties such as Fatah. The success or failure of current peace efforts in tandem with the future decisions of Israel, the U.S. and the West to engage or not to engage Hamas will be instrumental in the choices Palestinians make and the continued evolution of Islamism and Nationalism in the Palestinian territories.

Donncha Cuttriss is a student in the Study of Religions Department under the supervision of Dr. Oliver Scharbrodt.

# 'What is it that you do again?': thinking about criminal responsibility

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My object all sublime, I shall achieve in time, to let the punishment fit the crime —  
the punishment fit the crime. (Gilbert & Sullivan, *The Mikado*)

## Finding the Problem

I study the intersection between contemporary neuroscience and the theory of criminal responsibility. Hanging around disciplinary intersections like this can be fun: people don't always look where they are going and if you wait long enough you might witness a crash or two.

Casting aside the metaphor, my job begins by identifying the problems and tensions that emerge from the different ways in which we view the world. What might those problems be in the case of neuroscience and criminal responsibility? Well, we can divide it into two classic problems.

The first is the problem of competing descriptions. Simplifying somewhat, we can say that neuroscientists describe human behaviour from the bottom-up, beginning with chemical and electrical signals between individual nerve cells and working up to the functional processing that takes place within and between different brain regions. These descriptions are mechanistic, deterministic and reductive.

By way of contrast, theorists of the criminal law describe behaviour from the top-down, beginning with the system of legal norms and values, and working down to the intentional and psychological capacities that they think supports this system. These descriptions invoke the concepts of consciousness, intentionality, freedom of the will, and so on.

The worry is that these two sets of descriptions cannot live side-by-side; that one must necessarily supplant or eliminate the other; and that, due to the successes of the natural sciences, the most likely candidate for elimination is the criminal law.

The second problem is the problem of enhanced control. The worry here is not that the traditional understanding of criminal responsibility will be done away with, but, rather, that the technologies derived from neuroscientific discovery will enlarge the scope of our responsibilities.

For example, drugs and other medical interventions that can enhance cognitive function could have two effects on criminal responsibility. First, they might bring people who were traditionally excused from responsibility within the scope of criminal liability. This might be due to their having some now-treatable cognitive defect. And second, in the drive to reduce and control risk in society at large, we might all be legally obliged to “up our games” and partake of these enhancements.

Although I do focus on the first problem, the second strikes me as being the more interesting and practically relevant of the two. What is particularly interesting about it is that the law has been dealing with it for some time.

There is, I argue, a class of cases that have come before the courts involving “precommitment failures”. These are situations in which someone committed a crime in a state of “abnormal” agency. This state would normally excuse them from liability, but, because they failed to take steps that were available to avoid this state, they can be held responsible. These cases are similar to the hypothetical worries about cognitive enhancement mentioned above.

The key question then becomes: when, and under what conditions, is it legitimate to hold a person criminally liable for failing to avail of opportunities for enhanced control?

## Assembling the Tools

One of the tools that I use to answer that question is game theory. Game theory was developed in order to understand the dynamics of strategic interaction. In the parlance of game theorists, a “game” is not something frivolous or trivial. It is any situation that has players, actions, payoffs, and information. This, it turns out, covers nearly all social interactions.

There are two main reasons why game theory can help us to think about the law. First, laws deal with social interaction. Indeed, laws are designed to structure and place limits on our social interactions. So any tool that can be used to model and understand social interactions is of benefit to legal theory. Second, through the concept of *equilibria solutions*, game theory helps us identify which laws are possible.

Here’s a simple game that can illustrate my point. It’s called *divide-the-cake*. Two people, Ann and Bob, are given a cake to divide among themselves. The rules of the game are as follows. They each demand a fraction of the cake. If the fractions add up to one or less, they receive whatever they demanded. If the fractions add up to more than one, the cake is taken away or spoiled.

This is an example of a bargaining problem. These arise whenever two or more people are trying to negotiate some sort of deal which is mutually beneficial. And although dividing a

cake is somewhat trivial, this basic game has been used by political and moral theorists to understand questions of distributive justice: Who is entitled to what? Which distribution of social goods is the fairest? These are not trivial questions: they are central to the moral foundations of legal systems.

To answer those questions from the perspective of game theory, we must first try to identify the equilibria solutions to the game. There is a precise definition of what an equilibrium is, but, very roughly, we can say it arises whenever the combination of the players’ actions is such that no player has an incentive to change what they are doing.

In the divide-the-cake game, there is one glaringly obvious equilibrium: the fifty-fifty split. At this point, neither player has an incentive to demand more or less. But things are not that simple. It turns out that every combination of fractions-demanded that adds up to exactly one is an equilibrium. Think about it: as long as the fractions sum to one, the player demanding more than half has no incentive to demand less, and the player demanding less than half, knowing the position of the other player, has no incentive to demand more or less.

This is disturbing because we would probably like the fifty-fifty split. Indeed, experimental evidence confirms that people have a preference for equitable distributions. But how can the fair split get a foothold in society if there are other potential equilibria? Fortunately, there is a way.

Experimental testing and computer modelling of the divide-the-cake game has revealed that if the game is played repeatedly, if players learn from experience, and if they can be more discriminating in their choice of who they bargain with, fifty-fifty becomes the dominant equilibrium. Evolutionary game theorists have argued that these observations can account for the human preference for equitable solutions. This engrained preference then serves as a constraint on possible legal norms.

## **Constructing a Solution**

Now you may be wondering: what relevance does this have to the problem of enhanced control? This is where I enter the third stage of my research and try to construct a solution using the tools I have identified and defended in the second stage. I can only offer a brief sketch of that solution here.

My solution begins by pointing out that the problem of responsibility has significant parallels with the problem of distributive justice. Whereas the latter is about sharing out some social surplus; the former is about sharing out a social burden. The burden in question relates to the *effort we are expected to expend in order to avoid risk*.

To expand on this, we can say that the criminal law defines the activities that are socially

unacceptable or, to put it another way, the activities that give rise to unacceptable levels of risk. We are all burdened with avoiding those activities. The norms of responsibility dictate exactly where the burden lies. Thus, the law of criminal responsibility can be modelled in the same way as the divide-the-cake game.

This casts the problem of enhanced control in a new light. We can see now that this problem arises whenever new information is added to the game that changes how we think about the risk burden. By paying close attention to the trade-offs between increased effort and reduced risk, we can identify the situations in which it is fair to impose liability for failing to avail of the opportunities for enhanced control.

Thanks to my supervisor, Dr. Mary Donnelly, and to the Irish Research Council for the Humanities and Social Sciences for funding my research over the past three years.

# Buckling of thin-walled cylinders: experimental and numerical investigation

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## Introduction

Thin-walled structures, also known as shells, combine light weight with high strength and are used in a diverse range of fields including aerospace engineering, civil engineering and chemical engineering. Common applications of these shells include oil and gas storage tanks, powder or liquid storage tanks in pharmaceutical plants as well as airplane frames and ship bodies. Although these thin-walled shells have a wide variety of uses, this research is motivated by storage tank collapse in the process industry. Thin-walled cylindrical tanks common in the food and biotechnology sectors are prone to buckling (or inward collapse) due to accidentally induced internal vacuum. During the sterilisation process, steam can condense, causing a reduction in volume. This results in an equivalent increase in external pressure, triggering collapse, or buckling of the tank. Such a collapse, if it occurs, tends to be catastrophic resulting in the complete destruction of the vessel (see Fig. 1). Notwithstanding that the basis of this type of failure is understood and can generally be averted, it is still a regular occurrence, often due to the inadvertent closure of line control valves during a sterilisation cycle.



Figure 1: Examples of tank collapse

Large discrepancies exist between classical shell buckling theory and results of shell buckling experiments. Experimental values have been shown to fall anywhere between 20-

70% of the theoretical value. This wide disparity has been attributed to two main factors, namely:

- Geometric imperfections
- Material variation

Geometric imperfections comprise any geometric feature which distinguishes the tank from a perfect tank. In an ideal world, the perfect tank would be perfectly circular and have a smooth uniform wall surface. However, many imperfections may be caused during the manufacturing process of the tank including dents, welded seams, wall thickness variation, out-of-roundness or non-circularity. These imperfections all affect the performance of the shell.

Material variation accounts for a non-uniformity of the material used, such as variation of strength in the metal. The aim of this research is to find the factors influencing this type of collapse and find an improved method to predict and prevent collapse.

## Methods of Research

This research is divided into two major categories: experimental and numerical.

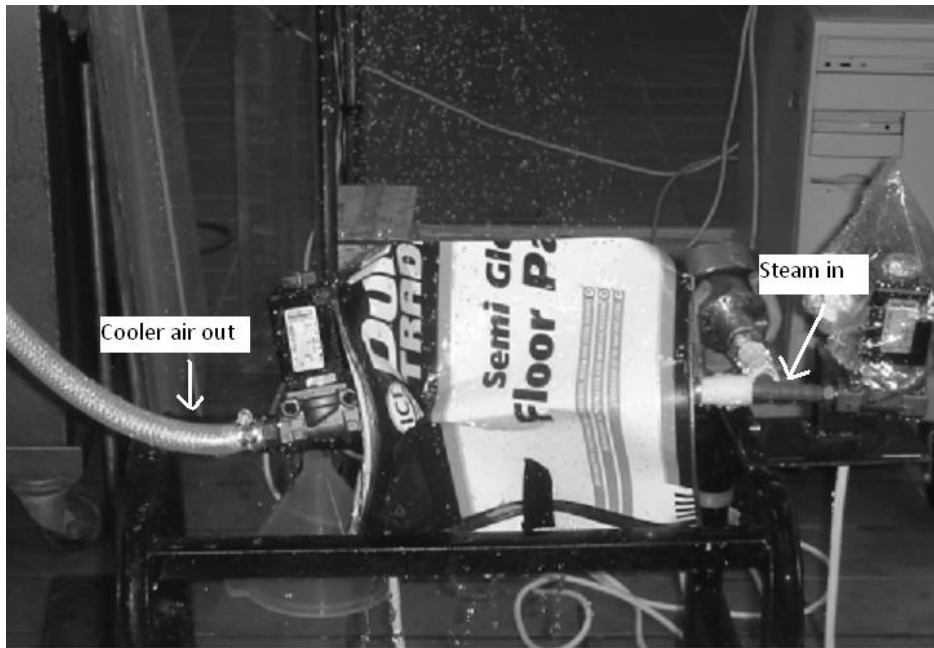
### Experimental

Experiments are carried out in the laboratory on small-scale steel cans in order to replicate the behaviour of the real tanks. The manufacturing process of the cans is as follows:

- The main body of the can is cut from a flat sheet of rolled steel
- The main body of the can is passed through rollers which bend it into a circular shape so that the two ends meet
- The meeting ends are welded together forming a seam
- The top and bottom of the can are added on by means of a folding process

These cans contain imperfections typical of those caused inadvertently by the manufacturing process and so are suitable for this study.

The cans are positioned on an experimental rig with openings at each end. Steam at 100°C flows in one end, pushing out cooler air through an outlet pipe at the other end. At each end is a valve and when the can has been filled with steam and the cooler air emptied, the valves are closed, sealing the can so no steam can escape. The cans are allowed to cool under normal atmospheric conditions in the laboratory. As the steam cools it contracts creating a vacuum, or increase in external pressure. This leads to an



The deformed shape of the can is unusual. The can deforms with six panels (or lobes) forming a hexagonal cross-section. This deformed shape is geometry dependent and so for a longer can, or one with a greater wall thickness, the deformed shape might have maybe 8 panels or 20 panels.

Figure 2: Laboratory Experiment set-up

instantaneous sucking-in of the can walls, the buckling, and ultimate collapse of the can (See Fig. 2). Throughout the experiment, pressure inside the can is monitored in order to record the buckling or collapse pressure at the point of collapse of the can. By carrying out experiments on a large number of cans, we can quantify the dispersion of the collapse pressure.

## Imperfection Measurements

Since geometric variability is known to be a major factor influencing this collapse, geometric surveys of the cans were conducted. A measurement rig was custom-built to take full surface geometric data of the cans allowing us to record any imperfection. The cans were centred and secured on a base plate which rotated  $360^\circ$ , and four dial gauges, recording surface data, moved vertically on linear actuators. Three of the dial gauges were positioned at  $120^\circ$  intervals outside the can with the fourth on the interior, recording thickness imperfections. The base plate rotates and the actuators move vertically until measurements of the entire surface of the can are taken.



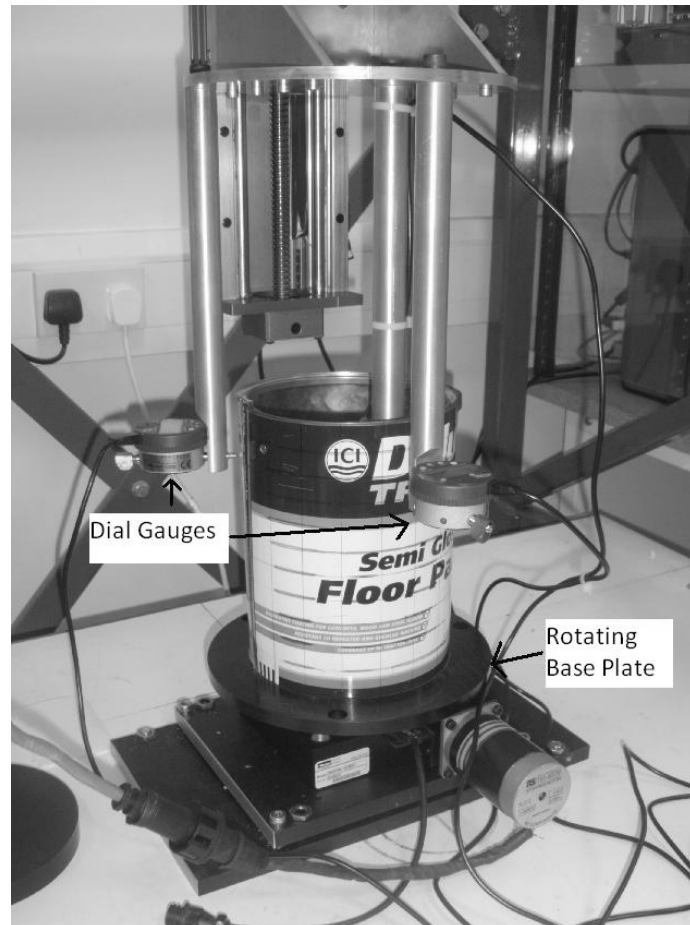


Figure 3: Measurement rig set-up

### Finite Element Analysis

This real-can geometry is then modelled and analysed using finite element analysis software. In this way, all geometric imperfections of the cans may be modelled. This allows us to predict more accurately the behaviour of the cans. Finite Element (FE) Analysis is the state-of-the-art in engineering analysis and is used in all modern structural analysis and design. A model of the structure is created in the software program which then performs an analysis using preset loading and boundary conditions. The loading conditions describe how much force or pressure the structure is subject to while the boundary conditions describe the fixity of the structure, i.e. how free it is to move. The model was set up as shown in Fig. 4 using the same geometry and material properties as the experimental cans.

The analysis is then performed (See Fig. 5) and results are compared to the experimental behaviour.

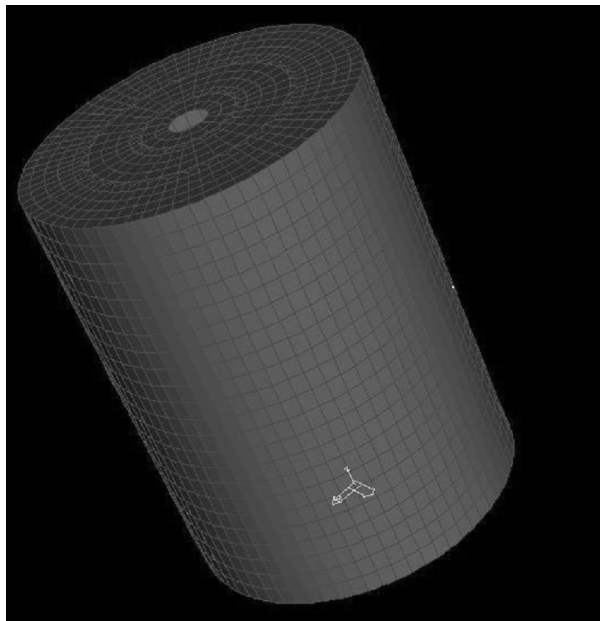


Figure 4: Finite Element model of can

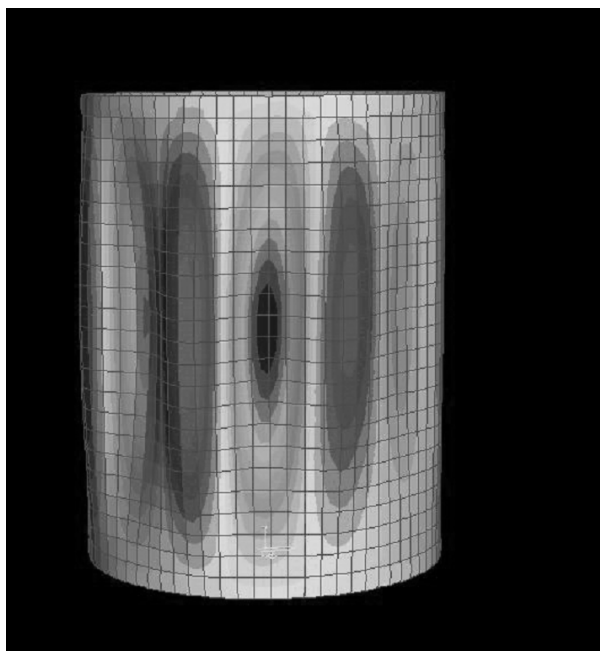


Figure 5: Deformed shape of can predicted by Finite Element Analysis

Table 1: Comparison of Experimental and Numerical Results

Can	FE Analysis kPa	Experimental kPa	% difference (FE-Exp.)
A	22.2	19.93	11.4
B	21.7	20.31	6.8
C	22.2	20.86	6.4
D	24.0	21.37	12.3
E	23.2	21.7	6.9
Mean	22.7	20.38	

## Results and Discussion

The buckling pressures predicted by the Finite Element Analysis are in good agreement with the experimental collapse pressures (see Table 1). Three of the cans are within 7% and the other two are within 12%. The reason for this larger discrepancy is that there was a problem with the steam inlet pipe during the experiments for cans A and D and so this affected the data somewhat. The FE analysis tends to overestimate the buckling pressures slightly and also over predicts the number of lobes. This may be possibly due to other unobserved geometric imperfections in the real cans that aren't included in the numerical analysis.

## Conclusion

An experimental and numerical analysis of the buckling of cylindrical shells under a uniform external loading is presented. Geometric imperfections based on measured data of five cans were modelled in a nonlinear finite element analysis. Buckling collapse experiments were carried out in the laboratory and the results compared. The study shows that the numerical analysis of the buckling process predicted by the FE model closely follows the experimental behaviour.

Caitriona de Paor is a student in the Department of Civil and Environmental Engineering under the supervision of Dr. Denis Kelliher and Dr. Kevin Cronin. The author would like to acknowledge contributions to this research from Dr. William Wright, Sean McSweeney, Paul Conway, Tim Power and Michael O'Shea and funding from IRCSET Embark Initiative.

# **'You wouldn't pass the salt' — from accusation to request; or the impact of learning context and learner identity on the acquisition of situational variation in highly advanced learners of English**

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## **Introduction**

The field of second language acquisition is a fascinating and global topic. Many of us have spent long hours pouring over textbooks, memorising vocabulary and perfecting our grammar only to find that when we arrive in the country no-one understands us or our use of language unexpectedly gives rise to hilarity or even causes offense. We've been told, 'Don't worry. Spend a few weeks in the country and you'll soon soak up the language'. Again, this is not always the case. While many learners return from their time abroad showing and feeling huge improvements, there are others who seem not to have benefited from the experience. In fact, it is well known that people can live in another language environment for years and never 'pick up' the language. So, if learning doesn't necessarily help and spending time in the country doesn't always produce the desired results, then what are the factors that can help transform us from tongue-tied novices into eloquent conversationalists?

## **Background**

In order to explore the factors, we need to look at the background to second language acquisition research.

For a long time, second language acquisition was thought to be the result of changing habits or acquiring new ones. All we needed to do was 'listen and repeat' and eventually we would get there. However, many realised that this explanation in no way accounted for two specific phenomena:

1. learners are capable of producing novel sentences i.e. sentences that they have not heard before
2. all learners make the same mistakes.

To explain those phenomena, language acquisition researchers adopted a cognitive framework to the field. This trailblazing framework allowed a quantitative science to emerge which took the field out of the realm of habits into that of science. It was argued that we are all hardwired to acquire language, that we are all endowed with a 'language acquisition device' which ensures that we acquire a second language following a predetermined and fixed route. All learners will follow the same path irrespective of their first language (L1) or learning context i.e., where learning takes place. This route or path is known as interlanguage. This was revolutionary. It meant that language acquisition was systematic and could actually be analysed and quantified universally. The theory was underpinned by a series of studies into the systematic acquisition of grammatical features and developmental sequences such as forming questions and negatives. These studies showed, very compellingly, that there is a natural order of acquisition of grammatical features and that there are fixed stages to acquiring questions and negative forms. To use a metaphor, interlanguage is like a train. It has a fixed route and a fixed number of stations. When the train stops, it affords the passengers (learners) the opportunity to offload unnecessary baggage (old grammatical forms) and replace them with the newer forms.

As compelling as the argument for a purely cognitive framework is, it has several drawbacks. It presupposes that language is a monolith, i.e., that a language is a single, unchanging entity. It also presupposes a final destination (the native speaker) and if we reach that point further learning is neither necessary nor even possible. Likewise, it works on the premise the learner is a fixed, stable entity with no control over the journey; and that all learning contexts are equal. The train ploughs on regardless of external conditions. Moreover, one of the most depressing presuppositions is that learners seldom reach the final station of this journey with most leaving the train, or fossilising, some distance before the last stop.

However, since the late 1990's there has been a growing and convincing body of work advocating that language acquisition is, at least partially, socially constructed. Many now believe that language acquisition does not take place in a vacuum and that it is not necessarily a fixed process; rather, that it is dynamic and fluid and that the key elements in the process i.e., language, learner and context are also dynamic and fluid entities which change and develop over time and space forming a highly complex socio-cognitive ecosystem.

## **Current Research Project**

The current research project aims to explore the dynamic relationship between these key entities and attempts to prove empirically that learning context and learner identity are crucial to the acquisition of the ability to vary language to suit the social or contextual situation by investigating the language of 20 non-native speaker teachers of English.

The key questions posed are thus:

- Is there a relationship between language proficiency level and a learner's ability to vary language to suit the situation?
- Does time spent in the target language country aid the acquisition of variation in speech? If so, how much time is needed and how frequent should the visits be?
- Does social and/or self-imposed identity act as a barrier or a conduit to the acquisition of variation?

In order to explain this point of view, we need to break down some of the beliefs held by those working from a purely cognitive point of view.

## Language as a Monolith

The data used to underpin the interlanguage theory is based solely on grammatical aspects of language. However, it has long been acknowledged that language is more than a set of grammatical rules which we can categorise as correct or incorrect. It also has a very significant contextual/social aspect which can be varied to suit the situation.

There is no doubt that social context has a significant impact on what we say. It provides the speaker with a range of choices. Although such choices do not always impede comprehension, they can have serious effects on our relationships with people if the wrong selection is made. Just think of the impact on the listener of the following two questions:

- What is your name?
- Sorry, what was your name again?

The first question could be an imposition on the listener. It is reminiscent of an interview or even interrogation; while the second is more likely to put the listener at ease.

This area is known as sociolinguistic competence and while it has long been studied in first language, it is a relatively new area in second language acquisition studies. All aspects of language provide opportunities for variation. From the point of view of vocabulary, for example, when visiting the doctor we may refer to 'stomach' problems, but when talking to a child, the same problem becomes a sore 'tummy'.

In pragmatics — or how we do things with language, e.g. requesting, complaining, greeting, suggesting — this choice can be even more stark. Making the wrong choice can cause offense and can lead to negative stereotyping. It is not uncommon to hear, 'I don't like the (add a nationality of your choice). They are so rude!' Many of the (nationality of your choice) are not aware of how rude they sound in English, as a direct translation of the utterance would not have the same negative impact in their own language. Take for example, 'Girl, give me two coffees'. This kind of request would cause grave offense to a

native English speaker, but would be a perfectly normal way of requesting for Russians — both male and female. If we analyse our own use of English, the misunderstandings that can occur become apparent. Take for example the following exchange:

A: Are you OK?

B: I'm fine thanks

A perfectly innocent interaction? Move the context to an Irish pub and we have a disgruntled customer with the impression of the Irish as caring, but unwilling to take an order as s/he will not get the pint of Guinness and two gin and tonics required.

To sum up, it is clear that language is composed of so much more than a sequence of grammatical structures. The social/contextual aspect of language, which was once seen as peripheral, plays a pivotal role. It can therefore be surmised, that the notion of one fixed form of language does not hold true. What we have instead is a complex, dynamic blend of distinct varieties or discourse domains which come together to form a unified body. So, if this is true, how does a learner acquire the ability to vary language according to social/contextual demands? This question will be answered by exploring the following two elements.

## Learning Context

Generally speaking learning context has been divided into 3 categories:

- foreign language classroom
- immersion classroom
- study abroad

Traditional SLA research would posit that context has no impact on what is acquired. However, recent research into sociolinguistic competence has shown considerable differences in the nature of language acquired between classroom learners and study abroad learners in that study abroad learners acquire more variable aspects than classroom learners.

However, it is impossible to talk about all study abroad experiences as equal. In fact, research into the impact of language acquisition has produced very disparate results with some studies showing major improvements and others showing no real improvements when compared to 'at home' students. So, if all contexts are equal, how can this be the case? Well, there are many variables underlying study abroad. These include: duration of stay, intensity of contact with native speakers and accommodation.

## Length Matters

Recent research has been quick to point out the importance of intensity of contact over length of study abroad experiences. However, the current project is establishing a positive link between duration and intensity of contact. As part of my own research, I have looked at how contact with native speakers and type of language exchanges encountered is affected by length of time spent in the target language country. Results show that those who spend more than 1 year in the target language country are 5.5 times more likely to have exchanges with native speakers 'very often' than those who have spent 3 months or less. This gives rise to interesting findings regarding type of exchanges with native speakers. For those who spend a year or more, 50% cite 'very often' transactional and interactional exchanges; whereas for those who spend 3 months or less, the figures are 16.7% and 8.3% respectively. The fact that half the learners encounter transactional and interactional language very often shows firstly, that length does matter and that, secondly, they are able to take part in a much wider range of discourse domains; that opportunities to 'be' and 'do' are much greater. This leads us on to the role of identity.

## Identity

As already mentioned, those working from a purely cognitive point of view, see learner and native speaker identity as static entities in that they don't evolve or change. A learner is just a learner. However, this is very far from reality. Just like native speakers, non-native speakers are also a compound identity. By that I mean we are able to 'be' and 'do' a variety of identities. For example, we may 'be' a teacher 'doing' explaining a new concept to pupils. After that, we can change to 'being' a customer 'doing' asking for advice and later to 'being' a friend 'doing' gossiping. So, we can see that learner identity can and should be dynamic and to progress a learner should be afforded opportunities to develop these identities.

However, identity also plays another role. But this time it is self-imposed identity. That is the identity that the learner imposes on him/herself with regards to the second language. And just as we've seen that opportunities or lack of can have a serious effect on learners ability to develop a compound identity then a self imposed identity can act as a barrier or a conduit to language acquisition. If a learner positions him/herself as an outsider or fails to find a connection with the language or culture, this may prove a barrier to learning. Recent studies have shown how urban learners of the Irish language often fail to find a linchpin and often feel disenfranchised from this perceived rural language. In other words their lack of identification with the language can prove an almost insurmountable barrier. On the other hand being able to position yourself within the target culture may help with acquisition.



So, to go back to the title of the article — 'You wouldn't pass the salt' — from accusation to request, we can see that the acquisition of the more social or variable aspects of the language require the complex and dynamic interaction between cognition, context and identity. The learner needs to have acquired the requisite grammatical knowledge to understand the sentence; however, the acquisition of grammatical forms is not enough to differentiate between the possible different meanings. To be able to accomplish this, the learner requires exposure to opportunities for exchanges across a wide range of discourse domains and variation in speech. This is best achieved through prolonged and intense contact with the native language. This, in turn, will lead to the development of compound identities where the learner can 'be' and 'do' as necessary; and finally, self-imposed identity as in where the learner positions him/herself in regards to the target language and culture.

Thanks to my supervisor, Dr Martin Howard. Anne Marie Devlin is student in the French Department under the supervision of Dr Martin Howard

# Aspects of the Life of Colmán of Lynn

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## Introduction and Background



Figure 1: The medieval hagiographer at work in the scriptorium

Hagiography is narrative material relating to the saints. This may take various forms, including poetry and prose tales, but most often it consists of the written Life of a saint. From the outset it is to be kept in mind that a ‘Life’ of a saint does not necessarily equate to a biography, though it may contain biographical information. Rather, it is useful to view hagiography as containing as much, if not more, information about those who composed it than it does about its subject saint. Saints’ Lives provide a useful window into concerns and issues important to the communities in which, or for which, they were produced. A Life composed in the twelfth century may therefore allow us great insight into the politics, policies, religious and world-views of the twelfth-century society in which the Life was composed, but tell us relatively little about the saint and society of the seventh-century setting.

The Life of Colmán son of Lúachán is a little-studied example of such a work set largely in the seventh century but composed in the twelfth century. The only surviving version of it is a fifteenth-century copy of the original in a manuscript currently stored in Rennes. The text was composed at the monastic settlement of Lann Mhic Lúacháin, present day Lynn, a few miles south of Mullingar. It is an unusually lengthy Life, considering it was produced by a community about which very little is known, and which most likely did not have much influence in the midlands of the twelfth century. Given this, it is odd that detailed analysis of it has not, to date, been undertaken. Thus it greatly merited the current research. The Life is composed in Irish using a mixture of prose and verse, the latter often being used to reiterate or expand upon certain episodes. A wealth of information is contained therein on topics such as miracles, property claims and transactions, tribute, historical information and the political stance of the community regarding both secular and ecclesiastical neighbours. The current paper seeks to highlight its revelations about the microcosm of Lynn in the twelfth century, extending the evidence available from historical and archaeological sources.

The concerns of a small midlands monastic community in the twelfth century would have reflected the concerns of the wider community of the time. Great upheaval was occurring in both church and state during the eleventh and twelfth centuries. In the century following the death of Brían Bóroma in 1014, political stability was often threatened as numerous provincial kings began to vie for the kingship of Ireland over an extended period of constant conflict and shifting alliances. The church too was undergoing vast change. It had become wealthy and highly involved in secular affairs, to the point that it was said that the numerous powerful churches of the midlands possessed more property and wealth between them than the kings did. Reform from Europe had begun to spread in Ireland, centred largely in Munster and thereafter Armagh, chief church of St. Patrick. Many churches, especially those in the midlands, resisted such reform, having become accustomed to high status and wealth. The continuing expansion of some of the larger churches saw smaller communities swallowed up and saw tensions arise over property between churches, and indeed between church and state.

## **Concerns of the Life**

### **Property, Land, Wealth**

A preoccupation with property in the Life of Colmán highlights a primary concern of the community at Lynn during this period. Numerous episodes in the Life recall how the saint performed some miracle for a local ruler and was granted property or tribute in return. Sometimes the saint only has to ask the king for land, citing the need to build another church, and his request is granted. In return, the secular ruler is blessed with good luck

in battle and harvest. In the majority of these cases, the land acquired, or tribute agreed upon, is detailed minutely, including dimensions and boundaries of property, with long and very precise descriptions of tribute to be given at particular times of the year. Notably, the majority of property transactions are claimed to be free of tax for Colmán, and his successors, 'until doom'. The mention of the successors is important, as it allows the community at Lynn to validate their claim over everything originally due to the saint. This is a common and useful motif in hagiography whereby concerns of the contemporary present are, via the Life, reflected into the past to give them (an often false) authority.

Much previous scholarship has come to the conclusion that, due to the large proportion of the text making some form of property or tribute claim, Lynn must have been ambitiously, if not shamelessly, portraying itself as being on par with far larger and more influential midland ecclesiastical centres such as Clonmacnoise, Durrow, Rahan and Clonard, all of which were in close proximity to their smaller neighbour. It has also been assumed that grandiose claims were a desperate attempt, in a time of upheaval, to extend the influence of the church at Lynn. This has been a generally accepted opinion in the last century since the Life was first edited and translated. However, in light of existing work on place-name identification, and in conjunction with modern cartographic knowledge, it has been possible to identify, locate and map far more of the numerous place names in the text than hitherto expected. This has produced an image of the claims of Lynn quite different from what had previously been accepted. What has emerged is a far more localised area of concern, stretching to a maximum radius of about eleven kilometres. Rather than seeing an ambitious establishment seeking to claim tribute and property far beyond the realistic, we see a church vehemently consolidating what was likely already under its influence. Its focus is on the local community of which it was an important part. Analysis of the tribute claimed to be due to the church supports this, as food, drink, clothing and animals due at particular times of the year are detailed. Indeed, it would seem that every individual in the locality was obliged to provide some offering to the church. However, large claims of gold, silver and other articles of wealth are absent.

### **Lynn and its Secular Neighbours**

Given the aforementioned context of tensions and upheavals, a picture is painted of a church reminding its locality that such-and-such an area of land belongs to it, and to no-one else, reminding them that, at certain times of the year, such-and-such tribute is due from them so as not to risk the wrath of Saint Colmán. The same reminder is made to local rulers of the twelfth century, whose ancestors are depicted in the Life in varyingly positive or negative lights, depending on their conduct in relation to Colmán. Rulers who give freely of tribute and property are saved from death, rejuvenated or granted victory in battle. Those that transgress against saint are cursed, sometimes having their forts destroyed; sometimes the saint promises that their descendents will lose the kingship for

a number of generations until apology is made. Here, the author of the Life displays his knowledge of history. In one example the historical sources do record that a certain king lost the kingship for three generations before it was restored, which corresponds with what the author has claimed was a curse by Colmán. Again, contemporary information is projected into the past to give it authority. The king in the twelfth century is reminded that perhaps he owes his kingship to the magnanimity of the saint.

The relationship between Lynn, its surrounding local kingships, over-kingships and other, more influential, ecclesiastical centres is inextricable. Aside from the relationships portrayed directly between Lynn and surrounding kings, the Life also provides much information on the relations between the local, less influential, rulers and their overlords, allowing a glimpse into local politics which is not available from other sources. The local rulers of the area immediately surrounding Lynn were the Fir Tulach. Their over-kings were the southern branch of the Uí Néill, Clann Cholmáin, a very influential family on a national stage. One episode in the Life relates how the Fir Tulach used to have their residence on a certain island-fort until it was taken from them by Clann Cholmáin (whose king at the time incidentally stole the Fir Tulach king's wife). The Fir Tulach king was outraged by this, according to the Life. Historical sources mention clearly that the island fortress was used by the Clann Cholmáin in the eleventh century, but do not mention how they came to use it. If the information in the Life is to be believed, this and other episodes can help to greatly increase our knowledge of the politics and history of the midlands of the early medieval period.

### **Lynn and its Ecclesiastical Neighbours**

Tension between churches in the midlands is also demonstrated in the Life. The aforementioned Clonmacnoise was undergoing a period of aggressive expansion in the eleventh and early twelfth centuries, and seems to have come into conflict with Lynn. This is depicted in an episode where Ciarán, patron of Clonmacnoise, visits Colmán to request that the latter acknowledge him as his superior. Colmán refuses, stating that he will acknowledge no-one other than Mochuta as his superior. Mochuta was patron of Rahan, a large and influential church close to Lynn. Through this episode, we may read that Lynn sought to ally itself with Rahan to bolster its position against the expanding Clonmacnoise, which may have been seeking, or bordering on, properties claimed by Lynn. None of this information appears in the historical sources, and it is always necessary to keep in mind the political agenda with which the author is working when considering its reliability. Nevertheless such information adds further depth to our understanding of the intricacies of church politics of the twelfth century.

## Incidental Information in the Life

Much incidental information on daily life and the social construction of Lynn may also be extrapolated from the Life of Colmán. Key positions within the church are described, such as the abbot, or successor to the saint, the steward-family of the church and its chief craftsman, a position of great esteem at the time. We are also told what meals were to be eaten on certain festival days, and how milk should only be drunk at such times under the unfortunate circumstance of having run out of ale. The tale of how Mullingar, in County Westmeath, acquired its name is also contained in the Life, the only source for this information. In this episode, Colmán causes a miracle to occur in which the stone of the mill grinding corn to flour grinds the opposite way to its usual course, hence Mullingar, Muillenn Cerr, the Backwards Mill.

## Summary

The preceding information gives only a glimpse of the depth and scope of the Life of Colmán to serve as an introduction to the research being undertaken on the text, as well as to outline the importance of studies in hagiography. Reading such texts in the context of their accepted conventions, and historical standpoint, it is possible to peel away the strata and reveal at least some of what they have to tell us about the time in which they were composed. By comparing and contrasting them with archaeological and historical material, it is possible to tell what is historically accurate or inaccurate. Inaccuracies are not to be immediately viewed as flaws, as has previously been the case. Rather it may be asked why the authors of hagiography chose to include chronologically, or otherwise, inconsistent material? This method of questioning can help to go beyond that which is historical, providing insight into the psychology and political and social interactions of the period. Thus the texts may reveal an ever clearer and more detailed insight into medieval Ireland's rich cultural heritage.

## Suggested Reading

For those with an interest in the Life of Colmán, I would point you to:

*The Life of Colmán of Lynn, Betha Colmáin Laine*, ed. L. Daly, trans. K. Meyer, (Dublin, 1999).

For a general overview of Irish history and political dynasties, the following is excellent:

Byrne, F.J. *Irish Kings and High Kings*, (London, 1973).

Gavin Dillon is a student of Roinn na Sean- agus na Meán-Ghaeilge, Department of Early and Medieval Irish, under the supervision of Professor Máire Herbert. The author would like to acknowledge the support, kindness and wisdom of the staff and postgraduate students of the department.

# Non-locality of two ultracold trapped atoms

**Thomás Fogarty**

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If the price of avoiding non-locality is to make an intuitive explanation impossible, one has to ask whether the cost is too great. (David Bohm)

## Introduction

Quantum mechanics is the physics of the very small and the very cold. When particles are small and cold they take on wave properties and thus act differently to anything you can imagine in the world you see around you. Throwing tennis balls through brick walls, walking through two adjacent doors at the same time, even having a cat that is both dead and alive at the same time might seem weird to you, but in quantum mechanics this is quite normal. It is this strange playground of physics that has attracted people to quantum mechanics, and the advent of cold atom technologies allows us to, not only theoretically but physically, study these weird systems. In recent years, cold atoms have provided an excellent testbed for investigating these quantum effects. As the system is cold, it is incredibly clean and noise-free due to the lack of thermal vibrations and collisions with particles around it.

## Quantum Entanglement

One of the most bizarre concepts of quantum mechanics is quantum entanglement. Entanglement was very controversial when it was discovered during the formulation of quantum mechanics and even today it still amazes and astounds physicists. At its heart it is quite simple; if we have two particles and they are entangled, we cannot know everything about one particle without knowing everything about its entangled partner. At first this may seem trivial, but in fact it is very powerful. For example, say I have two dice and I put them into a machine that creates entanglement. I then give one die each to two different people and I send them into two different rooms so that they cannot communicate with each other. I ask them to roll their dice and record the outcome of the dice roll. At the end of the exercise I take the two lists of the dice outcomes and I compare them. I find something astounding has happened, the two lists are exactly the same, if one person rolls a six then the other person rolls a six, if one person rolls a two then the other person rolls a two, etc. This is strange as the outcome from rolling a dice is entirely random, yet each random throw of the dice results in the same number on both dice. As a result of the

entanglement between the dice there are correlations in the “measurements” performed on each dice. What is even stranger is that the distance between the dice does not matter; if one person was sitting in Cork with one of the entangled dice, and the other person was in a rocket going to Neptune, they would still roll the same outcome every time. Due to the entanglement, there is a connection between two particles no matter where these particles are and we can use this property in upcoming future technologies.

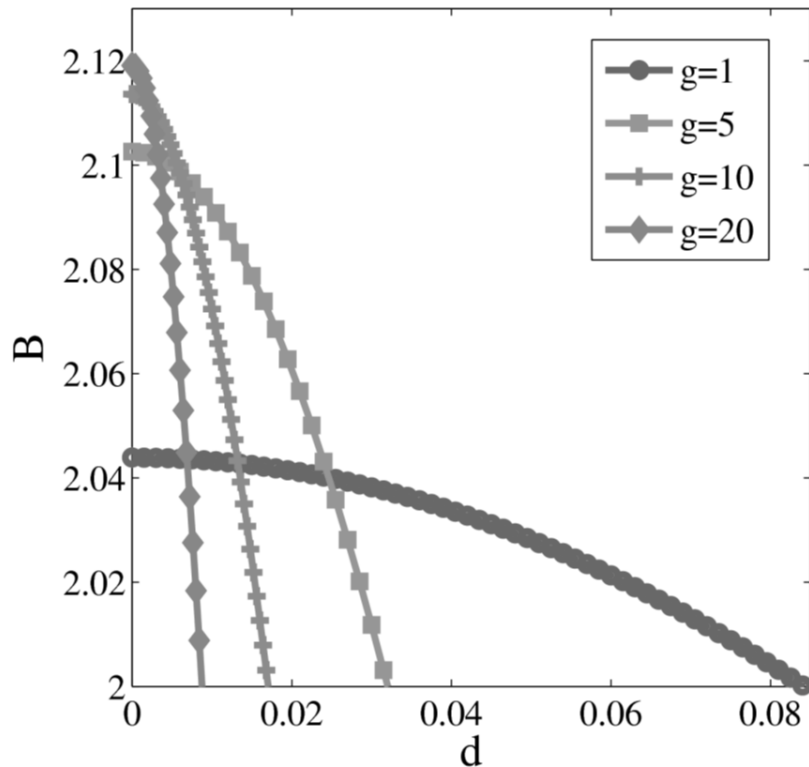
The potential of entanglement stretches far beyond playing dice. Current research in the area of quantum technologies revolves around exploiting quantum entanglement to ensure 100% secure communications. With classical communications a message is sent and is encoded with a random encryption key which both parties hold, and the resulting message is decoded using this key. However an eavesdropper can intercept and also receive this key and can attempt to break the code, hence uncovering the secret communication. However, by exploiting the strange effects of entanglement we can ensure secure communications. If Alice creates these entangled particles and keeps one half of the set and sends the other to Bob they can use these particles to send a private message. If an eavesdropper Eve intercepts Bob’s entangled particle, and tries to send a duplicate atom to Bob, both Alice and Bob will be able to detect that someone is listening as the entanglement between Alice’s particle and Bob’s stolen particle will be broken. The transmission of the message is then stopped and no information has been stolen.

## My Research

My research involves theoretically investigating whether entanglement is present between two atoms held by a harmonic trapping potential. A harmonic trap is a mathematical model that is a very good approximation of most traps made in experimental labs. The harmonic potential is a beautiful model in physics due to its simple solution and evenly spaced energy spectrum. The model I investigate has two atoms in separate harmonic traps. I can manipulate the system by changing the distance between these particles or tuning the interaction between these particles. By changing these parameters I can see how the entanglement would be affected if the particles are on top of each other or far away from each other, if they can interact or if they can’t. What is particularly nice about this model is the fact that, unlike many problems in physics, it is mathematically solvable. This ensures that numerical techniques are not needed to solve the equation, eliminating the associated risk of introducing errors into the calculation.

To calculate the entanglement in this system I use a measurement, first formulated by Northern Irish physicist John Bell in 1964, that measures the non-locality between two particles. Non-locality is the direct influence of one object on another distant object, which is what happens between our entangled particles. So in this case non-locality implies entanglement. John Bell formulated an inequality which when calculated to be less



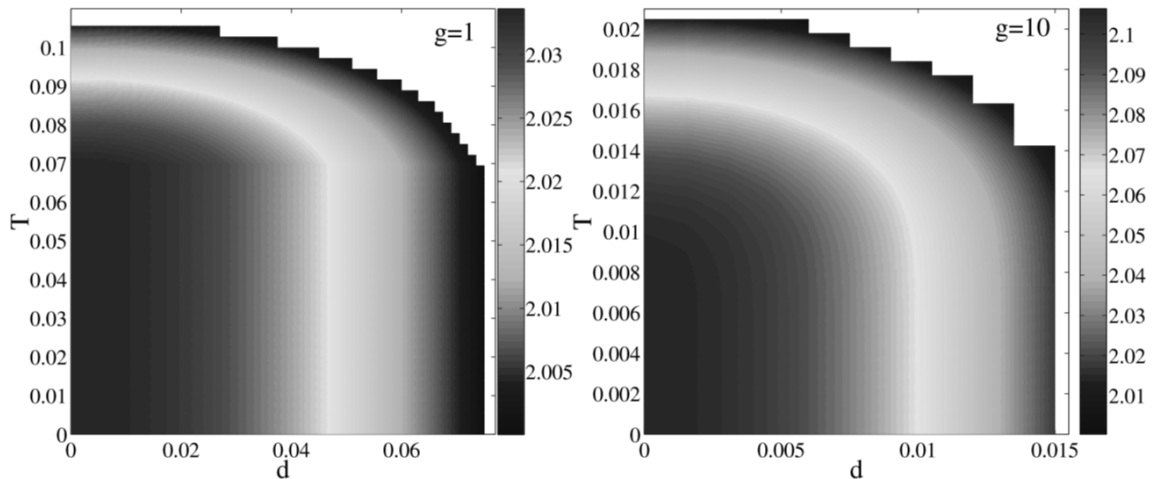


Violation of Bell's inequality is evidence for non-locality between the two particles, and hence these particles are entangled. Here the violation is plotted against interparticle distance for different values of the particle interaction,  $g$ . Intuitively if  $g$  is large the particles interact more and the entanglement should be large. Interestingly it is seen from the figure that entanglement lasts longer for lower interaction strengths, but it is not as strong as the large interaction case when the particles are in direct contact with no separation.

Figure 1: Violation of Bell's inequality versus particle separation for different values of the interaction strength

than 2 means that there is no non-local correlations between the particles and thus no entanglement. However if this measurement is greater than 2 there is non-locality and entanglement present between the particles. This is a very powerful experimental tool that was first used in 1982 and has been a staple of quantum information experiments ever since.

Violation of Bell's inequality is evidence for non-locality between the two particles, and hence these particles are entangled. Here the violation is plotted against interparticle distance for different values of the particle interaction,  $g$ . Intuitively if  $g$  is large the particles interact more and the entanglement should be large. Interestingly it is seen from the figure that entanglement lasts longer for lower interaction strengths, but it is not as strong as the large interaction case when the particles are in direct contact with no separation. For my model there was entanglement calculated between the two particles. In Fig.1 I have plotted the violation of the inequality versus the distance between the particles. As can be seen the entanglement dies off when the particles are at large distances from each other. This makes sense as we cannot entangle two particles at different sides of the earth if they have



In the left panel the interaction is low,  $g=1$ ; in the right panel the interaction is high,  $g=10$ . The intensity of the violation is graduated in the colour scale from blue to red. It is plotted against temperature and particle separation, both of which are scaled. It is evident from the graphs that the lower interaction is more resilient to higher temperatures than the larger interaction strength.

Figure 2: Violation of Bell's inequality is shown for two different interaction strengths

never been in contact with each other. From this data we know that the particles must be very close to each other to create entanglement between them, but once this entanglement is created, we can separate them out and the entanglement will survive. Another thing apparent from the data is how the entanglement changes with the interaction between the particles. With increasing interaction we get an increasing entanglement; however for a low interaction we see that the range of the entanglement is greater than that for a high interaction. Classically speaking this is counter-intuitive, how can a smaller interaction be more resilient to the changing distance between the particles? For the answer we need to delve into the dynamics of our particles. The interaction is inversely proportional to the scattering length of the particle, so if we increase the interaction, we decrease the scattering length. The scattering length is the range of the interaction, so the larger the scattering length the greater distances the particles can interact over.

In the left panel the interaction is low,  $g=1$ ; in the right panel the interaction is high,  $g=10$ . The intensity of the violation is graduated in the colour scale from blue to red. It is plotted against temperature and particle separation, both of which are scaled. It is evident from the graphs that the lower interaction is more resilient to higher temperatures than the larger interaction strength.

## Outlook

Future work will concentrate on investigating entanglement between more particles, and looking at the strange effects that can be found in one-dimensional cold gases. One such example is a NOON state in which particles on a ring rotate clockwise and counterclockwise

at the same time. This is analagous to Schrödinger's famous, if unfortunate, cat which was both dead and alive at the same time. Another interesting idea is the Anderson orthogonality catastrophe which tells us that if a system is suddenly perurbed there is zero probability that our system will act in the way that we expect. So, for example, if we suddenly give a gas a "kick" surprisingly nothing happens...

Thomás Fogarty is a student in the Ultracold Quantum Gases Group under the supervision of Thomas Busch. The author would like to acknowledge IRCSET for funding my research under the EMBARK initiative RS/2009/1082.

# A web-based early-warning service to monitor drinking-water treatment plant operations

**Franclin S. Foping**

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## Introduction

Drinking contaminated water can be harmful to our health. According to the World Health Organization, about 1.8 million people die every year across the world from water-borne diseases mainly caused by polluted drinking water. Furthermore, the cryptosporidium outbreak that happened in Galway in 2007 indicates the urgency to provide appropriate solutions in order to counteract this ominous situation in the country.

Water treatment plants (WTP) are basic components of modern water supply and distribution systems. These are engineering systems that purify raw water to specific safety levels. The raw water passes through a series of treatment phases wherein it is processed and purified according to existing safety protocols regulating drinking water. After undergoing a purification step, the drinking water is distributed to the consumers through a network of pipes, pumps and reservoirs. The research presented in this report is focused on the safety of these critical infrastructures. In particular, the goal is to develop a novel Web-based early warning system (EWS) for monitoring and assessing the safety level of WTP.

EWS have been used for many years in the drinking water industry with the objective of timely detect the presence of harmful chemical, microbiological, biological and radiological agents in the water. However, the presence of harmful agents in the water, on its own, does not provide a complete explanation of drinking water disasters. This is because malicious agents are just one parameter used to assess the safety of a system.

The idea of a new Web-based EWS will be presented briefly in this article. Based on it, WTP are viewed as components of a complex socio-technical system. The EWS, which is currently under development, will be able to receive inputs from its users, who are working in different agencies and WTP, as well as from sensors. Then, it will assess the safety level of WTP and finally it will dispatch warning messages whenever the safety health of WTP is above a predefined threshold.

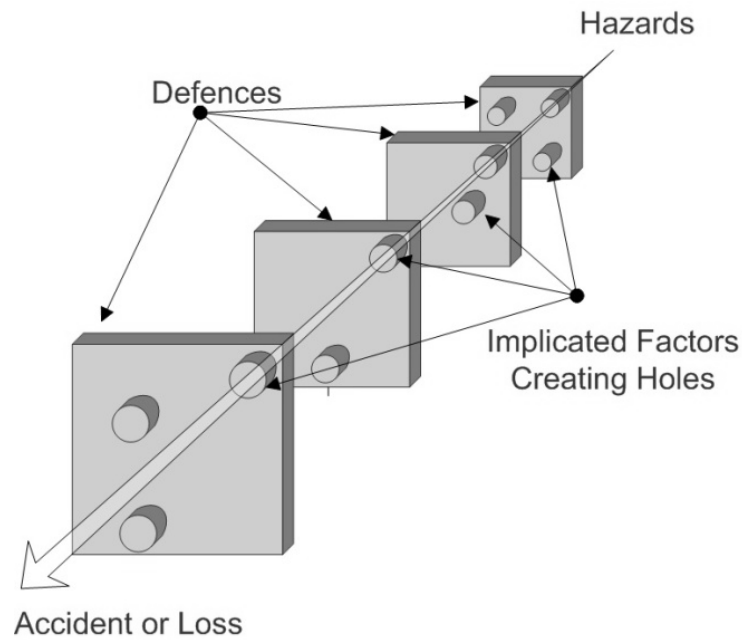


Figure 1: The “Swiss Cheese” Model

## Problem Statement

The work presented here is based on the assumption that failures and accidents in WTP can be better explained by using the tenets of the socio-technical theory. This means that WTP and their associated EWS are not just technical entities. In contrast, they are components embedded in larger social and organizational networks, which all together form a complex socio-technical system. In order to understand the origin of failures in a typical complex system, an analogy was presented by James Reason in the early 1990s: the “Swiss-Cheese” model, which is depicted in Figure 1. According to this model, hazards are prevented from bringing about accidents by a sequence of safeguards, each of which may have some holes in them, thereby making the entire system more vulnerable. It should be noted that the presence of a hole in a barrier at a given time depends on implicated factors such as active failures and latent conditions (i.e, actions and/or decisions that may have unforeseen consequences in the future). In addition, the holes are in constant flux. Thus, an accident can happen if by any chance the holes are aligned so that a hazard can traverse the entire system from one point to another.

The “Swiss Cheese” Model Given the diversity of the users in terms of their geographic location and their role in the socio-technical system, two key questions need to be answered:

1. What access mechanism of our system will be available to end-users?
2. Another concern raised by the provider is related to mechanisms and policies that will have to be devised in order to handle the diversity of users.

The most popular method for deploying an application is to record it on a CD/DVD and

dispatch it to customers. They will need to install it on their computers and run it from there. Because of this, the service provider (application owner) will have to send another copy of the application every time a patch is released or a new version of the application has been released. This process could be very cumbersome if the number of customers is significantly high. Also, customers will need to possess up-to-date computers equipped with advanced and cutting-edge hardware, as some functionalities of the applications may be disabled if their computers do not meet the minimal requirements in terms of processing power, e.g, if the computer is short of memory or disk storage. This kind of application is known as *on-premises software*.

Another interesting alternative to deploy our system may consist of making it accessible from a Web browser such as Mozilla Firefox, Google Chrome or Internet Explorer. Such applications include Google's GMail which allows one to check, print and reply to emails online without having to install any additional software on one's computers. In order to run these types of applications, only a Web browser and an active Internet connection are required and there is no requirement for a dedicated or above average computer. These types of applications address several issues that were raised by their on-premises counterparts. For example, updating a Web application is a swift and straightforward process as it is only performed on the provider's computers, not on customers' premises. Another advantage is that there is no need to dispatch a CD or a DVD of the application to potential customers, all they have to do is log on to the provider's Website and use the software online. This kind of application is referred to as *software as a service*. This category of application also provides a valuable answer to the second question raised above. Indeed, software as a service applications have a better return on investment, making them very appealing. In addition, software as a service applications can handle several users simultaneously. They can then be seen as a "one size fits all" solution. From a provider's viewpoint, it means that a software as a service application can serve several users regardless their geographical locations. Table 1 summarizes the different characteristics of two types of applications discussed in this section.

In this project, we propose to build a novel type of EWS that will be accessible from the Internet using the software as a service deployment model, due to the complexity of our socio-technical system, which involves several users located throughout the country. Figure 2 shows an overview of our socio-technical system. A given WTP is just a small component, albeit a key one of the overall system. Several interactions can be noticed in the socio-technical system. For instance, a WTP is regulated by the water service authority that is part of a local authority. The local authority is ultimately responsible for the WTP, which is supervised and audited by an inspector of the Environmental Protection Agency (EPA). These simple use cases illustrate the extensive amount of collaboration being carried out in our system, as well as its level of complexity. In short, the software as a service deployment model was selected for our EWS because we want to bring together all parties involved in the treatment process for drinking water in this country.

Table 1: Characteristics of the two types of application

	Software as a service	On-premises software
<b>Cost</b>	Relatively cheaper, sometimes free when the provider relies on advertisement	Usually more expensive
<b>License</b>	You only pay for what you have used	An upfront license fee is required
<b>Accessibility</b>	Online	On premises
<b>Software requirements</b>	Normally there is no need to install any software to run it	Yes, that is why we purchased an upfront license fee
<b>Hardware requirements</b>	Minimal. The bulk of the application can be run online	Yes, because the application runs from your computer
<b>Update process</b>	Very easy as it is performed on the provider’s premises	Cumbersome as the customer is ultimately responsible for that
<b>Multi-users simultaneously</b>	Yes, thanks to its “one-size-fits-all” feature.	Normally only one user can run the application at a time.

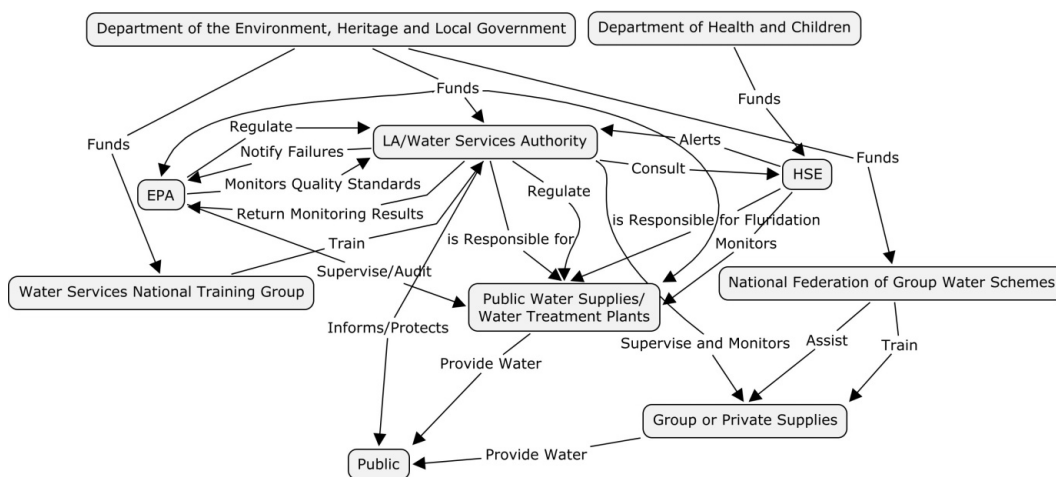


Figure 2: An overview of the entire system

## **Project Goals**

The ultimate objective of this Ph.D. research is to make use of the latest Web technologies to build a Web platform for a new type of EWS. The aim of this novel EWS is to be used by organizations that altogether form the governance model of the drinking water treatment and distribution system in the Republic of Ireland, such as Local Authorities, WTP personnel, the Health Service Executive and the Irish EPA.

The system, which is currently under development, will first receive inputs from users working in different agencies and WTP, as well as from sensors. Then will assess the safety level of WTP and finally it will dispatch warning messages whenever the safety health of WTP falls above a threshold. Our system will also show a visual representation of all WTP and their current working conditions, powered by Google Maps.

## **Conclusion**

This paper briefly discussed some characteristics of a novel EWS for WTP that will be deployed over the Internet. The EWS will not only detect the presence of holes in the safeguard as shown in Figure 1, but also provide an explanation of the presence of these holes. To the best of our knowledge, this will be the first such EWS to be deployed over the Internet. Another research goal of our project will be to clarify the relationship between Web technologies used to deploy applications. Several other issues regarding security will be tackled in our research project. The EWS is currently in the implementation phase and we expect to complete the first version of the prototype shortly.

Thanks to my supervisor Dr. Ioannis Dokas and the EPA for supporting this research project.



# The impact of kidney failure on blood pressure

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## Introduction

The aim of my research is to look at kidney failure and the problems associated with it, in particular high blood pressure (hypertension). The main organ of the excretory system is the kidney. The kidneys are paired organs lying in the posterior abdominal wall on either side of the vertebral column. They are covered in a tough fibrous capsule.

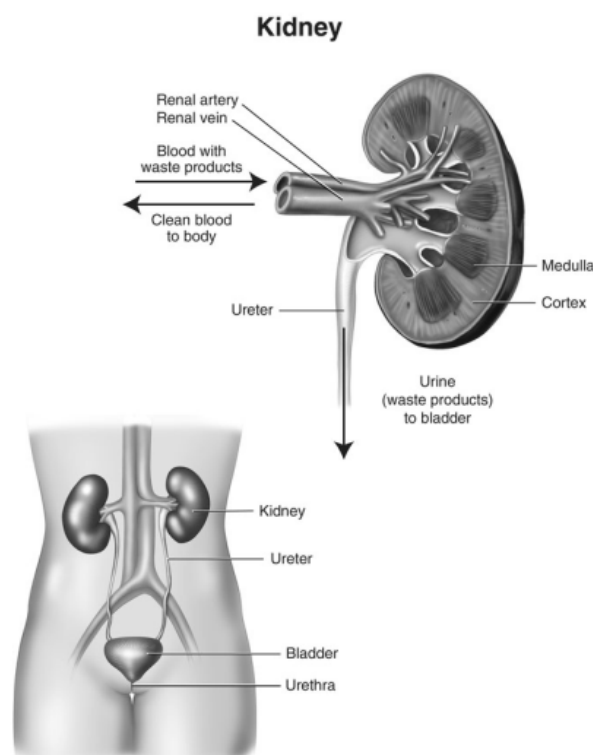


Figure 1: Kidney position and structure

The function of the kidneys is maintaining body fluid balance. They do this by filtering blood to produce urine, getting rid of waste material and keeping nutrients in the body. This particular function is carried out by structures called nephrons within the kidney. Each kidney contains approximately 1 million nephrons.

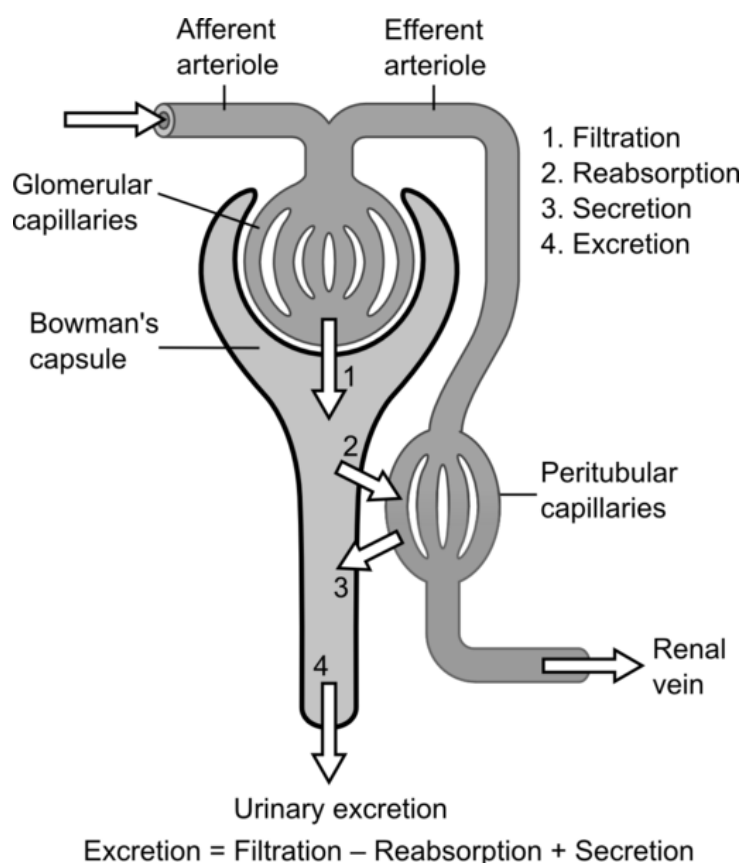


Figure 2: Nephron structure

## Urine Formation

Urine is made in the nephron. Blood enters into the nephron through a small artery, the afferent arteriole, and from there into a highly permeable structure called the glomerulus.

The glomerulus rests on top of a sieve like structure called Bowman's capsule. Slits in Bowman's capsule allow small molecules (e.g., glucose, water, sodium) to pass through its wall and into the nephron. Larger substances (e.g., protein and red blood cells) cannot pass through the small slits and leave the glomerulus through the efferent arteriole. The smaller substances that are filtered enter into the tubules of the nephron. Here the fluid or filtrate can be altered in two ways:

- Reabsorption* — a process by which something is retained in the body by moving it across the tubules and back into the blood
- Secretion* — this involves the movement of a substance from the blood into the tubules. At the end of all of these alterations what remains is urine to be excreted.

Probably the most important part of urine formation is what is called glomerular filtration, i.e., the filtration process that occurs across the glomerulus. In a clinical environment, in a case where a patient is suspected of having some sort of kidney impairment, a test called

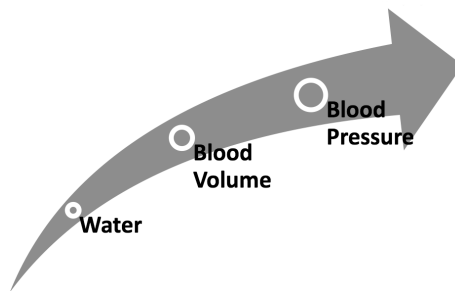


Figure 3: Relationship between body water and blood pressure

glomerular filtration rate or GFR is carried out. This test is an index of kidney function, which tells us how well the patient's kidneys are functioning. So, if a patient has renal failure (loss of kidney function) this will cause a very visible decrease in GFR.

### **Body water and blood pressure are linked**

The main component of our blood is water. The amount of water in the body determines blood volume (i.e., the amount of circulating blood we have). If we drank 1L of water over a 15 minute period, this water would make its way into our bloodstream. We effectively now have an extra litre of blood because of the presence of this extra fluid. Our blood volume has now increased and this has the direct effect of increasing our blood pressure, as our body tries to deal with the extra volume of blood.

So to combat the rise of blood pressure our kidneys react, via reflex neural and hormonal mechanisms, by excreting more water to decrease the amount in our blood. In this way the renal system has knock-on effects on the cardiovascular system. By controlling water loss (water secretion) and water retention (water reabsorption), the kidneys regulate blood pressure.

### **Renal Nerves**

Our kidneys are innervated by a particular type of nerve called sympathetic nerves. When these nerves are stimulated (sympatho-excitation) the major effect is to constrict the afferent arteriole. In other words, stimulation of sympathetic nerves makes the arteriole entering the nephron smaller in diameter. This means less blood enters into the glomerulus and, as a direct result, a decrease in filtration occurs and less urine is produced. Conversely if sympathetic nerve stimulation is decreased, (sympatho-inhibition) less constriction is initiated. This results in dilation or widening of the arteriole into the glomerulus. This allows more blood flow into the glomerulus, more filtration occurs, and more urine is produced.

Times when the body would want to inhibit these nerves (sympatho-inhibition) are times when we need to increase GFR, for example as described earlier when we drink a lot of water and we need to excrete it. So, we would want to increase stimulation of these nerves when we need to retain water, for example if we were dehydrated. If these relationships are disturbed, then there is a progression into a state of hypertension, leading to an increased risk of heart failure and stroke. An essential element in this feedback relationship is to understand whether damage to or disease of the kidney itself can act as an initiator of sympathetic drive, leading to a deranged cardiovascular homeostasis. Homeostasis as defined by the French physiologist Claude Bernard (1813-78), refers to the stability and maintenance of the internal environment ('milieu intérieur') of the body. Homeostasis involves physiological processes by which the internal systems of the body are maintained in equilibrium despite variations in the external conditions.

## **Renal Receptors**

Within the kidney there are specialised sensory receptors (responsible for the pain associated with kidney stones). These sensors are called mechanoreceptors and chemoreceptors. The mechanoreceptors are sensitive to pressure changes within the kidney and information from here will be relayed to the brain. The chemoreceptors are chemical sensors that are particularly sensitive to salt (NaCl). Again, information from these sensors is relayed to the brain. Depending on whether pressure is high or low, or whether dietary salt levels are high or low, the brain will respond by causing the release of particular hormones or by activating or inhibiting the sympathetic nerves.

## **Renal Disease**

Chronic renal disease (CRD) is an insidious deterioration of kidney function which becomes apparent after the loss of some 90% of nephrons. Its occurrence is increasing at an alarming rate in the increasing population of diabetic type 2 and obese patients. CRD is associated with a hypertension resistant to management by conventional drugs.

When CRD gets to the stage where the kidneys function so poorly that they can no longer keep you alive, a kidney transplantation is sometimes the only option. This often involves the replacement of the failed kidney with a healthy donor kidney. However, removing the diseased kidney adds to the risks during surgery, so what often happens is the healthy donor kidney is simply grafted into place as can be seen in Figure 4.

In patients with this type of transplantation, where the diseased kidney is not removed, the drug resistant hypertension is most common. This led researchers to believe that the cause of the hypertension may be arising from the diseased kidney. In fact, the most prevalent theory is that the diseased kidney's sensory receptors are over-activated. Their over-

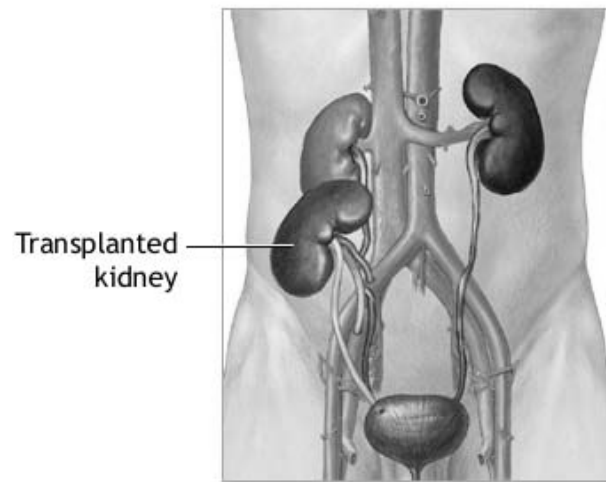


Figure 4: Kidney transplant

activation causes over-activation of the sympathetic nerves, which will have the knock-on effect of increasing blood pressure and leading to a hypertensive state.

## My Project

My research project examines why such resistant hypertension exists with renal failure and possible treatments for it. There is a strong association between hypertension and chronic renal disease and, although the underlying mechanisms are unclear, experimental and clinical studies have implicated the sympathetic nervous system (the nerves innervating the kidney). There are sensory receptors within the kidney which, when challenged with physiological stimuli (e.g., increased body water or salt), can increase or decrease sympathetic nerve activity as part of the reno-renal reflex, as previously described.

## Research Background

Previous studies in the rat have shown renal injury to elicit an immediate and sustained increase in blood pressure, plasma noradrenaline secretion (a direct marker of sympathetic nerve activity) and renal sympathetic nerve activity. Studies in human subjects, found that the rate of sympathetic nerve activity was three times higher in renal transplant patients who retained their diseased kidneys, compared to normal subjects. Moreover, if, during transplant surgery, the diseased kidney was removed, the rate of sympathetic activity could not be distinguished from the control subjects. The consensus is that this inappropriate and excessive stimulation of the sensory receptors within the kidney by the disease process elicits increased sympathetic drive, contributing to a state of hypertension.

## My PhD research

To examine the cardiovascular effects of CRD, metabolic tests were carried out on laboratory rats with a drug-induced renal injury. Metabolic tests involve housing the rat in a specially designed cage that allows me to take various measurements, e.g., water intake, urinary output. Analysis of urine samples and plasma samples allowed me to quantify the effect of CRD on the rats compared to normal healthy control rats. A 70% decrease in individual kidney functions (i.e., GFR, sodium excretion rates, water excretion rates) was observed in the CRD rats.

Next, to examine whether CRD could have an effect on the sensory receptors of the kidney and the kidneys control of blood pressure, I looked at levels of a substance called noradrenaline. This is a substance that is released during sympathetic nerve activation. CRD rats had increased levels of noradrenaline in the blood (plasma). This suggested that over-activation of renal nerves was occurring, as more noradrenaline was being secreted.

The effects of CRD were further examined during surgical experiments. This type of experiment allowed me to directly measure renal nerve activity during different physiological challenges. During my experimental protocol, the rat's BP is increased and decreased to observe how the rat's cardiovascular system and renal system reacts. In the control rats (healthy rats) blood pressure was corrected quickly and the reno-renal reflex was intact. The CRD group's reflex regulation of blood pressure was blunted, however, and the reno-renal reflex was greatly inhibited. Sympathetic nerve activity was at a high level throughout the experiment and was neither activated further nor inhibited, as would be expected in healthy rats. These results indicate ineffective cardiovascular control of blood pressure. Such impairment could contribute, if only in part, to the hypertension associated with CRF.

To further analyse the source of the sympatho over-activation I carried out further metabolic tests, this time with prior renal denervation (loss of nerve supply). This in theory would block the sensory signals arising from the diseased kidney and, as a result, decrease sympathetic nerve activation and BP. In these denervated rats sympathetic activation was reduced suggesting that this is a very possible cause of irregular blood pressure control in CRD patients.

## Conclusion

My research thus far has had a number of milestone findings:

1. CRD has associated with it increased noradrenaline rates which could be a direct result of sympathetic nerve over-activation
2. CRD rats exhibit dysregulation of many cardiovascular and renal reflexes
3. Denervation in CRD rats appears to negate the effects of sympathetic over-activation.

The most important thing to be taken from my PhD research is that renal denervation is a viable treatment for drug resistant hypertension. This treatment can obliterate the irregular and incorrect sensory signals being sent from the diseased kidney and which cause hypertension. In fact in recent months my data has been translated into man, with renal denervation in humans with drug-resistant hypertension normalised blood pressure. In the coming months I will continue my experiments to further bolster my findings to date and also to investigate the sensory transduction mechanisms involved in drug-resistant hypertension. In doing so it may be possible to isolate a particular drug treatment for this hypertension.

Thanks to my supervisors Professor Edward J. Johns, Dr. John Mackrill and Dr. Therese Ruane-O'Hora, Dr. Chun Long Huang for his invaluable experience and my colleagues, Claire Thompson, Evelyn Flanagan and Maria Buckley.

# Bioprotectants for control of the emerging food-borne pathogen *Mycobacterium avium* subspecies *paratuberculosis* (MAP)

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## **Bacteriocins**

In order for bacteria to survive and grow in a particular environment, they must be able to defend themselves against competing bacteria. To do this, many produce antimicrobial compounds which kill their competitors without harming themselves. Bacteriocins are an excellent example of bacterially produced antimicrobials. Bacteriocins produced by lactic acid bacteria, which are safe bacteria found in milk, cheese and a variety of fermented foods, are the focal point of this research.

Nisin is by far the most researched of all bacteriocins. Its first use as a food preservative was in 1953 and its use has been approved in 48 countries worldwide. After nisin, lactacin 3147 is one of the most thoroughly researched bacteriocins. The bacterial strain that produced lactacin 3147 was found in Ireland and lactacin 3147 is an Irish-owned bacteriocin. Although there are today a number of other bacteriocins available, nisin and lactacin 3147 are the primary interests of this research.

Extensive research into bacteriocins has confirmed them to be safe and natural food antimicrobials that can kill a number of disease-causing, as well as spoilage bacteria, in natural yoghurt, cheese and a variety of other foods. In addition, an exciting application of bacteriocins lies in their potential as antimicrobials against pathogens (disease-causing bacteria) responsible for hospital-associated infections such as methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* (Cdiff).

## ***Mycobacterium avium* subspecies *paratuberculosis***

Although *Mycobacterium avium* subspecies *paratuberculosis* (MAP) is not as commonly known as some other disease-causing bacteria, it has gained much attention in recent years due to its association with Crohn's Disease. Along with ulcerative colitis, this disease is categorised as an Inflammatory Bowel Disorder (IBD). Crohn's disease is a chronic inflammation of the gastrointestinal tract and patients with this disease often present with severe abdominal pains, rectal bleeding, arthritis, diarrhoea and ulceration of the stomach. IBD, in general, affects males and females equally, with those aged between 15 to 25



being most at risk. The question of whether a single type of bacteria could be responsible for this condition has yet to be answered. Conflicting scientific publications have led to ambiguous viewpoints which continually keep the question of association open.

There is no doubt, however, regarding the bacteria's role in Johne's disease. Johne's disease is a contagious disease which can affect all ruminant animals. There are four unique stages of infection: silent infection, subclinical, clinical and advanced clinical disease. The disease manifests itself through localized chronic infections of the lower intestine (ileum) which cause a thickening of the cell wall. This prevents the normal uptake and absorption of nutrients, which in turn leads to a characteristic wasting away of the animal, despite the fact that the animal seems to be eating very healthily. As the infection increases, the lack of protein uptake causes a condition known as "bottle jaw" where an obvious swelling occurs under the jaw. Infected cattle become increasingly emaciated and die of dehydration and severe cachexia (defined as fatigue and weight loss in an individual/animal that is not actively trying to lose weight).

Unfortunately, MAP can be excreted into the milk and faeces of infected animals in very high numbers which opens a possible route for human infection. Concern regarding the survival of the bacteria in pasteurised milk has also raised more questions than it has answered as conflicting scientific publications do not agree on the effectiveness of this process in eliminating MAP. Although the levels of MAP found in milk and milk products at retail level is extremely low, the bacterium is very difficult to grow in the laboratory and thus numbers present can be dramatically underestimated. Due to the similarity between the symptoms of Johne's and Crohn's diseases, and until it can be definitively established that the consumption of MAP infected milk does not lead to human infections, the elimination of this pathogen from the food chain is highly desirable.

Difficulties with respect to growing MAP is just one of a number of challenges which face MAP researchers. The rate at which MAP grows is exquisitely slow in comparison to other bacteria. For example, a population of a typical laboratory bacteria (*E. coli*) grows in about 16 hours whereas MAP can take an incredible 16 weeks to grow to detectable levels. Furthermore, the external layer of the bacteria cell is extremely thick, which makes it resistant to a number of forms of antibiotics and disinfectants including chlorine. Even though these characteristics can be seen as an obstacle, they also offer a unique challenge for researchers who wish to gain a greater insight into the world of *Mycobacterium avium* subspecies *paratuberculosis*.

## **Aims of this research**

The aim of this research is to take advantage of the antimicrobial activity of bacteriocins by identifying bacteriocins that have particularly good anti-*Mycobacterium* activity (can kill or inhibit the proliferation of *Mycobacteria*) and using these in food.

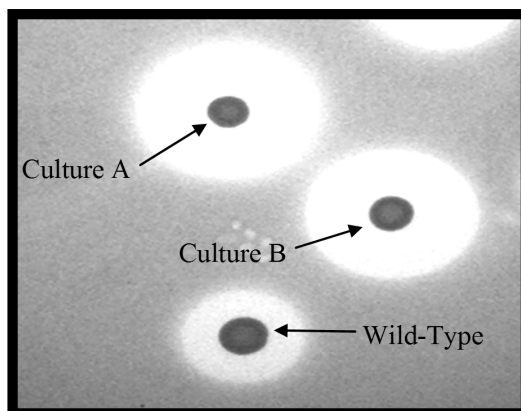
As noted earlier, the rate at which MAP grows is extremely slow. Therefore another *Mycobacterium*, the non-pathogen *Mycobacterium smegmatis*, is often used for preliminary investigations. The first goal of this project was to screen a collection of tens of thousands of bacteriocin producers (each producing slightly different forms of nisin) to identify those which produce forms of the bacteriocins which most efficiently kill *Mycobacterium smegmatis*, with a view to then testing the activity of these compounds against MAP. The bacteriocin-producing bacteria that produce the best results will then be selected and the bacteriocin being produced will become the subject of closer investigation. This requires the purification of the bacteriocin, after which the ability of the purified bacteriocin powder to kill *Mycobacterium smegmatis* and MAP will be assessed more specifically.

Unfortunately the bacteria within our bacteriocin-producing collection are genetically modified (GM) microorganisms and thus are not permitted in food even if they efficiently kill MAP. However we have at our disposal a technology which allows us to generate non-GMM forms of the most interesting bacteriocin-producing bacteria. Thus bacteria producing these lead-peptides will be recreated using a food-grade approach, followed by the production of a food-grade powder that can be assessed to test its ability to control MAP in food.

## Results to date

Since this project commenced in Feb 2009, one of the first successes of this project has been the implementation of rapid screening approach to quickly assess the activity of bacteriocin-producing bacteria against the rapidly growing mycobacterium, *Mycobacterium smegmatis*. This was achieved by growing the bacteriocin-producing bacteria as localised 'spots' on agar plates which hopefully will produce the bacteriocin in the region encircling the 'spot'. The *Mycobacterium* is then added but if the bacteriocin has anti-*Mycobacterium* activity (i.e., it produces a chemical/protein which has the potential to kill the bacteria), the *Mycobacterium* will not be able to grow around the 'spot' and a zone of clearing will be seen (see Figure 1). If the zone of clearing is greater than that produced by nisin or lactacin 3147, then it is apparent that we have identified an improved alternative to these bacteriocins which can be the focus of further investigation. Once this procedure was optimized, rapid screening revealed that a number of strains producing forms of Nisin that inhibit *M. smegmatis* more effectively than the existing form of the bacteriocin (see Fig. 1). Analysis of the improved forms of nisin revealed that they had enhanced antimicrobial activity as a consequence of genetic changes corresponding with a particular region of the structure of the nisin molecule known as the 'hinge'. A number of these 'hinge'-altered nisin proteins will be the focus of further study.

In parallel with these studies, another issue being addressed is the question of whether the bacterium can survive the cheese-making process or more specifically the manufacture of



From the picture it can be clearly seen that the zone of clearing for cultures A and B, which are both new forms of nisin, are far greater than that produced by the original nisin producer [wild-type] In addition to the existing bank of bacteria producing nisin-like bacteriocins, a similarly sized bank of bacteria producing lacticin 3147-like bacteriocins is in the process of being created and again this bank will be screened, with the lead bacteriocins going forward for further assessment.

Figure 1: Inhibition of *Mycobacterium smegmatis* by the bacteriocin proteins being produced by spots of the cheese bacteria *Lactococcus lactis*.

a smear ripened cheese produced from raw milk. The smear is a collection of various bacteria, yeasts and moulds deliberately added to the surface of the cheese which gives the cheese its specific taste and texture. This on-going study is also investigating the ability of a lacticin 3147-producing cheese starter culture to limit the survival of MAP. To facilitate an accurate assessment of the survival of MAP both agar-based and molecular methods (methods which specifically target the genetic make-up of the organism), known as Real-Time Polymerase Chain Reaction, will be employed to detect MAP. Hurdles to be overcome in this study relate to the levels of background bacteria, yeasts and moulds other than MAP, in raw milk, the cheese smear, which interferes with the growth characteristics of MAP and the optimisation of methods to extract the bacterial DNA from the dairy products.

## Conclusions

The frequency with which new nisin bacteriocins with anti-*Mycobacterium* activity have been discovered has been a cause of great excitement. With additional collections of producers of nisin-like bacteriocins to be screened, and the potential of lacticin 3147-like bacteriocins yet to be fully realised with respect to MAP, it is anticipated that a large arsenal of anti-MAP compounds for food applications will soon be at our disposal. For more detailed reviews regarding bacteriocins, and their food and clinical applications,

see Bacteriocins: developing innate immunity for food, in Nature Reviews Microbiology (Cotter et al, 2005) and Discovery of medically significant lantibiotics in Current Drug Discovery Technologies (Piper et al, 2009).

Brian Healy is a student of the Microbiology Department of UCC under the supervision of Prof. Colin Hill, Dr. Paul Cotter and Prof. Paul Ross. The author would like to acknowledge The Department of Agriculture, Fisheries and Food for the funding received to carry out this research.

# Early-warning system for safe drinking-water: A domain-specific modelling approach

**Syed Imran**

Cork Constraint Computation Centre, UCC

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## Introduction

The quality of drinking water in Ireland was brought forcefully to the attention of the Irish public with the outbreak of cryptosporidiosis in Galway City during 2007, which affected more than 90,000 people, causing illness in over 240 people, and led to the imposition of a boil water notice in Galway City for 5 months during the peak tourist season. In 2008, the Irish Environmental Protection Agency (EPA) identified 36% of public water supplies (339 supplies) that required detailed profiling, that is, the representation of all the physical items that may constitute the drinking water treatment plant in order to ensure their capability to provide clean and wholesome drinking water. These water supplies, which were included on a Remedial Action List, required a range of actions to their drinking water treatment plants to ensure they could achieve this.

The aim is to develop a novel Early Warning System for water treatment plants. Its main goal is to connect people who are working in different organizations but act as one system for the provision of safe drinking water in the Republic of Ireland, i.e., State Agencies such as the Environmental Protection Agency, the Health Service Executive, Local Authorities, Water Treatment Plant Personnel, National and Private Laboratories. An additional goal is to assess the hazard level that is to indicate a seriousness of vulnerability problem that needs timely intervention for each water treatment plant, which are registered in the Early Warning System and to disseminate timely warnings to all stakeholders associated with a water treatment plant.

An important component of the Early Warning System is the one which will allow its users to systematically collect and represent their knowledge about risks and vulnerabilities of water treatment plants. The goal of my research is the realisation of this component by developing a graphical language able to represent concepts related to the domain of water treatment plants operations and safety. The graphical language will be an integrated component of an Early Warning System. The models specified by the graphical language will represent different facets of the domain and executable code will be generated automatically. In short, the objective of my research is to develop a Domain Specific Modeling

language as a component. In order to allow the users to interact with this component of the Early Warning System, a dedicated software editor will be developed.

To achieve this, Domain Specific Modeling approach has been used to define a graphical language as a means to identify and represent the risks related to drinking water treatment and supply. The language aims to design and develop systems that will capture the complexity of drinking water systems. It will also facilitate the stakeholder's contribution in capturing the knowledge on potential risks to their drinking water supplies and allows earlier intervention to reduce the potential consequences of hazards on the treatment plant. The aim is to develop a language that can be used by both technical experts and non-technical personnel.

## **What is Domain Modeling?**

Domain modeling can facilitate the translation of knowledge from the real life situations into visual graphical models. In order to develop a Domain Specific Modeling language, an extensive knowledge and understanding of the particular area or domain is required. The involvement of domain experts is essential to perform the detailed analysis. Several visits were made to local authority drinking water treatment plants that co-operated with this research who understood the benefits to their organisation from the outputs of this research. Detailed information on drinking water treatment plants was acquired and documented. An overall view for specifying the components of Domain Specific Modeling language is illustrated in Figure 1 on p.88. The physical entities and processes involved in the treatment of drinking water, and the hazards and vulnerabilities that can affect its safety and security were identified, based on system safety engineering approaches. The identified and validated concepts are then used to specify the components of our Domain Specific Modeling language.

## **Dedicated Editor**

The objective is to provide a customized view of the drinking water treatment facility and an ability to carry out a risk analysis of it. The 'dedicated' software editor will serve as a platform for performing the risk analysis on different scenarios that may threaten the drinking water quality supplied from the water treatment plant. The editor will also provide the features to perform the profiling.

The 'dedicated' editor will consist of a set of icons that can be graphically dragged and dropped to generate the drinking water treatment plant profile applicable to the particular plant as it exists on the ground. It will also allow the validation of the drinking water treatment plant profile and the specific set of hazards that may threaten the plant.

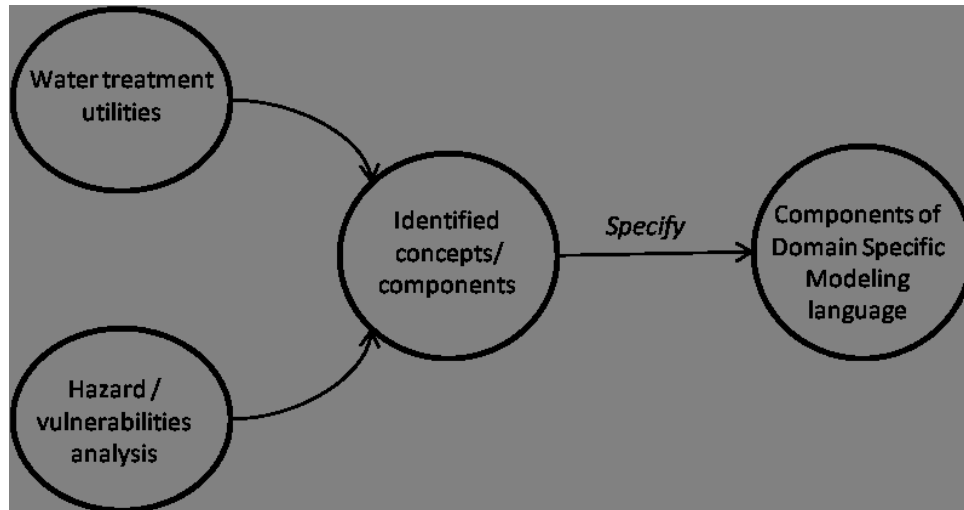


Figure 1: Software development process for specifying the artefacts of Domain Specific Modeling Language.

## Summary

The goal of this research is to develop a knowledge modeling tool and its dedicated editor. The tool is based on Domain Specific Modeling approach and serves as a prominent component of a whole early warning system. Many technical and research challenges emerged during the development phase and require further research in effective performance and improved validation.

Software that serves as an Early Warning System in the area of drinking water treatment and supply will be a very useful contribution in supporting proactive risk management and its practical application by range of organisations in Ireland and would enable the provision of wholesome and clean drinking water to all consumers.

Syed Imran is a student from the Cork Constraint Computation Centre of UCC under the supervision of Dr. Ioannis Dockas. This work is supported by the research project SCEWA (Grant No 2007-DRP-2-S5), funded by the Irish Environmental Protection Agency under the DERP grand scheme.

# An overview of a study on patients' experiences of bowel symptoms and symptom management strategies following surgery for rectal cancer

**Margaret Landers**

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## Background

Colo-rectal cancer is reported as the second most common cancer among both males and females in Ireland with approximately 2,700 patients diagnosed annually. There has been a dramatic improvement in colo-rectal cancer survival over the last 15 years with approximately 50% of patients now expected to survive this cancer in Ireland National Cancer Registry (2009). Earlier diagnosis lends toward more effective and less invasive surgical treatments such as anal sphincter saving surgery. Sphincter saving surgery is now viewed as an advance over the traditional approach involving abdominal perineal surgery which typically leaves patients with a permanent colostomy for life. Sphincter saving surgery preserves the anal sphincter and therefore a permanent colostomy can be avoided.

A colostomy is a *surgical* procedure in which a *stoma* (or opening) is formed by bringing the end of the *large intestine* or *colon* through an *incision* in the *abdominal wall* and *suturing* it into place. A colostomy means that bowel motions are emptied from an opening in the abdomen into a (colostomy) bag. Although a permanent colostomy is avoided, bowel function may be altered following sphincter saving surgery. This is due to the fact that rectal reservoir capacity is changed after surgery which is caused primarily by a reduction in the size of the rectal remnant. As a consequence, sphincter saving procedures can lead to altered bowel symptoms both in the long and short term such as faecal incontinence, bowel urgency and bowel frequency.

A lack of published literature exists on the self-care strategies patients use to manage the bowel symptoms experienced following sphincter saving surgery. Moreover, it is not known if there is a relationship between the bowel symptoms experienced and the self-care strategies patients use to manage symptoms, thereby presenting a gap in the literature. The lack of literature in this area may be due to the fact that bowel function is a very private matter for individuals and patients may be reluctant to talk openly about their bowel problems to researchers. However, many patients continue to live with poor bowel control following sphincter saving surgery which impacts on their daily life. Therefore, it



is important that patients are given the opportunity to share their concerns about problematic bowel symptoms that they may be experiencing. It is also important to explore what self-care strategies patients find most helpful in managing their bowel symptoms.

## Data Collection

For this study, a questionnaire was designed to collect data about patients' bowel symptoms experiences and symptom management strategies following sphincter saving surgery. Increased anonymity for patients is one of the most important factors in the use of questionnaires in a study. The embarrassing nature of the bowel symptoms experienced may make it difficult for some patients to discuss them at an interview. In addition, they might find it easier to write about their experiences in the comfort of their own home in the knowledge that their anonymity is maintained. The questionnaire asks patients to identify the bowel symptoms that they are currently experiencing and the self-care strategies that they find most effective in helping them to manage their symptoms. In addition, an open-ended question was included at the end of the questionnaire. The aim of this part of the questionnaire was to give patients the opportunity to write about the bowel symptoms that were most troublesome for them, in their own words. It was hoped that these comments would give further information on effects of the bowel symptoms on their everyday lives and the management strategies they used to deal with them.

## Findings

Although the study is currently at data collection phase, some preliminary findings are available. Findings to date highlight that altered bowel motion is a common occurrence for patients following sphincter saving surgery for rectal cancer. The unpredictable nature of the bowel symptoms experienced following surgery caused some patients to fear losing control and becoming incontinent. A small number of patients are unsure what to expect in the long term following their surgery. In the open-ended question, one patient revealed that he had suffered from poor bowel control since the surgery and wondered if his bowel function would ever return to normal:

I often feel that my bowel symptoms will last for the rest of my life. (Participant 1)

It was noted that for the self-care strategies used in managing symptoms patients largely learned through trial and error. By adding certain foods to their diet, patients were able to treat symptoms such as diarrhoea and constipation. For example, some people developed strategies of excluding certain foods such as pulses or planning when and what food could be eaten. This involved determining which foods should be 'cut out' or 'put in'. However, the process of identifying offending foods was laborious and was not always successful for

patients. In addition, medications were taken by some patients to manage symptoms with some degree of effectiveness. Patients also wore protective pads and used barrier creams and moist wipes to protect their skin from becoming sore.

Patients were constantly fearful of the risk of becoming incontinent. This was particularly the case in social situations, leisure activities and when at work. They were sensitive about the embarrassing nature of bowel symptoms experienced and the need to be adjacent to a toilet at all times. Some patients responded by avoiding, or withdrawing from social activities due to fear of experiencing an acute episode of faecal incontinence and the stress associated with not always having immediate access to a toilet. One patient reported that because his work involved travel, he could not go back to work as he was worried that he would not always have immediate access to a toilet. One patient who used public transport to get to work reported that he now:

avoids breakfast to allow for safe travel to work. (Participant 2)

However, the study also highlights that in some cases the bowel symptoms experienced following surgery improve over time. One patient reported that while he initially found the frequent visits to the toilet 'disheartening' his bowel symptoms had improved over time and as a result he now felt less anxious when out socially.



Two roads diverged in a wood and I . . . I took the one less travelled and it has made all the difference (Robert Frost)

Figure 1: Care of Patients

## Conclusion

This study is giving patients the opportunity to share their experiences and views about the bowel symptoms they experienced following sphincter saving surgery for rectal cancer. This subject was largely unexplored in the literature. The study revealed that the bowel symptoms experienced following sphincter saving surgery caused both embarrassment and inconvenience to patients. The study also highlights the use of a variety of self-care strategies by patients to manage symptoms, in an effort to prevent embarrassment

and to live their lives as normally as possible. It is possible that the variety of self-care strategies adopted by patients to manage bowel symptoms may be unknown to health care providers but may be of interest to other patients. The findings from this study data will provide valuable information for health care professionals involved in the care of patients following sphincter-saving surgery for rectal cancer (Figure 1). It is anticipated that the findings will provide useful data to inform practice and future developments of interventions on self-care programmes, to help patients to manage their bowel symptoms both in the short term and long term following surgery.

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# Occupant monitoring for facility management using Radio Frequency Identification

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## Introduction

Mankind's rapidly increasing advancements in different industrial sectors demand a great price of environmental impact and climate change in return, specifically in the buildings and construction industry. The largest source of greenhouse gas emissions and energy consumption worldwide are buildings, estimated to account for almost 48% of all such emissions. Energy-related Carbon Dioxide (CO<sub>2</sub>) counts for about 82% of all greenhouse gases emitted by human activities. This total energy consumption translates to approximately 3.5 Billion Euros per annum. According to a report from the United Nations Environment Programme, the right mix of appropriate government regulations, greater use of energy-saving technologies and user behavioural changes can substantially reduce CO<sub>2</sub> emissions from buildings. The Energy Performance of Buildings Directive places an onus on all EU member states to rate the energy performance of buildings in a Building Energy Rating certificate which is effectively an energy label required at the point of rental or sale of a building.

These figures and percentages strongly imply alternatives to proper energy management in buildings for minimising CO<sub>2</sub> emissions. Efficient energy and environmental performance management systems for residential buildings do not exist; such systems consist of an ad-hoc integration of wired building management and monitoring for non-residential buildings. Goal of the Information and Communication Technologies (ICT) for Sustainable and Optimised Building Operation project, along with its strategic partners is to improve asset management while supplementing efforts to meet the requirements of the Kyoto protocol.

The project envisages to:

- enhance the management of large-scale, complex networks, services, and mobile users by introducing new network and management technologies;
- develop frameworks and algorithms to support collaborative support and contributions for energy efficient buildings;

- support different end-to-end networks and services through sensors and Radio Frequency Identification (RFID) hardware.

## Research in Occupant Monitoring

Previous research has concluded that an excessive energy usage is accounted for due to behaviour of occupants and their energy usage. There is a strong need to monitor this behaviour and analyse building energy consumption demands and requirements on its basis. Until now, no standard method exists to determine occupant behaviour within buildings; different approaches are used based on a building's size, type, and functional use. Some of these approaches include fixed and preset supply of energy, whereas others perform requirements analysis based on occupant requests. We propose a methodology of continuously monitoring occupant density patterns to estimate energy usage requirements for optimal thermal comfort and cost savings. By definition, 'Occupant Density gives the number of people present in a building space at a particular time', whereas, an 'Occupant Pattern represents the use of a building space over a specific period of time'; this can also be considered as the collection of occupant density data over a specific time period. Essentially, based on these two parameters, 'optimal' thermal comfort is envisaged to be achieved through controlling the Heating, Ventilation, and Air-Conditioning (HVAC) module of the Environmental Research Institute at University College Cork. Operation and maintenance of building components along with thermal comfort needs is one of the most important and challenging goals of a building's Facilities Management (FM) team; the only question by facilities managers is "How to?". Occupant patterns are valuable in helping make predictive building control decisions because they can provide peak and off-peak energy usage timings.

## Radio Frequency Identification (RFID)

Different technologies are available that can be combined with building operation and FM activities, one in particular is Radio Frequency Identification (RFID). As part of the Networked Embedded System project, we implement fixed and mobile location-based sensing solutions of occupants and inventory items management in FM application scenarios using RFID. Occupant tracking and localisation is achieved through a passive RFID gateway portal setup. The portal houses four RFID antennas that read the unique IDs of tags passing through and transfer it to the RFID reader. Passive RFID tags, having no battery, are form factored as cards/badges and are handed out to occupants or users of a specific building facility and are to be carried at all times. Ultra High Frequency (UHF) RFID technology is generally not used for personnel tracking and localisation due to problems of UHF not being able to penetrate through liquids and metals. Despite this, long-range and high data

rates of UHF offer an interest and challenge to use these low cost RFID tags in our application scenarios. In order to ensure effective and reliable tag readings, specific rules or constraints are to be followed, therefore, users are trained in appropriate tag placements and their usage.

## **Workflow Strategy**

Raw Data collected from RFID is stored into a local database where it is filtered and applied with business logic in order for unique IDs to correspond to specific personnel or items, thereby being translated into meaningful data. The central database is accessible via the Building Management System (BMS) which in turn controls the HVAC and other building components. The facilities manager has access to the BMS in order to take control decisions based on the data gathered from Wireless Sensor Networks and RFID. This can also be an automated process through making the system learn and predict from previous occupant pattern trends. Thermal comfort in this way is based on the dynamic flow of entrance and exits of users within a building facility.

One might argue that this can be achieved through other tracking and tracing technologies, e.g. Passive Infrared sensors. Another argument may concern the privacy and security of individuals. The application diversity of using RFID is not just to count the number of occupants but to also identify them for emergency evacuation scenarios. In such scenarios, prioritised evacuation can be executed for the elderly, young, or disabled. In the case of fire emergencies, fire fighters can be updated of the exact number and identity of people trapped inside a building under fire.

## **Conclusion**

An essential source of CO<sub>2</sub> emissions within buildings is due to unnecessary heating and ineffective or absent methods of heat recovery. Using RFID technology, occupant monitoring within buildings is performed in order to determine their density and patterns. This accounts for analysis of their usage behaviour towards energy resources in order to provide optimal thermal comfort through predictive building control decisions. It is important to properly utilize such resources based on needs and requirements in order to have effective energy management throughout the building. Eventually, people operate and consume buildings' energy resources and it is only our choice to be responsible towards the amount of CO<sub>2</sub> emission and hence, towards climate change and environmental impact.

Thanks to my supervisor, Professor Karsten Menzel, colleagues, and members of the Networked Embedded Systems (NEMBES) and the Informatics Research Unit for Sustainable Engineering (IRUSE) research groups at the Department of Civil and Environmental Engineering, University College Cork.

# Family members' experiences and concerns as loved ones undergo chemotherapy treatment for cancer

**Bridie McCarthy**

School of Nursing & Midwifery, UCC

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## Introduction

Imagine hearing that one of our family or someone we dearly love has just been given a diagnosis of colorectal cancer, has to undergo major surgery and then at minimum, a six month course of chemotherapy. These are stories doctors relate to patients and their families every day. However, when it comes to us personally, when we are that family member sitting in that chair in the doctor's office with a loved one, and, hearing those words, we are shocked to the core. Our lives as well as theirs, will change forever, and whether we know it or not we (family members) are the most important people for that patient to help them get through this most difficult life-threatening experience. So the question is — how would we face it? How would we deal with it and, what would it be like for us as family members to care for, help and support a loved one who is on one of the most challenging journey's of their lives? This study aims at looking at some of these issues from the family members' perspective with a view to identifying family members' experiences and concerns in this cancer type context.

## Background

Recent changes in healthcare management generally, and in cancer care in particular, indicate a major shift in the clinical management of cancer from hospitals and healthcare professionals (HCPs) to patients and their families. Several factors have contributed to this shift; shorter hospital stays, the global shortage of nurses, decreased financial resources and increased emphasis on outpatient treatment. One of these changes is in the administration of chemotherapy, whereby a patient receives treatment in the outpatient (chemotherapy) unit but is not admitted overnight. Prior to this patients receiving chemotherapy were treated as in-patients in hospitals. This change in practice then has shifted the responsibility for clinical management of cancer from hospitals to patients and their families.

Colorectal cancer (CRC) is cancer of the colon and is second only to lung cancer as a cause of cancer death in Ireland. Next to non-melanoma skin cancer, CRC is the second highest registered cancer in Ireland affecting both males and females (National Cancer Registry, Ireland (NCRI) 2006). Following a diagnosis of CRC various treatments or a combination of treatments are proposed. For example, treatment may begin with surgery followed by a course of chemotherapy. According to the NCRI (2006) almost 40% of patients with CRC are now being treated with chemotherapy.

Chemotherapy however, can present many undesired side-effects. Patients can experience symptoms such as nausea, vomiting, diarrhoea, anorexia, fatigue, alopecia, poor sleep, pain and forgetfulness. While many patients cope well, high proportions develop significant psychosocial distress, anxiety, depression and/or hopelessness.

With the administration of chemotherapy now in chemotherapy units, coupled with more aggressive treatment regimes, patients and family members are more likely to encounter side-effects of chemotherapy at home where there is limited access to oncology nursing or medical specialists. In these situations, the side-effects of chemotherapy may exacerbate patients' suffering and trauma and burden of care for family members. In addition, research indicates that family members often misconstrue the side-effects of chemotherapy as evidence that the cancer illness is worsening, and this increases their fears in relation to the future of their loved one.

In summary, the management and treatment of CRC is changing. Many family members are now caring for patients, who attend chemotherapy units, in their own homes. While this might be welcomed, the many side effects caused by chemotherapy can be particularly worrying for both patients and their families. Chemotherapy units are relatively new to Ireland and a review of the literature highlights a paucity of research on family members of patients with cancer who are attending chemotherapy units. The aim of this study therefore is to explore family members' experiences as loved ones undergo chemotherapy treatment for colorectal cancer and to develop a theory of their resolution processes.

## **Method**

In order to examine these issues, family members of patients with colorectal cancer who, had undergone surgery and are now undergoing chemotherapy, are being interviewed, in order to understand their experiences and concerns. In addition, the strategies family members use to resolve these issues are being explored in order to capture how family members manage the difficulties and personal challenges of caring for a loved one with cancer.

Family members are being asked to tell their story, to reflect on their experiences of what it has been like for them from when they first heard about their loved one's diagnosis of



cancer to where they are presently. During the initial interviews family members' stories were listened to without interruption except to clarify or give more detail on some spoken issues. However, as interviews continue and as some issues are being repeated by family members, then these issues are explored in more depth to see how family members resolve some of these concerns.

This study is currently ongoing. However, some of the findings emerging from the interviews with family members include: managing uncertainty, guarding emotions, monitoring patient deterioration, distancing from outsiders and keeping routines.

As interviews continue each interview is compared to the next interview to identify what are the commonalities and what are the differences with family members' experiences and concerns. Family members' main concerns along with how they resolve these concerns will be explored examined and then developed into a theory.

## **Conclusion**

The outcomes of this study will be particularly relevant to a number of people. It is envisaged that findings from this study will provide oncology healthcare professionals with a clearer understanding of family members' experiences and concerns during the chemotherapy treatment stages of CRC. This knowledge and understanding will help healthcare professionals to be more sensitive to family members needs and how best to support them as individuals and as families.

Additionally, it is envisaged that the findings will help to establish better support structures that give family members a voice firstly, in relation to having access to oncology healthcare professionals, secondly to receiving cancer related information from healthcare professionals. Thirdly, findings will contribute to establishing best practice guidelines for involving family members in the care of patients with cancer. These structures could be viewed as recognising the rights of family members to have information and support from healthcare professionals thus enabling them to provide better care and outcomes for loved ones with cancer. Finally, these structures would give oncology healthcare professionals a practical workable approach to guide support structures for family members.

Similar to establishing best practice guidelines for oncology healthcare professionals, it is expected that the findings from this study will influence policy makers to establish best practice policies and guidelines as to how best to support family members during the chemotherapy stages of cancer treatment. In doing so, the operationalisation process could be made more visible to those healthcare professionals who practice in cancer care contexts and who are responsible for rolling out these policies.

Given the lack of research on family members' experiences and concerns in the chemotherapy stages of patients' treatment, data generated by this study will significantly impact on

healthcare professionals and family members and thereby will impact on the wider public. It is hoped that the findings will help to increase the public trust of the healthcare system at a time when trust in the cancer care programme has received much criticism in Irish media news and political fora. Establishing policies that are open and transparent, that aim to improve patient outcomes, and support family members; family members and healthcare professionals will help to rebuild this public trust by responding to the needs and concerns of family members of patients with cancer who are at the core of patient care management. This is all the more critical at a time when there are limited resources.

Finally, family members can have a significant impact, both on costs to the healthcare system and to patient outcomes, but this will only be realised if more attention is given to responding to their needs in the cancer-chemotherapy care context.

Bridie McCarthy is a student in the School of Nursing & Midwifery under the supervision of Dr Tom Andrews and Professor Josephine Hegarty.

# Superfluid qubits in ultracold atom systems

**Suzanne McEndoo**

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If there's one thing that makes for an exciting subject, it's the physics of extremes. Contemplating extreme speeds brought us revolutionary theory of special relativity. There is also a whole world of strange effects on the other end of the spectrum, the realm of the extremely slow and the extremely cold.

As you go from steam to water to ice, the temperature of H<sub>2</sub>O goes down but at the same time the atoms are moving more slowly. Physically, temperature is just another way of talking about the average speed of atoms. Because there is a slowest possible speed, no speed, there is a corresponding lowest possible temperature, which we call absolute zero.

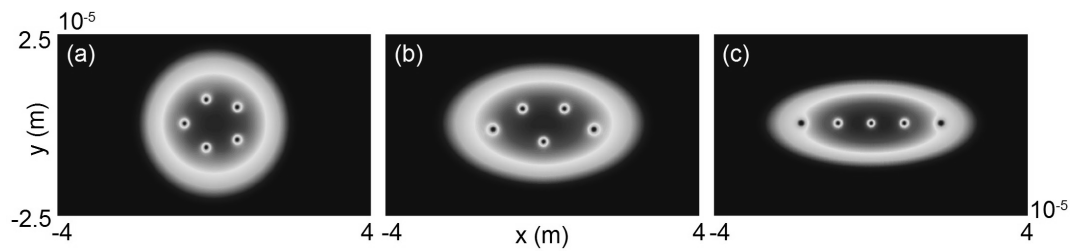
## Making Atoms Ultra-Cold

Ice, we all learn in school, freezes at 0° Celsius. Going further down the temperature scale, nitrogen in the air will liquefy at –196° Celsius, the temperature of outer space is –270° Celsius, and absolute zero itself is –273.15° Celsius. In order to cool atoms down to such low temperatures, lasers are used to bounce photons (particles of light) off an atom, slowing its movement. This is just like trying to walk against a strong wind. Physicists in Tyndal National Institute use lasers in this way to cool atoms to 0.00001 degrees above absolute zero.

If atoms get even closer to absolute zero, within a billionth of a degree, their behaviour changes completely. No longer are they whizzing around in different directions like in a gas, now they start to move like an army, marching along as if they were a single giant atom. This is not a solid, liquid or gas, but a new type of matter called a Bose-Einstein condensate. This is something Einstein and an Indian physicist called Bose predicted using mathematics in 1924. It took scientists another 70 years before they were finally able to create this in the lab in 1995, earning a Nobel prize for their efforts.

## Quantum Whirlpools

One of the ways in which a Bose-Einstein condensate is different from liquid or gas is that it's a superfluid, so it flows without friction. Without friction, the usual rules of flow take on new forms. Once you set a superfluid flowing, it will keep moving without any outside help. If you stir a cup of regular coffee and make a whirlpool, as soon as you take the



(red) with 5 vortices (blue) in a) an isotropic or round trap, b) a trap compressed 1.5 times more in the vertical than the horizontal, and c) a trap compressed twice as much in the vertical. We can see how by changing the shape of the trap containing the condensate in a very simple way, the behaviour of the vortices can be engineered. For condensates compressed by a factor of two or larger (c), the vortices form a straight line, the so-called linear vortex crystal.

Figure 1: Numerical simulations of a Bose-Einstein condensate

spoon out, friction will slow down the coffee and your whirlpool will disappear. If you instead had some superfluid coffee, that little whirlpool would stay in your mug forever. These whirlpools, or superfluid vortices, have been created in labs around the world. With a large number of these vortices in a round, or isotropic, trap, the vortices form a regular, triangular lattice. While these triangular lattices are interesting objects of study, they must generally be treated as a large object, and the motion of each individual vortex cannot be resolved.

In my research, we restrict ourselves to smaller numbers of vortices. Here, instead of a triangular lattice, rings and clusters are found in isotropic traps. We used both numerical simulations and mathematics to model these systems. We found that by simply compressing the Bose-Einstein condensate along one direction, the vortices would move from a ring to a straight line. Figure 1 shows numerical simulations of this effect for five vortices. In the first condensate, the trap is isotropic and thus a ring is formed. As the trap is compressed 1.5 times tighter in one direction, the ring structure is deformed but not fully destroyed. However, for as low as twice as compressed, the ring structure is entirely overcome and replaced by a linear vortex crystal.

## Quantum Information and Schrödinger's Cat

While new forms of matter and superfluid vortices are interesting to scientists in their own right, they also have potential applications in the world of quantum information. When a physicist talks of information in a computer, they talk of the physical aspects that represent the 1's and 0's of binary, current flowing or not flowing, lights on or off. Any system that can have two distinct states can encode this type of information with varying degrees of usefulness. We can even apply this to our superfluid whirlpools, with flow going clockwise being a 0 and anticlockwise a 1. Compared to the technology in the

average family computer this is needlessly complicated. However, there is something that the quantum world can offer that current computers can't achieve.

Erwin Schrödinger, an Austrian theoretical physicist who spent his later life living in Ireland, talked about a cat in a box, rigged with a poisoned gas. He tells us that there is a 50% chance that the cat has died, but without looking into the box, we can't tell if the cat is dead or alive. He said that this cat was in a new state, one where it is both dead and alive at the same time. Because we cannot observe a cat being both dead and alive, once we open the box and have a look, we force the cat into just one of those states. This state of being dead and alive at the same time is known as a superposition state.

While this isn't true for cats or computers (and we don't suggest you try it at home) for quantum systems like superfluid whirlpools, though, this third way of being is possible. Here, instead of "dead", "alive", and "dead and alive", we have "clockwise", "anticlockwise", and "clockwise and anticlockwise at the same time". This extra state gives a whole new way of thinking about information. For example, if you search for a number in a list, you must check each number one at a time until you find the right one, which can take a long time for a long list. However, if you could create a number which was a superposition of all the numbers in the list you can look at the superposition instead.

An additional bonus provided by the superfluid vortices is that they are more stable than many quantum systems. This is due to the fact that the fluid flow holding the information will not dissipate as a regular fluid would (like your coffee).

Through our research into physical systems, such as superfluid vortices, we can show how to engineer new and novel systems and implement this new way of computing. This global effort to create new quantum information technologies will open up the concept of information, and how we can interact with it, to a whole new world.

Suzanne McEndoo is a student in the Department of Physics in the College of Science, Engineering and Food Science, under the supervision of Dr. Thomas Busch. The author would like to acknowledge funding from Science Foundation Ireland under Project No. 05/IN/1852.

# Bridging the quality gap in diabetes care

**Sheena Mc Hugh**

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“At the end of the day it’s not about me and it’s not about the hospital, it’s about the patient.” The sentiment of this GP was echoed by many others during interviews which I conducted to better understand attitudes towards improving diabetes care. Ultimately, the purpose of the health system is to improve the health and quality of life of the patient, not the system itself. This goal appears obvious and yet a gap remains between the ideal, as set out in national and international guidelines, and the reality of care delivered to people with diabetes.

## The Quality Gap

The gap in quality is by no means a distinctly Irish problem and we can certainly learn from the efforts of other countries. However the techniques we choose to improve the quality of care will need to be adapted to fit our national context and local circumstances. With this in mind, I began my research by surveying a national sample of GPs to examine how care is currently provided in general practice. Registering, reviewing and recalling patients are the 3 pillars of a comprehensive diabetes service. Only half of GPs surveyed were routinely recalling patients with diabetes to review their health while less than half were using a patient register. There was also deficient access to necessary services to support diabetes care such as dietetic services, chiropody and podiatry services and retinal screening. Thus little progress had been made towards structuring diabetes care in general practice since the last survey conducted in 2003, before the establishment of the HSE.

## Building a bridge

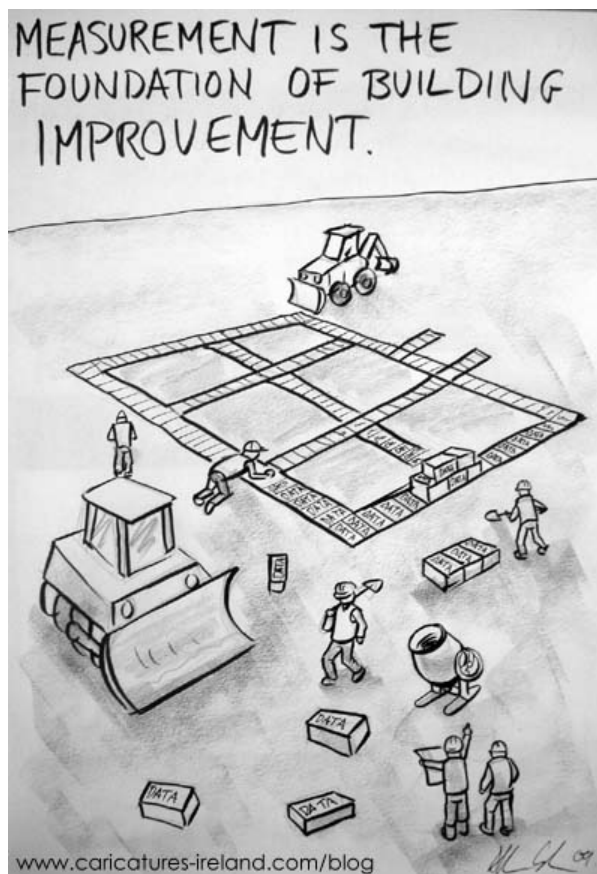
Quality improvement interventions usually employ several different methods to enhance care. Some of the methods which have proved popular and effective include auditing care and providing feedback to health care professionals, developing a computerised recall system to help track patients and enhancing the role of the nurse. However no one strategy has proved to be the missing ingredient. In fact quality improvement interventions usually include so many ingredients it is difficult to make conclusions about what works for whom. What all of the interventions have in common is their aim to improve quality and their attempt to structure and organise care delivery albeit by different means.

Ireland has a number of “islands of excellence” when it comes to improving the delivery of diabetes care. These “pockets of interest”, as one GP put it, arose out of both necessity and interest in different areas around Ireland. Having worked with three such groups in the East, Midlands and South of Ireland, we demonstrated the effectiveness of adopting a structured approach to diabetes care in general practice. This is the 1st national study of structured care in the Irish community and combines data from over 3000 patients with Type 2 diabetes. We looked at how care was delivered in the practice (i.e. process of care) and also how well these patients ‘do’ having received structured care (i.e. outcome of care). The majority of patients were receiving a high standard of care with outcomes such as metabolic control, blood pressure and cholesterol being checked and recorded by the GP on a regular basis. Patients were also doing well. For example the average cholesterol level among patients was 4.1mmol/l meeting the standard of less than 4.5mmol/l set out in the guidelines. Not only are patients doing well by our national standards, they are also doing well compared to results from the UK.

However there is always room for improvement! Lifestyle factors such as exercise and diet need ongoing attention both from doctors and patients. Half of all the patients enrolled in structured care fell into the obese BMI category ( $>30\text{kg/m}^2$ ). Overweight and obesity continues to be a major challenge in the provision of diabetes care as this patient group are at increased risk of cardiovascular complications and cardiovascular disease mortality. Consequently there is a growing need to collect information on the long-term complications associated with diabetes including heart problems but also blindness, foot amputations, and renal failure. Only then can we be certain that there has been a lasting improvement.

## Getting over it

And yet if we know our destination why have we not reached it? This is one of the fundamental questions driving my research. From my interviews with GPs it seems the barriers to improvement occur at many levels. At the health system level, the lack of integration between the general practice and hospital settings creates a barrier which impacts on the delivery of care, the providers and the patients causing “a big palaver”. For example “if you check the cholesterol, get it to the patient to bring to the hospital and it gets lost in the process lots of times and then it seems incredibly wasteful of effort and time and resources to repeat it a few times”. Some GPs felt there was a lack of resources, remuneration and recognition for chronic disease management. Hence at a professional level, diabetes care becomes a “labour of love” for many GPs around Ireland. It is this “vocational” incentive which is currently driving our “pockets of interest”. However the lack of recognition could lead to “bad feeling” among health care providers and leave them indifferent and apathetic to future change. GPs were sceptical about future improvements



based on empty promises and dashed hopes in the past.

It's an idealistic approach, and I'm afraid, in my lifetime, anything idealistic has never come to fruition. . . Not even once has the idea ever come into play. In practical terms, they never work, and haven't worked in the past. . . but that doesn't mean you should stop hoping for it.

## Conclusions

Without sounding too much like Barack Obama, there are opportunities to change and improve diabetes care. Those with a special interest are pioneering a structured approach to care and producing positive results which suggests the barriers are not insurmountable. However, this level of interest is not sustainable in the face of increasing demands and dwindling resources. The challenge now becomes creating a national infrastructure which supports local efforts to cross the quality gap to avoid a situation whereby the quality of care received by patients is determined by geography.

Sheena Mc Hugh is a student in the Health Services Research Institute- the Irish Health Research Board's Cross-Institution PhD Scholar Programme in Health Services Research under the supervision of Prof. Ivan J. Perry (UCC), Prof. Colin Bradley (UCC) and Prof. Ruairi Brugha



(Royal College of Surgeons). The author would like to acknowledge the Health Research Board for funding this research. Credit is also extended to Allan Cavanagh for permission to use the cartoon from [caricatures-ireland.com/blog](http://caricatures-ireland.com/blog).

# Blue biotechnology — drugs from our oceans

## Lekha Menon Margassery

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### Introduction

Fungi are one of the major health concerns in modern life. It is known that up to 20% of patients with blood stream infections in intensive care units are affected by disease producing fungi such as *Candida* and *Aspergillus*, sometimes dominating the infections in doses that could be lethal. Patients who are immune-compromised/ immune-suppressed – including the elderly, HIV-infected patients, chemotherapy recipients, and transplant patients — are more prone to fungal infections. There are anti-fungal drugs available, but they are expensive and can have severe side effects such as nephrotoxicity (kidney damage). In addition, a major concern is that fungi such as *Candida* can become drug-resistant. Therefore there is a pressing need to identify new drugs to treat fungi and the diseases associated with them.

- chemical- based drug discovery has not worked
- virtually all the drugs are from microbial origin
- There is a need to explore new environments to avoid rediscovering the same classes of drugs.

### Life saver — The sponges

Oceans cover about 70% of the earth and it is highly diverse in terms of its wealth – the marine organisms. It has been seen previously that microbes, such as bacteria and fungi, produce natural substances that can have applications in the pharmaceutical industry, and there are likely to be many undiscovered compounds produced by trillions of microbes present in the world that could have major positive health implications. In our work, I am focusing on microbes that are associated with marine organisms called sponges (Figure 1), because these are known sources of bioactive compounds (substances, like antibiotics, that have an effect on the living organism). One such example of a bioactive from sponges is Jasplakinolide, which is anti-cancer drug.

Sponges are aquatic animals; the great majority are salt water species, living in habitats ranging from the tidal zone to the deep sea, and around the world from the Polar Regions

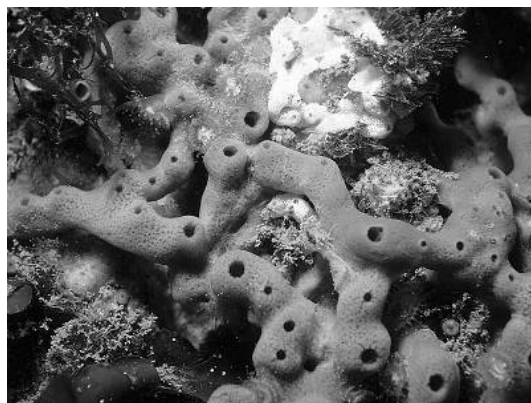


Figure 1: Sponge — *Haliclona simulans*

to the tropics. They are usually found attached to rocks but some get attached to soft areas. They are simple animals and do not have any organ systems. Sponges are immobile filter-feeders, acting like chimneys as they pump large volumes of water through their system and filtering out what they need to eat, and pushing out what they don't. Microbes such as bacteria and fungi that are pumped in with the water can take up residence in the sponge. Sponges need to have a strong community of "defence microbes" because of their tremendous exposure to pathogenic microbes. The area that is being targeted for research is the bioactive compounds that these microbes produce as part of their natural chemical defence system.

## Methodology

For my research, live sponges are first collected and then I look to see if the microbes living inside them produce any interesting anti-fungal compounds. The sponge which I am working with is called *Haliclona simulans*. Once the preliminary screening is done, the bacteria associated with the sponge are grown in liquid media for few days until they produce the active compound (Figure 2).

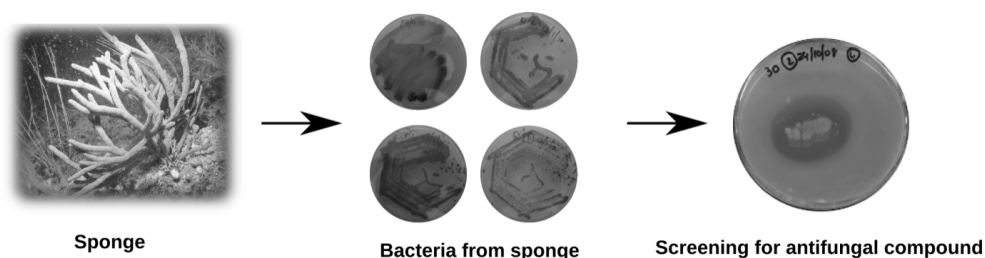


Figure 2: Bio-discovery of the anti-fungal compound

At this stage, the anti-fungal compound is extracted from the bacteria with organic solvents such as methanol, and then purified using a separation technique called HPLC (High-Performance Liquid Chromatography).

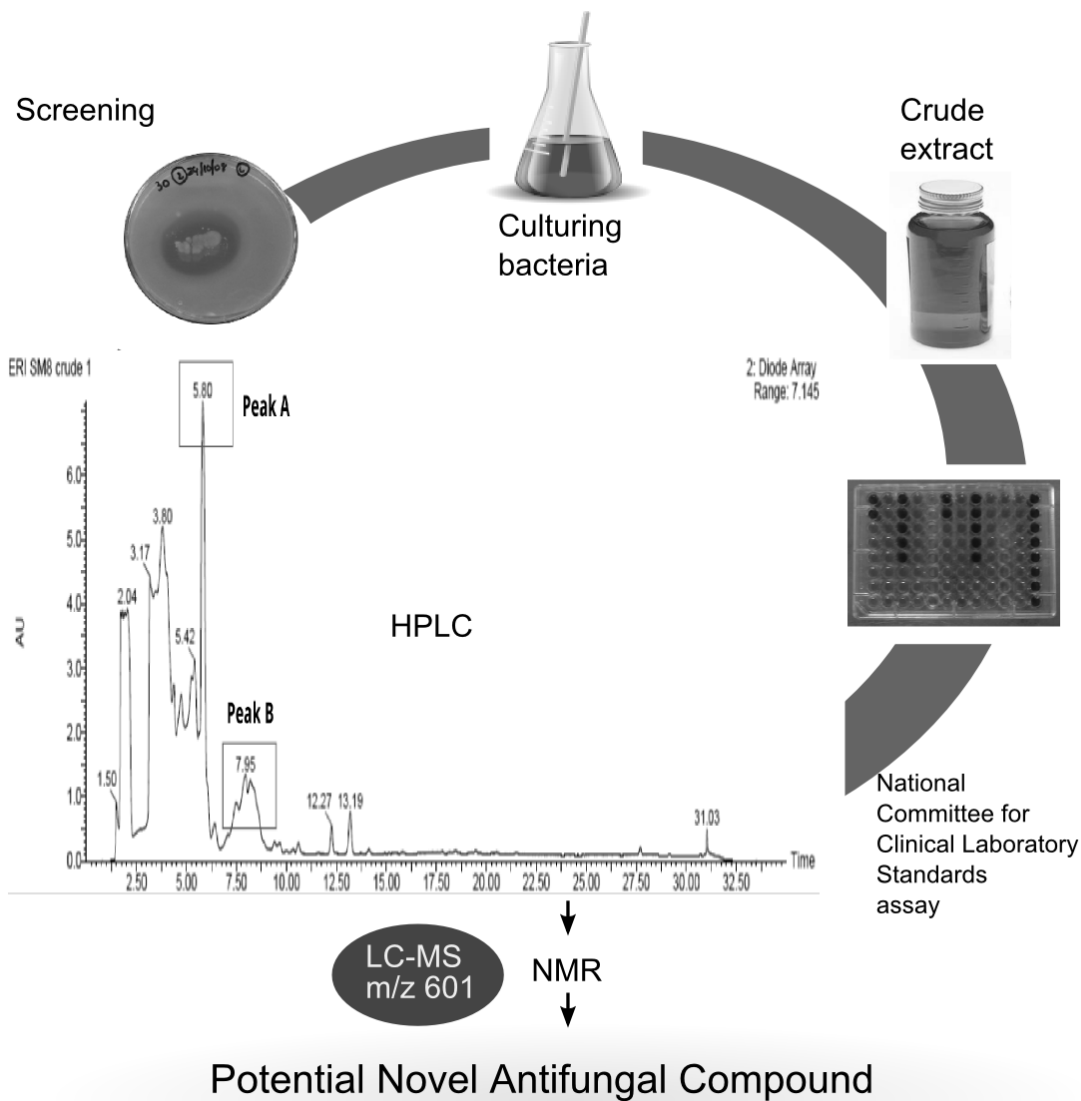


Figure 3: Purification of the compound

## Results

In our laboratory, I have recently extracted, separated and identified a new compound from sponge-associated microbes that has anti-fungal activities (Figure 3). The purified compound was analysed by LC-MS (Liquid Chromatography — Mass Spectrophotometer), a common method for identifying known compounds by determining its mass. The unique mass of our isolated compound indicates that it is a new discovery. The next step will be to obtain the chemical structure of the compound using NMR (Nuclear Magnetic Resonance) spectroscopy. This will help us to identify how the compound behaves both chemically and biologically.

## Prospects

Although there is some way to go, this work with sponge-associated microbes and the compounds that they produce could already offer hope to immune-compromised patients who are suffering from secondary, potentially deadly, fungal infections. Further work will involve testing whether these compounds have therapeutic potential, and expanding my screens to look deeper into the sponges present in our oceans for other life-saving drugs.

I would like to thank my supervisors Dr. John Morrissey, Prof. Alan Dobson and Dr. Jonathan Kennedy. I would like to acknowledge the Beaufort Bio discovery Awards Project for funding my research. I would also take this opportunity to thank Dr. Florence McCarthy at the ABCRF in UCC who has been collaborating with us for the LC-MS analysis. I would like to thank Dr. Sarah Knight from NUIG for helping me in the preparation of the article.

# Transport in the quantum world

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## Introduction

The relentless progression of technology is something we are all familiar with. Computers have gone from filling entire rooms to only taking up some desk space while at the same time becoming incredibly fast. Music was once stored on vinyl records but we can now store hundreds of albums on portable MP3 players. This progression is described by Moore's law which says that technology is getting twice as small and twice as fast every eighteen months. However, this progression can only continue unhindered for so long until it hits a fundamental wall. The problem is that the miniaturization of technology is moving it out of the classical, everyday world and into the quantum world, and devices will soon reach the size of single or few atoms.

Whilst moving into the quantum world presents a number of challenges, the benefits far out weigh them. Quantum computers, computers which utilize quantum mechanics, represent a paradigm shift in computing. These are extremely fast machines that can tackle problems beyond the reach of current computers. However, there are many fundamental problems that need to be solved before these machines can be realized. We need to build a new quantum toolbox before we can begin engineering these machines. One of the most basic and essential tools we need for this tool box is transport, the ability to change an object's position in space. To develop a tool for transport in the quantum world we first need to understand two of the fundamental differences between the classical world and the quantum world.

## Quantum vs Classical

We are all familiar with the behaviour of objects in the classical world but what changes in the quantum world? The key difference in the quantum world is that an object can no longer be thought of as a just a particle, but as wave at the same time, and vice versa. This is what we call wave-particle duality. For example, light, which we usually think of as a wave, can be viewed as consisting of particles of light called photons. Similarly, atoms, usually thought of as particles, can produce effects we usually associate with waves. This has a huge impact on the transport of atoms because in the same way that water waves in the oceans interfere with each other, the atoms will also interfere with each other.

Essentially what this means is that if you try and transport a quantum object such as an atom from A to B, interference during transport will cause the object to spread out between A and B.

The other major difference between the classical world and the quantum world is the idea of position. Instead of being at a well defined position as in the classical world, a quantum object has a certain probability of being at a position. Because of this transport from A to B is the same as initially having a high probability of being at A and then increasing its probability of being at B. But because of the wave-like interference spreading out the object's position, there is a probability of finding the object at A, or B, or any point in between.

This exact problem occurs when trying to transport atoms. This is a huge problem for developing quantum technology because, as you can imagine, transport is essential for building quantum devices. For most quantum devices our atoms are stored in traps or trapping potentials. These traps operate like valleys, it is easy to sit at the bottom, but a lot of energy is required to climb out. We can transport atoms between two traps by a process known as tunnelling, which occurs when two traps are moved closer together. Ideally, when the traps are moved apart again, the atom would have tunnelled from the initial trap to the destination trap, but the interference effects will prevent this from happening. All of this leads us to conclude that we cannot apply the classical approach to transport to quantum systems. We have to come up with new and different transport methods for the quantum world.

## **My Research**

My research aims to develop a method of controlled quantum transport which will allow us to transport a quantum object without it spreading out among the different stages of transport. To do this we introduce an intermediate trap between the initial position and our destination. At first glance this would seem to make the problem harder. If we attempt to transport our quantum object in an intuitive way, bringing the initial trap close to the intermediate and then bringing the intermediate close to the destination, our quantum particle spreads out among all three traps. The benefit of having this intermediate trap, however, is that it enables us to perform counter-intuitive transport. We achieve this by bringing the destination close to the intermediate trap first without moving the initial trap. After this we bring the initial trap close to the intermediate. This method doesn't work in the classical world, you cannot get to work by walking from your car into your office, and then walking from your house into the car. In the quantum world, however, this works extremely well. Our numerical simulations have shown that by using this process, the end result is that the atom is in the destination trap and has no probability of being found in either of the other two traps. The graph below shows the probability the atom has for

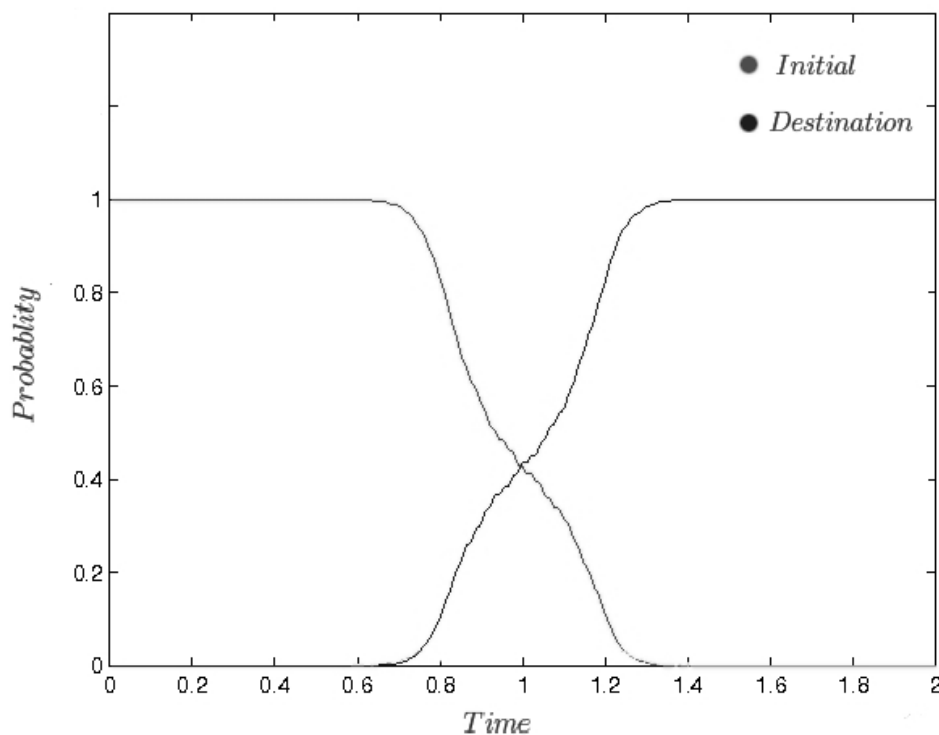


Figure 1: Probability the atom has for being in the initial trap (red line) and the destination trap (blue line) with time.

being in the initial trap (red line) and the destination trap (blue line) with time. From the graph you can also notice the at no time does the atom have any probability of being in the intermediate trap. We have also extended this beyond the mathematical description to radio frequency traps that are easily achievable in the lab.

Although we have the first tool for our tool box many more tools need to be added. A natural continuation of this research is to investigate methods of transporting clouds of atoms. The problem that needs to be solved is that the atoms in the cloud interact with each other. Like the interference effect that I have outlined in this article, interaction between the atoms disrupts the transport process. Another exciting idea that I would love to work on is investigating if the quantum transport method described above can be used with pairs of atoms to make logic gates, the building blocks of quantum computers.

This research is part of a large worldwide effort to develop tools for quantum engineering. We work in collaboration with The University of Nottingham on this counter-intuitive transport and also with ICHEC (Irish Centre for High End Computing) to run our simulations of these systems. As well as designing other tools, we need to investigate the counter-intuitive transport process in many other physical systems. This huge international effort into quantum engineering is due to the potential of quantum technology. It represents the next technology leap which will bring amazing new devices that will change



our lives. Ireland has a long history of being a centre for new technology and innovative research. We aim to continue this tradition into the future with quantum technology.

Tadhg Morgan is a student in the Physics Department under the supervision of Dr. Thomas Busch. The author would like to acknowledge funding from Science Foundation Ireland.

# Placebo measurement: a new approach

**Richard Morrisroe**

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“The question was a fashionable one, whether a definite line exists between psychological and physiological phenomena in human activity; and if so, where it lies?” -Tolstoy

## Background to the Placebo

Placebos are at the same time one of the most mysterious and familiar experiences that we all have. Who amongst has not felt relieved as we swallow a painkiller, sure in the knowledge that it will help? Conversely, the placebo is mysterious in that it suggests that what we think and feel has a large influence on how our body works, and whether or not it works well.

The word placebo comes from a Psalm from the Bible, and it originally referred to people who mourned loudly and falsely at a funeral. Over the next few hundred years, the term placebo came to mean any medicine prescribed by a doctor more to please a patient than to actually cure them. Some authorities on the subject have claimed that until the 20<sup>th</sup> century, all of medicine was the placebo effect.

Whatever the truth to that, the placebo was ignored until the experiences of an American surgeon, Henry Beecher on the beaches of Normandy during the final stages of World War 2 were to change all of that. Beecher had run out of morphine, and when asked by a nurse what they were to do, he told her to inject a solution of salt water into the patients who requested pain relief. Surprisingly, for both of them, the makeshift solution worked, and placebos came in from the cold.

Beecher never forgot this experience, and in 1955 he published an article in the Journal of the American Medical Association entitled “The Powerful Placebo”. This article was a collection of other research reports where patients had improved after being given placebos. Although some researchers in the 1990’s have argued that these findings were overblown, the article stimulated research into the placebo. The requirement in the US for clinical trials of all new medicines also spurred research into placebo, even if only as a control for the biologically based therapies.

Even still, many regarded the placebo as a myth, a psychological phenomenon which only influenced how people thought they felt rather than any objective measurement of bodily function. These ideas were shattered in 1979, when Levine and colleagues showed that some (but not all) placebo responses could be reversed by the administration of naloxone,

a drug which antagonises the opioid receptors in the brain and body. The conclusion drawn from this was that even the mere knowledge that one was being given a treatment could activate the body's internal painkilling system (or endorphins).

## **My Research**

Since that point, placebo research has proceeded in leaps and bounds, though not without its stumbles. However, even though we understand a lot about how placebos produce pain-relieving effects (and to a lesser extent in depression and other conditions), there is still no regular predictor of the placebo response. This is the gap in the literature which my project aims to fill.

Currently, placebos are predicted by asking participants to rate, on a 0-10 scale, how much benefit they expect to gain from a treatment. This does work, to a certain extent, in that higher ratings of benefits are expected to correlate with higher levels of pain relief from the treatment. However, it leaves about 90% of the variation in pain ratings unexplained, which is completely unacceptable. Furthermore, we have no current way of predicting who will respond to what placebo, which is a huge difficulty for doctors trying to improve care, researchers trying to study the effect and clinical scientists trying to demonstrate the worth of their new drug.

## **The Implicit Association Test (IAT)**

The way in which I am going to get around this problem is simple. In the last decade psychologists have developed a measure called the Implicit Association Test (IAT) which can assess attitudes from the speed at which participants can classify words into two different categories when they are presented on a computer screen. For instance, an IAT might measure the associations between flowers and insects and pleasant and unpleasant words. In a typical trial, people would see the word "rose" come up on the screen and would need to classify it as a flower by pressing a key. The really interesting part comes when people combine the flower-insect words with the pleasant-unpleasant words. In this case one key is used whenever rose or a pleasant word is seen on the screen, and the other key is used when insect or an unpleasant word appears on the screen. The method then reverses the arrangement so that flower and unpleasant share the same key, while insect and pleasant go together. The idea is that the difference in reaction times between the flower-pleasant and flower-unpleasant conditions is a measure of how strongly one likes flowers (or insects, for that matter).

Now, while you may think that the flower-insect difference is somewhat irrelevant, the method is very flexible, and has been applied to racial attitudes, gender attitudes, attitudes towards political candidates or even between different brands of soft drinks or foods. In

each of these domains, the method has shown its usefulness (although as per normal, there have been criticisms and debates over the methods and meaning of the results). There is a website which collects IAT data on many subjects (Project Implicit) and a quick internet search should allow you to complete an IAT yourself (which is undoubtedly the best way to understand the method).

## **My Plan of Action**

The aim of my project is to develop an IAT which can predict the placebo effect. This sounds simple. However, the most critical part of any IAT is the words used in the program, as well as the distinction (i.e. the pleasant-unpleasant dimension discussed above), and this is the part which has taken most of the time (and its not completed yet). To do this, I have sent out health, optimism and mindfulness questionnaires to over 1000 UCC students (apparently being optimistic is bad for your health, at least in UCC), interviewed doctors, alternative therapists and students, and asked people to tell me who the people they associate most with health are. The data I got from the ranking exercise I have then put into a method called a Repertory Grid, which will allow me to determine which words and phrases to use to measure the placebo response (at least in theory).

Another goal of my research is to develop a better self report measure of placebo expectancies. I talked about the current measurements above (i.e., how much do you expect this treatment to help you) and how this is useful, but not enough. Over the past six months, I have developed a measure called the Treatment Credibility Questionnaire which can assess the amount of belief people have in different forms of treatments for pain. I tested this in two samples, and currently over 1800 people have completed the instrument. Data analysis is ongoing, but it appears from early results that the questionnaire does what it is supposed to.

Obviously, the only way to make sure a measure works is to test it, and my measures are no different. Starting in the Autumn, I will be testing my IAT and questionnaire using a placebo analgesia experiment. In this, I will assess the pain reduction following a stimulus and the extent to which it can be predicted by my new measures. This is the crown of my research, and as it comes closer I feel more and more excited at the prospect of finally putting my ideas to the test of reality.

## **Conclusion**

In conclusion, my research is important in that it could teach us more about how we heal ourselves, how we can help others to heal, and how we can ensure that effective treatments are not rejected before getting to the hospital or pharmacy. I believe that this

research has the possibility to substantially increasing our understanding of the placebo, which that is something that we all want.

Thanks to my supervisors Dr Zelda Di Blasi, School of Applied Psychology, UCC and Dr Dylan Evans, School of Medicine, UCC. Thanks also to all of my participants, past and future.

# Effects of deep diving on the trachea of the leatherback turtle

**Colm Murphy**

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## Introduction

This work is concerned with the effects of deep sea diving on the trachea (airway passage) of the leatherback turtle. Leatherback turtles are capable of diving to depths greater than 1,200 meters. Humans, in comparison, may only reach depths of around 30 meters unaided. It is believed that the response of the trachea along with its material properties plays a leading role in determining the depth that can be attained during a dive. The long term objective of this research is to investigate the response of the trachea of the leatherback turtle during deep dives (300-1250m). Questions remain as to the material properties from which the trachea is composed of and how exactly does the trachea respond as it undergoes a deep dive. Answering these questions will help not only to build a complete understanding of the leatherback's ability to dive to depths greater than 1,000m, but will also inform the study of deep diving in mammals, even including humans, whose competitive free diving has been extended beyond 200 metres in recent years.

## Definition of a Trachea

The trachea or the windpipe is the tube-like passage through which organisms breathe air in and out. This process is commonly referred to as the respiratory system (Figure 1). The trachea begins in the neck at the larynx, which is more widely known as the voice box. It continues as a single airway until the point of bifurcation. This is the position at which it diverges into two separate tube-like structures called the bronchi. The bronchi, in turn, each subdivide into smaller passages which connect to the lungs. It is here that gaseous exchange takes place. The oxygen that is breathed in is transported through the trachea and the other airways into the lungs and converted to carbon dioxide. Carbon dioxide subsequently travels back up the trachea and is breathed out. In humans, the trachea consists of a number of c-shaped cartilage rings (Figure 2) that are connected to each other by a connective biological material. Cartilage is a firm and rubbery material that provides support and structure to biological matter, in this case the trachea.

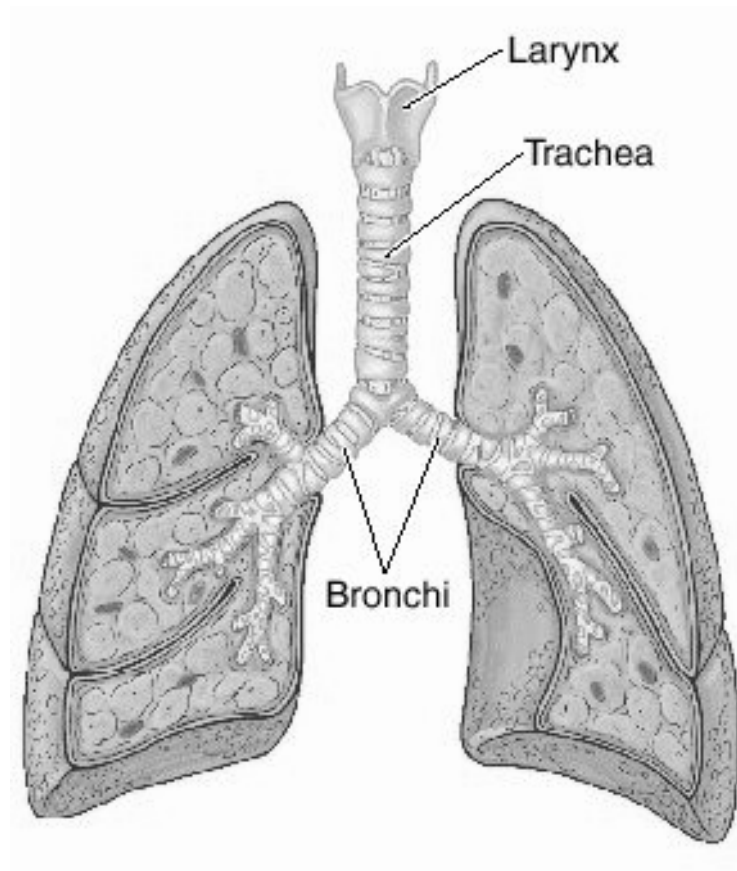


Figure 1: Respiratory System

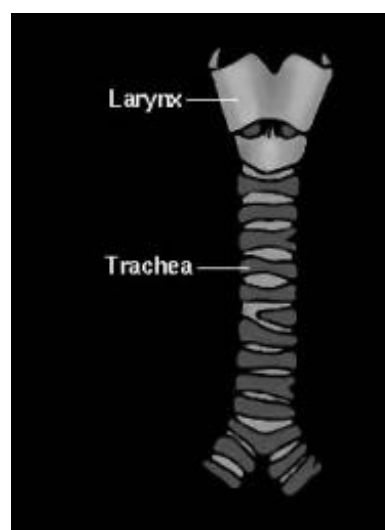


Figure 2: Composition of a typical human trachea

## Deep Diving

When any life form undertakes a dive, an external hydrostatic pressure is applied on that body. Hydrostatic pressure is the pressure applied by the surrounding water on a body and it increases linearly with depth. The deeper a body is in water the greater the hydrostatic pressure acting on it. A very important concern with diving is to avoid nitrogen decompression sickness, which is known more widely as ‘the bends’. This occurs when a body is returning to the surface of the water. During this stage of the dive, it is exposed to decreasing hydrostatic pressures. These decreasing pressures cause the dissolved gases inside the lungs to change into bubbles which lead to much discomfort in the body and may even result in paralysis or death.

Humans are capable of diving unaided to around 30m before experiencing ‘the bends’. The world record for deepest dive on scuba is 330m. In 2007 a navy diver set a record by submerging 610m using an advanced hard shell suit. The leatherback turtle, however, is capable of diving up to 1,200m naturally. How the turtle dives to these depths repeatedly and returns safely to surface level is not understood completely. It is hypothesised that the trachea collapses wholly or partially during dives. The trachea of the leatherback turtle differs in structure from that of Humans and also has different material parameters. Material parameters are the characteristic properties of a material which affect its strength and stiffness. Stiffness, in turn, is a measure of the resistance of a material to an applied force. The trachea of the leatherback turtle is composed of near complete elliptical rings (as opposes to c-shaped rings in Humans) of hyaline cartilage with only small amounts of intervening connective tissue. The resulting pipe-like structure has sufficient stiffness to remain open for respiration and has a high rotational stiffness that allows for limited neck movements.

## Methodology

The research to date this has been concerned with classifying the material parameters of the tracheal cartilage of the leatherback turtle. In order to do this a sample of a leatherback trachea was compressed in the laboratory (Figure 3(a)). The testing conformed to all biomechanical standards and was set up to replicate the response of the trachea as it is subjected to increasing hydrostatic pressures in a typical dive sequence. A model of the trachea was created using a structural analysis software program with the same testing details as that in the laboratory (Figure 3(b)). A basic rubber representation was deemed sufficient for modelling the trachea. The results from both sets of data (namely the force applied and the corresponding movement of the trachea at that time) were recorded. To run an analysis of a model the parameters of the material in the model must be declared. How the model responds to applied forces depends on its material properties. As the



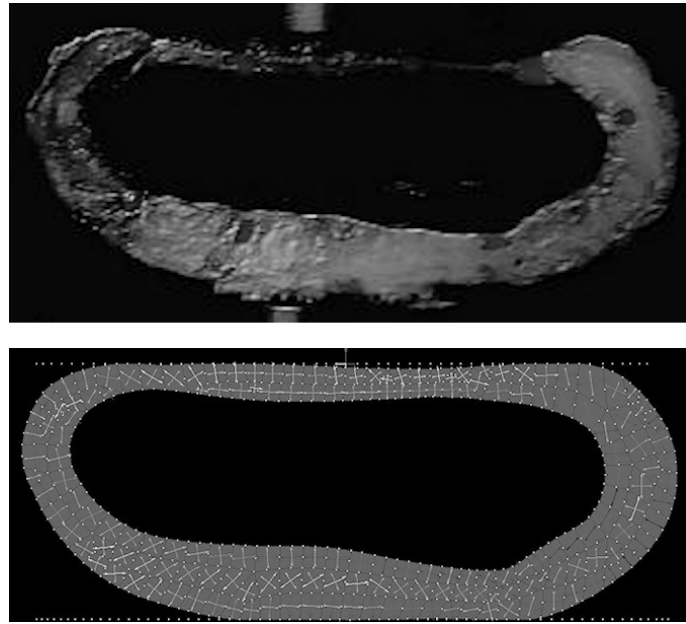


Figure 3: (a): [Upper] Trachea deformed in the laboratory test at time  $t = 140s$ ; (b): [Lower] Trachea deformed in the model at corresponding time

aim of this part of the research is to find out these parameters, it is hypothesized that by continuously running this model with differing values for the parameters, at some stage the response of the trachea in the model will match that of the response in the laboratory. This process is known as optimisation. Basically this involves providing initial ‘guess’ values as well as upper and lower boundary values for the parameters. The optimisation process changes the values accordingly until a prescribed error or tolerance is satisfied. In this case, the desired outcome is that the error between the model results and the laboratory results is minimised. This concept of finding out the material properties (or input parameters) from output responses is also referred to as an inverse method.

## Results

Figure 4 shows the plots of the experimental and final model results for the optimisation process. In both cases it is a graph of applied force versus displacement (or movement).

## Discussion

This research demonstrates the viability of using an inverse methodology to classify the non-linear material properties of tracheal cartilage. The graphs of forces versus displacement in Figure 4 show good agreement between the experimental and model data. How closely these curves match is an indication of the accuracy of the methodology. The gaps

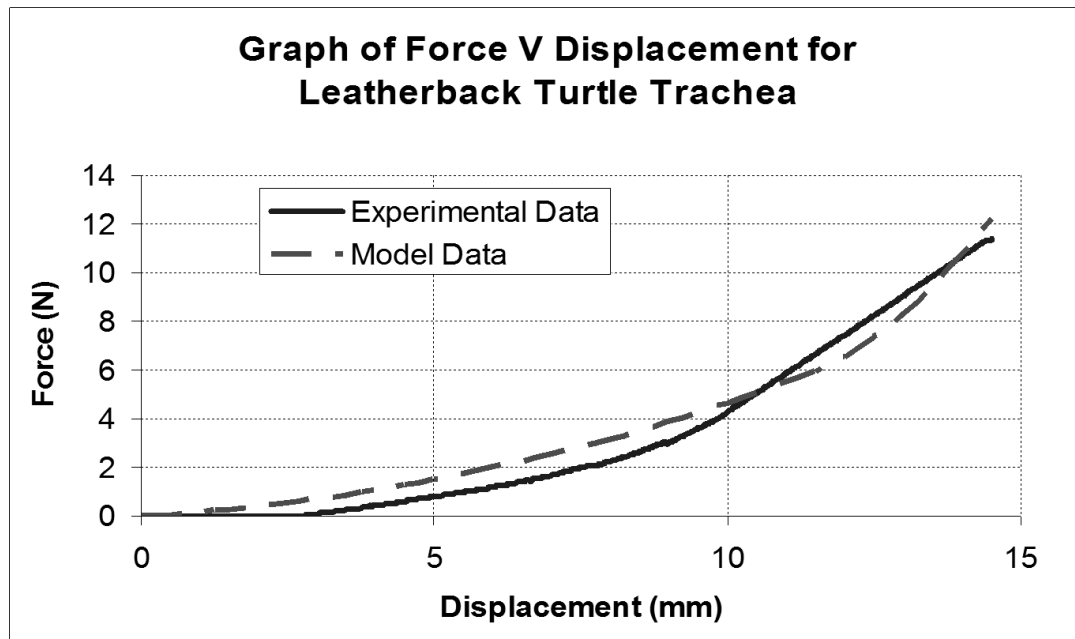


Figure 4: Plots of force versus displacement for the leatherback turtle trachea for the experimental and model data.

represent the error between the laboratory testing and the model. Means to resolve this error are currently being investigated. It is thought that by improving the geometry of the model and by considering more complicated material models better results shall be obtained. Work is also progressing on a two dimensional model of the neck section (Figure 5 (a) and (b)). This model shows how the entire neck section of the trachea responds due to increasing pressure in dives. The trachea is surrounded by the other materials in the neck of the leatherback turtle. In this model muscle is modelled as an incompressible rubber which is deemed sufficient for purpose.

Early findings from this research confirm the hypothesis that the leatherback trachea collapses (Figure 5 (b)) as it subjected to increased hydrostatic pressure in dives. Humans are unable to collapse the trachea to this extent due to different material properties of the trachea. Future work shall focus on improving the accuracy of the methodology discussed earlier and improving the models. Once the material parameters of the leatherback trachea have been established, a three dimensional model of the entire neck section shall be developed. This model shall provide a detailed description of how the trachea responds at any time and depth during a typical dive sequence. The results will, firstly, assist zoologists researching the diving behaviour and capability of the leatherback turtle and, secondly, provide insights into the application of structural engineering analyses and methodologies to finding solutions to biomechanical problems.

Colm Murphy is a student in the Department of Civil & Environmental Engineering under the supervision of Dr. Denis Kelliher. This research is being carried out in collaboration with Prof.

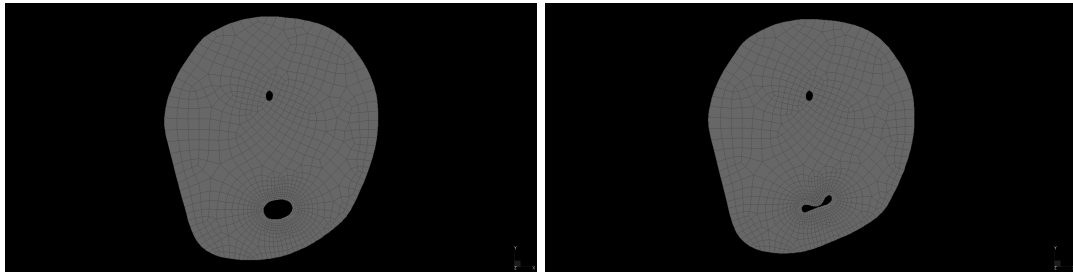


Figure 5: (a) [left] 2-D neck section in original position; (b) [right] 2-D neck section at 29m depth

John Davenport in the Department of Zoology, Ecology and Plant Sciences. The author would like to acknowledge funding from the Irish Research Council for Science, Engineering and Technology (IRCSET) through their EMBARK initiative.

# Does cash payment influence a GP's decision to prescribe antibiotics?

**Marion Murphy**

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## Introduction

Antimicrobial resistance is a major public health concern and one of the primary factors contributing to resistance is the unnecessary use of antimicrobials. Many countries have developed strategies in order to promote the rational use of antibiotics. Ireland is only one of three European countries where outpatient antibiotic use is increasing, at a rate of 3% per year since 2000.

The majority of antibiotic prescribing is conducted by General Practitioners (GPs) in the community, and wide variation is known to exist. The volume of antibiotics prescribed that are unnecessary in the community is unknown but it is believed that a number are used to treat minor respiratory tract infections. These conditions such as the common cold, sore throat, acute *otitis media* and acute bronchitis have no compelling evidence to support the use of antibiotics in their treatment. There are many external (non-clinical) factors that influence a GP's decision to prescribe, e.g., patient pressure and social factors. Patient pressure and time restraints have been quoted as potential reasons that GPs provide treatment, despite clinical evidence suggesting it is not necessary.

There is considerable debate internationally about how primary care services should be funded and delivered. As a result, policy-makers have used a wide variety of strategies to make the best use of the national resources and this often becomes a political debate. Access to primary care services operates on a two-tier system in the Republic of Ireland (ROI). General Medical Service (GMS) card holders attend GP surgeries free of charge and are entitled to free medications. Eligibility is means tested and in 2009, 33% of the population in Ireland were GMS card holders. When characteristics such as level of health are controlled, having a GMS card remains a very strong predictor of GP utilisation.

Non-card holders (private patients) must pay a non-subsidised fee to visit their GP. Almost all GPs in Ireland (96%) operate a mixture of GMS and private practice. In other countries such as the UK, GPs working for the National Health Service (NHS) are not allowed to charge patients for their family health services. There are many reasons that this regulation was introduced. A GP working in an unregulated private market may have an incentive to provide above the required services, an event known as 'supplier-induced

demand.' GPs can also be under more pressure from patients to provide unnecessary treatments due the pressure of the payment involved. The method of GP remuneration and patient demands have been acknowledged as some of the main factors that influence the practice of GPs. In Canada, both salary-based and fee-for-service GPs exist and it was found that there was an association between fee-for service GPs and high rates of antibiotic use. We postulate that this payment may affect the GP's decision to prescribe antibiotics in consultations in ROI.

## Aim

The aim of this study was to ascertain whether there was a variation in practice in prescribing antibiotic between GMS and private patients in the ROI.

## Method

Ethical approval was granted by the local ethics committee. All GPs nationally attending continuing medical education (CME) groups were invited to participate from October 2008 to April 2010. Ireland has a CME attendance of over 1,000 GPs. Participating GPs gathered data on 100 consecutive consultations including diagnosis and patient characteristics. When an antibiotic was prescribed during the consultation, details of the prescription and directions for use were recorded, for example, where a delayed or 'deferred' antibiotic prescription was given to dispense at a later time if necessary, as agreed by GP and patient.

## Analysis

Data was analysed using Microsoft Office Excel<sup>®</sup> (2007) and Statistical Package for the Social Sciences (SPSS<sup>®</sup>, Chicago, Illinois) version 15.0. The Pearson's chi-squared tests ( $\chi^2$ ) were performed to assess if associations existed between categorical variables; if the p-value  $<.05$  then there was a statistical relationship between the two variables. Odds ratios (ORs) were calculated to measure the strength of these associations; an OR of 1 implies that the occurrence is equally likely in both groups. An OR  $>1$  implies that the occurrence is more likely in one group; an OR  $<1$  implies that it is less likely. The Mann-Whitney test was used to compare numerical variables, i.e., to test whether one variable tends to have values higher than the other (a p-value here  $<0.05$  signifies a statistical difference) and 95% confidence intervals (CI) were calculated.

Table 1: Comparison of GMS and Private consultations

	Private	GMS	P-value ( $\chi^2$ test)	OddsRatio
No. of consultations	7,021	9,033	—	—
No. of antibiotic prescriptions (%)	1,516 (21.59)	1,656 (18.33)	<0.0005	1.22
No. of antibiotic prescriptions for respiratory symptoms (%)	1,037 (68.40)	1,028 (62.08)	<0.0005	1.47
No. of deferred antibiotic prescriptions (%)	235 (54.27)	198 (45.73)	0.006	1.34

## Results

Data were collected from 170 GPs, which resulted in 16,800 consultations. These GPs were from all over the ROI and a range of demographics and settings (e.g. urban/rural) were represented. The mean ( $\pm$ SD) number of consultations recorded per GP was 98.82  $\pm$ 5.85. This took an average of 3-5 working days for the GP to complete.

The mean age of GMS patients was 49.65  $\pm$  26.13 years, while the mean age of private patients was 33.82  $\pm$  20.59 years ( $p$ <0.0005, 95% CI:13.37-17.49). Antibiotics were prescribed at 3,380 (20.12%) consultations. Half of the antibiotics prescribed were for GMS card holders (1,656; 48.99%), 44.85% (1,516) were for private patients and 6.15% (208) were of unknown type due to missing data. The rate of antibiotic prescriptions in both groups was similar (GMS: 18.33%, Private: 21.59%). However, private patients were more likely to receive an antibiotic prescription ( $p$ <0.005, OR 1.22). People aged  $\geq$  65 years were less likely to receive an antibiotic ( $p$  <0.001, OR 0.69).

Private patients were also more likely to receive a deferred prescription ( $p$ =0.006, OR 1.34) (Table 1). The majority of antibiotics prescribed for both groups were for diagnosis or symptoms of a respiratory-related illness. A higher percentage of private patients (1,037, 68.40%) compared to GMS patients (1,028, 62.08%) received an antibiotic for a respiratory related illness. Private patients were more likely to receive an antibiotic when consulting with a respiratory illness ( $p$ <0.0005, OR 1.47) (Table 1).

## Discussion

GMS patients are known to be higher consumers of medical care; GMS card holders had an average of 6 visits per year in 2001, compared with 2.3 visits for those without a medical card. This can be partly explained by the higher age and worse physical and mental

health of the GMS population; and partly explained by the reluctance of private patients to pay the fee. Research to date on antibiotic prescribing in Ireland has not included non GMS card holders. Pharmacy sales data is available but holds no individual level information. Unlike other countries, information on diagnostic indications that are being treated with antibiotics in the community is not known in Ireland, although this data is vital in developing strategies to reduce antibiotic use.

This study has shown that private patients are slightly more likely to receive an antibiotic prescription (1.22 times). GPs often quote expectation and pressure from patients as a reason for antibiotic prescribing and this pressure would be expected to be increased when there is payment involved.

Older patients are more likely to develop complications such as pneumonia following a respiratory infection and therefore antibiotic use in this cohort would be expected to be higher than the general population. This study found that older patients were less likely to receive an antibiotic, indicating that inappropriate prescribing is occurring more in the younger, healthier population.

A limitation of the study was that GPs did not record the duration of symptoms of each patient. This may influence the decision of the GP to prescribe antibiotics. It is generally thought that on average private patients wait longer to visit their GP due to the cost implications and therefore likely to have worsening symptoms. This will be studied further in qualitative work that is currently being conducted.

## Conclusion

These results demonstrate that whether the patient pays for the GP consultation can have an influence on the GP's decision to provide an antibiotic prescription. Private patients are more likely to receive an antibiotic prescription. This was not expected, as GMS patients are higher users of medical care due to the higher age bracket and the lower socio-economic background of the group, and further supports the theory that external factors have a role in antibiotic prescribing in primary care. Deferred prescriptions were more likely to be prescribed to private patients, negating the need to re-consult if symptoms deteriorated. Age was also shown not to be a contributing factor, which was also not expected as antibiotics have shown to have more protective benefits in the older population. More research is required to follow-up both GMS and private patients to assess clinical outcomes post-GP consultation.

I would like to thank my supervisors Prof. Colin Bradley and Dr. Stephen Byrne. I would also like to thank the GPs who participated in the study, in particular the CME tutors for their support. Funded by the Health Service Executive (Strategy for the Control of Antimicrobial Resistance in Ireland)

# **Self-discovered breast cancer symptoms and women's help seeking behaviour: key findings from phase one of a two-phase study**

**Mairin O'Mahony**

Catherine McAuley School of Nursing & Midwifery, Brookfield Health Sciences Complex, UCC

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## **Background**

Breast cancer is the most common cancer among women in the western world. In Ireland, breast cancer was the most common cancer diagnosed amongst women during 2000-2004 with approximately 3,095 cases reported annually and an average of 947 deaths. It is well known that the earlier the diagnosis of breast cancer is made the more likely it is that women will have a better health outcome. However, 20-30% of women wait for one month or more before presenting to a Health Care Professional with a self discovered breast symptom. This is a worrying situation given the increased emphasis on prompt presentation of symptoms and the associated link with better health care outcomes for women diagnosed with breast cancer. Therefore, more work on help-seeking behaviour from the woman's perspective will help Health Care Professionals to understand women's needs and concerns surrounding symptom discovery and highlight the key issues linked to delayed help seeking. This paper reports on phase one of a two-phase study which explored women's help-seeking behaviour for a self-discovered breast symptom, from a qualitative perspective.

## **Aim**

The aim of phase one of the study was to explore women's help seeking behaviour for a self-discovered breast symptom, to find out more about women's experience of finding such a symptom and how this influences their help seeking behaviour. In addition, the researcher wanted to identify the key issues to be included in a questionnaire for phase two of the study.



## Methods

Following ethical approval, a qualitative descriptive study using semi-structured interviews with ten women who had self-discovered a breast symptom was carried out. Initially, women were asked to tell about their experience of finding a breast symptom. Then, more specific areas identified as being important in the literature review were explored with women. These areas included symptom related issues, emotional responses to the symptom, social issues, health seeking habits, access to health services and knowledge and beliefs about the symptom and its outcome. Women's socio-demographic details were recorded at the end of each interview.

## Analysis and Results

The interviews were recorded and transcribed by the researcher, following which all interviews were read and re read several times. Data were then analysed using content analysis, which involved identifying and summarising the key issues emerging for women within each of the main topics outlined above. The researcher was conscious of maintaining the credibility and dependability of the findings throughout the study. This was done by being true to the data, using women's direct quotes to illustrate the points being made, and discussing findings with the co-researchers to see if they agreed with the issues emerging.

## Findings

### **Socio-demographics, symptom discovery and help seeking behaviour**

Ten women took part in the study ranging in age from 25 to 55 years. These included seven Irish women, two Eastern European women and one English woman. All of the women discovered the symptom(s) themselves. Three women presented with a breast lump, four with breast pain, two with both lump and pain and one with a bloody nipple discharge. Four women had a family history of breast cancer which included aunt for two women and mother and aunt and mother and sister for two women, respectively. The time from symptom discovery to first visiting the General Practitioner (GP) was called "help seeking behaviour" and was either prompt (within one month) or delayed (over one month). Following symptom discovery, six women visited their GP within one month and four delayed over one month. Two of these women delayed from one to two months and two delayed for over three months.

## Factors influencing women's help seeking behaviour

The key facilitators for women's help-seeking behaviour were telling another person about the symptom; knowing about breast symptoms and their associated risks and the importance of early detection of breast cancer; and confidence in the health services overall. Delayed help-seeking was due mainly to women's denial and fear and family and work commitments. In addition, lack of knowledge in relation to family history and risk and the belief that breast cancer was incurable impacted on delay. The study highlighted that denial impacted on the help seeking behaviour of those women who delayed help seeking for over one month or more, as highlighted by one woman who said:

I thought if I ignored the symptoms, they would go away...

In addition, women experienced varying degrees of fear, causing some to delay and others to seek help earlier. Voicing concerns about the symptom to another person had a positive impact on help-seeking behaviour. In some cases, the competing social roles of family and work commitments prevented women from seeking help at an early stage. Women's knowledge and performance of breast self-examination varied. Notably, some women reported uncertainty around breast self examination and said that they never examined their breasts.

Health service utilisation factors had a positive effect on women's help seeking behaviour and overall, women expressed satisfaction with the GP services. A presenting symptom of a breast lump was significant for most women and caused them to seek help promptly. This supports findings from previous studies which highlight that the nature of the symptom impacts on early help seeking behaviour. Although women were aware that early detection of breast cancer was recommended, this did not always impact positively on their help seeking behaviour. Women believed that family history was the biggest risk factor for developing breast cancer. However, a false sense of security in the absence of a family history of breast cancer was noted amongst some women.

A belief that breast cancer was curable if detected and treated at an early stage was expressed by most women. However, this was not the case for one woman who delayed help seeking for over three months and expressed the pessimistic view that her breast symptom and its outcome would be permanent and incurable. In relation to a breast cancer diagnosis, religious beliefs and having a positive attitude were recognised by most women as being helpful to their health outcome overall. Although religious beliefs were important, few women relied solely on praying to God when they first found their breast symptom. Finally, although a strong belief in the use of conventional medicine for breast cancer treatment was prevalent, women also recognised the value of alternative therapies as an additional treatment.

## Conclusion and recommendations

This study increases Health Care Professionals' understanding of women's help seeking behaviour on self discovery of a breast symptom and highlights the key issues influencing delayed help seeking. i.e., psychological and social factors and women's knowledge and beliefs. Findings also clarify that these factors have potential to both initiate and inhibit women's help seeking behaviour. Thus, confirming their appropriateness for inclusion in the questionnaire for phase two of the study. The study emphasises the importance of continued focus on the message of early detection of breast cancer. New initiatives that address the barriers to prompt help-seeking need to be developed. In this regard, nurses have an important role to play in educating women about breast cancer and promoting early detection practices amongst women in both the acute and community health care settings. However, nurses will have to be supported in this role, if this health-promoting endeavour is to become a reality.

Mairin O'Mahony is a College Lecturer and PhD student in the Catherine McAuley School of Nursing & Midwifery, Brookfield Health Sciences Complex, under the supervision of : Professor Josephine Hegarty PhD, MSc, BSc, RNT, RGN, Acting Head of School of Nursing and Midwifery, Brookfield Health Sciences Complex, University College, Cork, Ireland and Professor Geraldine McCarthy, PhD, MSN, MEd, Dip Nursing, RNT, RGN, Acting Head of College of Medicine and Health, University College, Cork, Ireland.

# **Self-discovered breast cancer symptoms and women's help seeking behaviour: key findings from phase one of a two-phase study**

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# Development and administration of a screening tool for cardiovascular risk assessment in community pharmacy

Dónal Óg O'Donovan

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## Introduction

Cardiovascular disease (CVD) was the leading cause of death in 2005, causing 17.5 million deaths globally. In Ireland, 2006 figures indicate that CVD was responsible for 43% of all deaths, and 49% of deaths in people aged less than 65 years. It is predicted to remain the largest cause of death for the foreseeable future. It has been estimated that at least 25% of CVD patients have sudden death or non-fatal myocardial infarction without prior symptoms. It is important to try to develop a method for screening these asymptomatic people. If people at high risk of CVD can be identified early then they can be treated to reduce their risk. This will in turn reduce their incidences of cardiovascular instances (heart attack, stroke, etc.) and their burden on the health service. Screening tools are used to identify those people at high risk of developing CVD. These screening tools take a number of inputs such as patient's age, gender, or blood pressure, and use these to calculate the patient's risk of CVD. Many screening tools already exist to assess CVD risk. These tools have names such as Framingham, QRISK or ASSIGN but they all perform the same task; using a patient's characteristics to calculate their risk of CVD. The drawback of these screening tools is that they all involve invasive blood tests, e.g. lipid profiling, to check a patient's cholesterol. The requirement of blood tests means that an accurate calculation of CVD risk cannot be done quickly.

## Aim

The aim of this study is to pilot a novel paper-based questionnaire, relying on patient self-reporting of data in community pharmacies, that can be used to assess risk of CVD.

## Methodology

Ethical approval for this project has been granted by the local ethics committee. Two hundred and ninety two participants have already been enrolled in this project. Each one of these participants has completed an extensive questionnaire to record their lifestyle and dietary habits. These questions form a database of self-reported information for each



person. Each participant has also undergone a physical examination to check biometric information such as their blood pressure, waist circumference and cholesterol. Their risk of CVD will be calculated using established screening tools (Framingham, QRISK, ASSIGN mentioned above). Neural network software will be used to establish which self-reported questions can be used to accurately predict risk of CVD. When a range of inputs are known and the final result is also known, neural network software is used to establish which inputs affect the final result and to what extent. In this case the neural network software will identify what lifestyle and dietary information affects a person's risk of CVD in an Irish setting. These questions will then be used to form a questionnaire that will be used in community pharmacies. An expert panel of consultant cardiologists and community pharmacists will undergo a process of Delphi validation to fully validate the questionnaire. Delphi validation is a process whereby established experts in a field reach a consensus. In this case the cardiologists and community pharmacists will examine the data from the neural network and agree on the questions that should be included in the final screening tool. The final screening tool produced would be quick to apply and would consist of self-reported answers that would not require blood tests and would be quick and easy for patients to use.

## **Work to date**

We have completed data collection for each of the 292 participants. All data has also been entered into a database ready for analysis. A pilot study has also been conducted in community pharmacies. A questionnaire was developed using European Society of Cardiology (ESC) guidelines. This questionnaire used only self-reported data. Each question was assigned a weighting by the researchers. Upon completion of the questionnaire the weightings for each risk factor were added to give a score related to their CVD risk; low, moderate or high. The questionnaire was administered in six community pharmacies in the greater Cork region.

## **Conclusion**

The pilot study demonstrated that it is acceptable to patients to screen for CVD in community pharmacies. The questionnaire that will be developed will be fully validated and will accurately screen for risk of CVD. It will be easily to understand and quick to complete. It will be able to identify people at high risk of CVD who are asymptomatic and direct them to treatment before they suffer a cardiovascular event and become a burden on the health service.

I would like to thank my supervisors Dr. Laura Sahm and Dr. Stephen Byrne, all participants in the study so far and also my Clinical Practice postgraduate colleagues.

# Land and justice in South Africa

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## Introduction

When Nelson Mandela took office on 10th May 1994 as South Africa’s first democratic president, he pledged that out of “an extraordinary human disaster” would come “a society of which all humanity will be proud”. Since then, South Africa has been praised for overcoming racial division and hatred in a peaceful manner while developing economic growth. This positive picture of post-apartheid South Africa has been compromised in recent years by rising crime, xenophobic violence, unemployment, and service-delivery protests.

My research looks at how the new democracy has redistributed land and why less than 1% of the population still own the majority of the land. To understand the slow pace of land reform, I have examined the policies of the ANC, the polarised public debates on land reform, and the constraints on economic transformation. In order to achieve justice and ultimately reconciliation, problems with redistribution must be addressed. This requires not only more financial investment but also a significant review of policy direction, principles and priorities.

## The History of Land Injustice in South Africa

The “extraordinary human disaster” of apartheid in South Africa has its roots in a longer legacy, that of colonialism. Prior to colonial settlement, hunter-gatherers, pastoralists (herders) and mixed farmers populated the region for millennia. In 1652, the Dutch East India Company set up a base in what later became Cape Town. The policy of colonial rule regarding the native inhabitants was two-fold – direct rule and indirect rule. Direct rule by the British and the other settlers (Dutch, German and French who formed the Afrikaner/Boer grouping) involved destroying the local communities through slavery, land dispossession and armed conflict.

Indirect rule separated the black population into tribal reserves, called Bantustans or homelands, governed by Native Authorities. 7% of land was allocated for these reserves under the 1913 Land Act and increased to 13% in 1936. The amount of land black people could farm in the reserves was limited to three hectares, enough for sustaining a family

but not to earn a living. The purpose of this was to create a mobile labour force to work in the gold and diamond mines, commercial farms and industry. Family life was destroyed in this process. White governments supported white agriculture, jobs and industry through subsidies and job guarantees, and ensured blacks would provide a cheap labour force.

Apartheid, which began in 1948 under the National Party, cemented these policies. Millions of black, coloured and Indian people were forcibly moved from cities to townships on the outskirts. They could commute to work, but cities would be 'white by night'. In rural areas, black people were moved from 'black-spots' in white designated areas to ten self-governing reserves. By the end of apartheid in 1994, over a third of the total population (16m people) lived in the overcrowded and poorly resourced Bantustans. Millions more lived in townships and squatter camps with inadequate housing, no sanitation, poor water supply and no electricity.

The first democratic elections were held in April 1994. This followed a long and international campaign, four years of negotiation and periods of intense violence and state repression. Over 19m people voted, the vast majority for the first time in their lives. It was a celebrated moment in human history, with great hope that peace, justice and human dignity would become possible for all South Africa's citizens.

## **Land Reform and Reparative Justice**

By the end of apartheid, South Africa was one of the most unequal societies in the world. In 2001, the population was almost 45m, over 10 times that of Ireland. According to that year's census non-whites accounted for over 90% of the population. Yet in 1994, 60,000 white-owned farms occupied 70% of the land, approximately 85.2m hectares out of a total of 122.5m hectares. The support for whites and discrimination against blacks resulted in a two-tier agricultural system: industrialised farming for whites, and small-scale subsistence farming for blacks.

Addressing this legacy and creating a reconciled nation has been one of the major aims of the four ANC-led governments since 1994. The Reconstruction and Development Programme (RDP) (a redistribution programme) and a Truth and Reconciliation Commission (TRC) were set up in the early years of democracy. Land reform is key to the RDP, and is guaranteed by the human-rights based Constitution and a series of acts developed over the past sixteen years.

Overall, these policies form part of reparative justice. Across the world, various groups e.g. victims of war, the Holocaust, slavery, and indigenous communities decimated by colonialism, have sought reparative justice. This process aims to achieve reconciliation and prevent horrific abuses from happening again. Reparative justice proposes that what was wrongfully taken in the past should be returned, victims should be shown respect,

relationships mended and a more equal society created. It involves two forms, the acknowledgement of hurt and economic redress for that hurt, and I argue that both are required for reconciliation:

- Symbolic acknowledgement of hurt can involve public apologies, remembrance ceremonies and the creation of memorials and museums. Examples in South Africa include the Apartheid Museum and the Soweto Museum in Johannesburg, the Slave Lodge in Cape Town and the celebration of Freedom Day on the 27th April. In a divided society, a new moral balance must be developed. This requires changes in cultural values such as a change of racist attitudes, and the recognition that what happened in the past was wrong. Accountability and forgiveness, respect for democracy and human rights, are needed in order to achieve a multicultural 'Rainbow' nation.
- Economic redress involves financial compensation and/or the restitution of property/land to individuals, groups, or their descendants. It also involves more general redistribution of land and services for all those who suffered severe restrictions and trauma. Economic redress is one form of achieving socio-economic rights that empowers those who have been excluded. The TRC recommended a range of economic reparations, only some of which have been carried out by the state. In South Africa the origins of conflict are not only political and ethnic but also economic/resource-based. Therefore, economic transformation is required.

Land reform policy in South Africa aims to provide economic redress and security in three ways:

1. The restitution of land and property that had been taken from people from the 1913 Land Act onwards. Almost 75,000 claims (representing almost 1.5 million people and 95% of all claims lodged) have been processed to date. The majority of these were urban claims which are now complete, with compensation primarily financial. In rural areas, the return of land is the primary form of compensation and there are over 4,000 outstanding complex claims;
2. The redistribution of 30% of agricultural land to those who would wish to farm, under a model recommended by the World Bank. Rather than expropriation (compulsory purchase), the state provides grants to enable the purchase of land. This is termed a willing-buyer, willing-seller model;
3. The securing of tenure rights for those living and working on commercial farms and those living in the former Bantustans under tribal leaders, in particular to eliminate evictions.

Current government targets are to complete restitution by 2012 and the redistribution of 30% of white-owned agricultural land by 2014 (although this may be pushed back to 2025).

## A Polarised Debate: Where does the government stand?

Land reform has been controversial from its very inception. While a majority of blacks, coloureds and Indians support the return of land, recent research highlights few whites do so. Furthermore, few whites believe that land inequality is due to historical reasons. Commercial farmers, agri-businesses and some research groups fear that land reform could damage the economy and food production, like Zimbabwe's violent land reform. The South African Centre for Development and Enterprise said in a 2008 report that land reform "*could result in a dramatic decline in exports, and a withdrawal of international investment*". This is echoed by a statement (February 2009) from AgriSA, the commercial farmers union, that "*Excessive focus on the industry's transformation challenges and social functions, to the detriment of its core functions, namely competitive and sustainable food production, detracts from the ability of the sector to perform optimally.*"

On the other hand, land organisations, social movements and some academics argue that land inequality is unsustainable and land reform should help the poor secure stable livelihoods. These groups argue that the government should expropriate land and that "*the right to agrarian reform by landless poor and small scale farmers is being undermined in favour of a market-based model that has led to the concentration of land*" (Surplus Peoples Project 2009). They are also worried that tenure reform has been neglected and the power of dictatorial tribal leaders strengthened. What's more, over 1m farm dwellers and workers have been evicted from white-owned farms since 1994. Rather than a free-market, chemical-industrial model of farming, social movements propose smaller scale ecological farming and local food sovereignty, i.e. the right of people to democratically decide their own agricultural and food policies.

While the debate converges in a criticism of the government, it is highly polarised on what kind of reform is required and the kind of economic/agricultural system that should be developed. The government has steered a course between the two sides of the debate. Influenced by internal and powerful global forces, the 1996 Growth Employment and Redistribution policy (GEAR) has embraced global capitalism, "*making South African agriculture more competitive and efficient*" (ministerial speech, 30 July 2008). In 2008, the Department of Rural Development and Land Reform developed the Land and Agrarian Reform Project (LARP) to concentrate on creating black commercial farming. This requires matching inputs from applicants (like money, labour, machinery) to get grants and focuses on "*tradable and exportable goods*" (LARP, 2008).

At the same time, the government says it is committed to redressing the imbalances caused by colonialism and apartheid. It speaks of "*including the historically disadvantaged in the agricultural economy*" and "*promoting sustainable livelihoods*" (LARP, 2008). However the government shelved the 2008 Expropriation Bill (designed to legalise compulsory purchase incorporating fair and equitable compensation) after opposition from farmers'

groups and opposition political parties. Furthermore, according to recent government estimates, 90% of redistributed farms may have failed. Many critics attribute this to the low budgets and staffing allocated to land reform and the adoption of a free-market model that means little support (financial or otherwise) is given to new farmers who must compete on a global level.

## **In Conclusion**

In recent years protests about the failure of the state to adequately provide services and redistribute to the poor have become increasingly frequent. Today, the majority of South Africa's population still live in poverty and a quarter of the population live on less than \$1.25 a day. As food prices rose in 2008, life became even more difficult for many people. Since 1994, only 6.8% of land has been reallocated: 3m hectares under redistribution and tenure, 2.6m hectares under restitution. The 2002 Census on Commercial Agriculture counted just 45,818 farms that still possess the majority of land.

One of the main criticisms of government policy since 1994 is that political reform has been implemented, but not economic reform. It is clear that the government is rhetorically strong on reparative justice. However, the principles and implementation of its policies are not adequately pro-poor. As some commentators say, the government talks left but it walks right. Social movements feel that their voices are not heard and their influence is weak. Many businesses and whites have neglected reparative justice altogether.

The worry is that without addressing both economic and symbolic aspects of reparative justice, retribution, not reconciliation, could become a greater part of the political landscape in South Africa.

Siobhan O'Sullivan is a student in the Department of Sociology under the supervision of Dr Patrick O'Mahony. She would like to acknowledge funding from the Irish Research Council for the Humanities and Social Sciences and the UCC William J. Leen Fund.

# 'Don't ever ask for the true story': versions of reality and life stories in Atwood's short fiction

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## Introduction

My research focuses on Margaret Atwood's short fiction and intends to explore how Atwood uses this particular genre in order to challenge ideological discourses. It highlights the use of this genre in order to convey or subvert ideas and considers its place in literature. It then explores the function of storytelling in Atwood's short stories. Finally, it examines the representation of gender, Canadian identity and global issues in these stories. Storytelling has a key role in my thesis, as Atwood draws attention to the subjectivity of any narrative in order to emphasise the ideological aspect of these narratives. Therefore, this article considers the politics of storytelling in Atwood's short stories and uses two stories to illustrate how Atwood's writing is self-reflexive: "Giving Birth" and "Significant Moments in the Life of my Mother".

Much of Atwood's work is concerned with the fact that any writing, even those claiming to truth such as autobiography or historical narratives, is always a version of reality and not an expression of an absolute truth. This article therefore explores some of the techniques used by Atwood in order to draw the reader's attention to the fictionality of any story; that is to the fact that a story is always a construction and not an objective reflection of reality. It considers in particular Atwood's concern with language and its inadequacy to represent reality accurately, the self-reflexive, or metafictional, literary devices Atwood uses to highlight the fact that all stories are subjective and only constructions of reality. Finally, it emphasises the role of the writer and the reader in the construction of a story.

## Metafiction

Metafiction plays an important role in Atwood's fiction. According to Patricia Waugh, in *Metafiction: The Theory and Practice of Self-Conscious Fiction*, "metafiction is a term given to fictional writing which self-consciously and systematically draws attention to its status as an artefact in order to pose questions about the relationship between fiction and reality;" it involves "the construction of a fictional illusion (as in traditional realism) and

the laying bare of that illusion.” Therefore, a metafiction, or self-reflexive fiction, will use some devices that draw the reader's attention to the way a story is written and constructed, and consequently to its subjectivity, which often results in a blurring between fiction and reality.

A famous and obvious Irish example of metafiction would be Flann O'Brien's *At Swim-Two-Birds*, in which O'Brien uses the technique of story-within-story. In this novel, the author writes a story told in the first person by a narrator who writes a story about a writer who writes a story in which the characters live their own lives when their author is asleep. Similarly, in Atwood's story “Giving Birth”, we can see the narrator in the act of creating a story: she is sitting at her desk writing the story we are reading and explaining at the same time the process of writing: “This story about giving birth is not about me. In order to convince you of that I should tell you what I did this morning, before I sat down at this desk. . . Now. . . I am writing this story.” The narrative then moves on to the story the narrator is writing but the story is often interrupted by commentaries in parentheses that address the reader directly with the pronoun “you”. Such techniques break the illusion that what is represented is reality as it is clearly shown that the story is just that: a story, a fiction, a construction.

Furthermore, the narrator's ironic comment that “Jeanie isn't real in the same way that I am real” also draws our attention to the fact that if Jeanie is not real, then the narrator of the story we are reading is not real either; what we are reading is only a fiction. It is evident from these examples that by drawing the reader's attention to the process of writing, the author also leads us to consider the fact that any story, even if it pretends to be true, is a construction.

## Language

The fact that any story is a construction of reality is reemphasised by the use of language. Many of Atwood's short stories are concerned with the arbitrariness of language and the discrepancy between the word and what it represents, and draw the reader's attention to words and their meaning directly. Indeed, language can be seen as the expression of someone's perception of reality and will construct a different reality in the receiver's mind. People rarely question language; they tend to consider words as expressing the concept or object for which they stand. However, language is just another human construct and cannot be considered as an accurate representation of reality.

For instance, in “Giving Birth”, the story starts with a discussion of the words related to the experience of giving birth and how they are inadequate to represent this experience: “And *delivering*, that act the doctor is generally believed to perform: who delivers what? Is it the mother who is delivered, like a prisoner being released? Surely not; nor is it the child delivered to the mother like a letter through a slot. . .” These considerations on



language emphasise the fact that language is somehow inadequate to represent reality, but also that it is through this use of language that a reality will be created in the reader's mind. Therefore, both the author or narrator and the reader have a role to play in the creation of a story. The author represents a picture with the use of words, which will create a different picture in the receiver/reader's mind.

## Unreliable narrators

Most of Atwood's writing reveals the fact that an author and a narrator are unreliable. Atwood famously wrote in "Murder in the Dark" about the writer playing games with the reader. Through this story, we are presented with a game involving a murderer, a victim and a detective. Soon, the game becomes a metaphor for the game played between a writer, a book and a reader or a writer, a critic and a reader. In this metafictional story, the murderer/narrator becomes a metaphor for the writer "plotting [a] sinister crime", which highlights how stories are carefully planned and constructed. Moreover, the narrator tells us: "by the rules of the game, I must always lie;" therefore, we should never trust the narrator and we should not consider the story as being the truthful expression of the writer.

In "Significant Moments in the Life of my Mother", we can observe such an unreliable narrator telling the reader about her life story or, more exactly, moments in her mother's life that are the occasion for her to tell about her own life. Autobiography is, like any story, characterised by a selection and ordering of events. This is evident in this story as we can observe a double choice being made: what the narrator decides to tell us and what her mother had decided to tell her. The word "significant" in the title can then refer to each of these choices. Indeed, the narrator notes that all the stories her mother recounts are exciting, that she chooses these stories carefully. The story clearly highlights how a life story is a construction, how certain facts are turned into events while "the long stretches of uneventful time" are not mentioned, thus leading the narrator "to think that [her] mother, in her earlier days, led a life of sustained hilarity and hair-raising adventure." Thus, biography or autobiography should not be considered as a necessarily truthful representation of one's life events since the writer's subjective choice is involved.

Moreover, two persons relating the same event will often give two different versions as each person will have a different perception of the event, a fact also emphasised in the story. The mother's version of some stories from the narrator's childhood differs from the narrator's version, which is "the real truth" according to her, but, as a reader, we can never be sure which version to believe. Furthermore, events related retrospectively are highly dependent on memory, which is not always reliable. Indeed, in "Significant Moments", we can notice how often the narrator repeats the word "remember" and even acknowledges the failure of her own memory. All these elements combined together highlight how unre-

liable a narrative told in the first person can be, even if it is meant to be a representation of reality.

## Interpretation

Finally, the reader, or listener, also plays an important role as s/he is the one who will receive the story, interpret it and thus give it a certain meaning. This meaning will depend on the reader's context, but also on her/his life story. Atwood also draws attention to this process of interpretation in "Significant Moments" as the narrator, who is also the receiver of a story, keeps trying to interpret the stories her mother tells her: "Possibly this story is meant by my mother to illustrate her own stupidity, and also her sentimentality. We are to understand she wouldn't do such a thing now." Moreover, the term "significant" in the title can also represent the significance of these stories but, despite the narrator's best efforts to find a meaning for each story her mother tells, "Some. . . stories defy analysis." Whatever the mother/author meant, it is ultimately the reader who interprets the story and gives it meaning and this is something the author does not have full control of. Therefore, the meaning originally intended can be lost through the process of transmission of the story.

## Conclusion

All these elements show that any story, even a "true" story, is always a construction or re-construction. A story can never be an objective representation of reality; it will always only be a version of reality. As we have seen, Atwood, through the use of various metafictional devices, draws the reader's attention to the fictionality of stories, thus challenging the idea that the written word can be the representation of an absolute truth. Her writings invite readers to question narratives and not to accept them as an objective representation of reality, but rather as the biased expression of an individual's perception of reality.

Emilie Péneau is a first-year PhD student in the School of English under the supervision of Dr. Lee Jenkins and Dr. Alan Gibbs.

# Financing options for businesses in Ireland

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## Introduction

Starting a business is a complex process which requires multifaceted organisation and planning. Entrepreneurs begin with an idea which must immediately be tempered with the need to justify the creative concept, choose the business location, assess the competition and, most importantly, identify methods to finance it. This last task is the most crucial as, without capital, there will be no business. The majority of entrepreneurs face one fundamental problem; they rarely have the amount of capital required to see their ideas to fruition. Creating a business and executing a business plan requires finance. Given the global credit-crunch, it is pertinent that funding options available to entrepreneurs are investigated. An entrepreneur has numerous sources of finance to choose from. These range from funding provided by family or friends to various sources of debt and equity finance.

This research aims to explore the financing of businesses in Ireland, to provide a more in-depth understanding of the sources of financing utilised. The study is currently at the data collection phase, gathering information on the types of finance utilised by businesses throughout Ireland.

## Financing Options

In the current economic climate the flow of innovative start-ups into the economy is critical for future growth. However, the establishment and expansion of these innovative businesses requires finance. Raising the necessary capital is crucial. In an economic climate where funding has become increasingly scarce, it is crucial that businesses have a clear understanding of the different types of financing options available.

Having a business plan and finding your niche market is the first hurdle – raising money to make your business succeed can be an even bigger struggle. Fundamentally there are two categories of financing options for businesses: internal and external. Internal capital originates from within the enterprise while external comes from peripheral sources. The various types of financing options within each category are outlined in Figure 1 below.

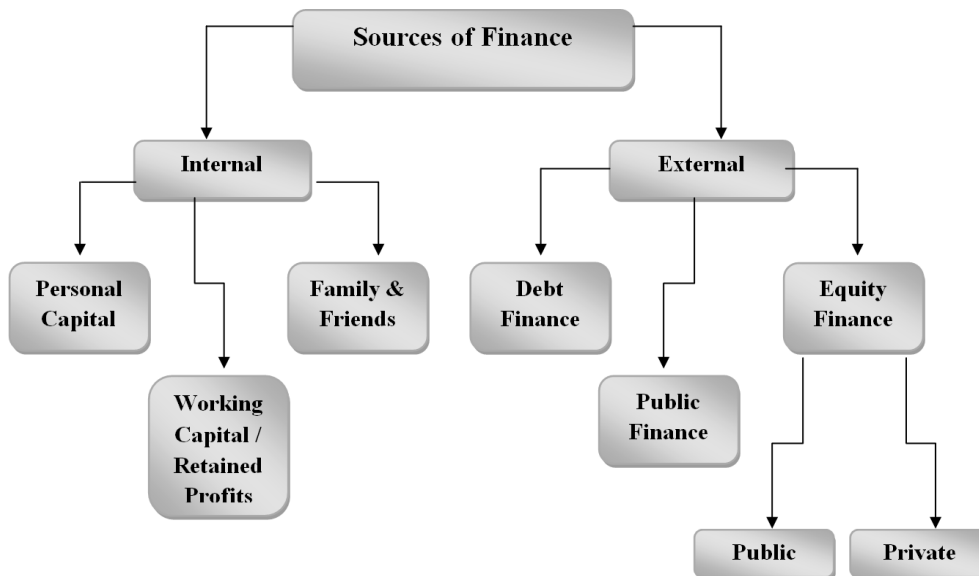


Figure 1: Sources of Finance

One type of internal funding is personal capital, where the entrepreneur invests his/her own money into the business or invests by foregoing his/her salary. Financing of a business therefore, often begins with the entrepreneur investing personal capital into setting up the business. Typical personal assets can include cash, shares, house and land to name a few. For example, Steve Jobs and Steve Wozniak, founders of Apple, started the company with \$1,300 in personal capital when Steve Jobs sold his Volkswagen micro-bus and Steve Wozniak sold his Hewlett-Packard scientific calculator. To finance additional growth, an entrepreneur may obtain capital from ‘family and friends’ who, as a group, will generally invest relatively small amounts. A third source of internal funds is retained profits (or earnings) which is income not paid out but instead reinvested into the business. However, businesses need to be up and running before they will have retained earnings to utilise. An alternative here would be working capital. This is essentially the cash required for the day-to-day running of the business. When larger amounts of capital are needed, entrepreneurs can attempt to obtain funding from external sources.

Externally, there are three options for raising capital. Firstly, there are various sources of debt. For example, a business loan or mortgage is a bank loan guaranteed for use by a business. Other sources of debt include business overdrafts, trade credit, leasing and hire purchase. Debt factoring (or invoice discounting) is also an option and involves a business essentially selling their debtor books (i.e., what customers owe) to a bank or financial institution which then advance funds on that basis.

Another source of external capital is public finance from government funded programmes. County Enterprise Boards provide various forms of financial assistance, including business priming grants, expansion/development grants and feasibility/innovation grants. Enterprise Ireland provides financial assistance to businesses in the form of grants. For example,

the feasibility study grant is available to assist businesses in investigating the viability of manufacturing a new product or process or to develop a new service. Enterprise Ireland also run an Innovation Voucher scheme, which will be open from 1st to 31st October 2010 and provides €5,000 for assistance in research. There are numerous such support programmes available from public bodies throughout Ireland.

The third external option is equity finance, a method of financing in which a business receives money in exchange for ownership. Raising equity capital is very different from raising debt, such as a bank loan. For example, banks usually require security such as a charge over assets of the business, will charge interest on a loan and seek repayment. Equity capital is invested in exchange for a share in the business and, as shareholders, the equity investors' returns are dependent on the growth and profitability of the business. One of the main benefits of equity finance, particularly in comparison to debt, is that investors assume the risk – if the business fails they lose their money. An equity investment is unsecured, fully at risk and usually does not have defined repayment terms.

Modern equity capital has its origins in America. In 1946 Georges Doriot, a professor at Harvard University, created American Research and Development (ARD) together with Karl Compton, president of Massachusetts Institute of Technology, Merrill Griswold, chairman of Massachusetts Investors Trusts, and Ralph Flanders, president of the Federal Reserve Bank of Boston. ARD was created to raise funds from individuals and college endowments and invest in start-ups in technology-based manufacturing. Now, over half a century later, equity has become the form of funding associated with entrepreneurial start-ups, especially in high-technology industries like biotechnologies, computer hardware and software, e-commerce, information technology and telecommunications. Many of today's most successful corporations were financed, in part at least, by equity, including Irish company Lily O'Brien's Chocolates, along with Amazon, Dell, e-Bay, Google, Intel and Yahoo to name a few. There are numerous forms of equity financing available to entrepreneurs.

The main source of equity is venture capital. This is the provision of finance for growth and expansion to companies with underdeveloped or developing products, usually at an early stage in their corporate lifecycle, or the provision of development capital to mature companies at a later stage. Venture capital is an investment made by professional investors, known as venture capitalists, who invest capital on behalf of third parties. Venture capitalists raise money from third parties such as insurance companies, banks, pension funds and private investors and, in Ireland, venture capitalists raise significant capital from government sources, such as Enterprise Ireland. With the capital raised venture capitalists form a fund and, during the fund's life, make equity investments. Venture capitalists often take an active role in the businesses they invest in, mentoring and monitoring investees. As described by Sean Gallagher of Dragon's Den "Banks give a loan, and then ask for interest payments. VCs [Venture Capitalists] make an investment and then they provide expertise and guidance".

Angel financing also represents an important source of equity finance. Business angels are wealthy individuals, many of them former entrepreneurs, who invest their own capital in emerging companies. Angels generally invest in young companies, at an early stage in their development, and can invest alone or as part of a group, usually in amounts that can range from €10,000 to €500,000. For example, in its early stages Amazon received a total of \$54,400 from two angels separately and \$937,000 from an angel syndicate comprised of twenty angels. Evidence suggests that in most vibrant entrepreneurial markets angel finance is the most significant, frequent and critical source of early-stage financing.

Public equity through government programmes is another source of equity. The Irish Government is actively involved in the equity financing of domestic businesses. The Business Expansion Scheme (BES) is one programme. The BES is a source of early-stage financing and has been in existence since 1984. The scheme allows an investor to obtain income tax relief on investment up to a maximum of €150,000 per annum. Enterprise Ireland also offers equity financing for manufacturing or service companies and high-potential businesses. Enterprise Ireland fund a number of equity programmes through its 'Seed and Venture Capital Programme'. The programme has promised €175 million to fund eight venture capital funds, which are in turn raising multiples of this amount from private investors.

Finally, corporate equity programmes provide capital to innovative, small companies, usually at an early stage in their development. For example, Intel Corporation and Johnson & Johnson both operate venture investment funds which focus on making equity investments in young innovative companies. Corporate venture capital involves a subsidiary of a large company making an equity investment in a small, usually young, innovative company.

## **Ireland's Equity Market**

The Irish equity market has grown tremendously in recent years. In 1997, total equity investments into companies based in Ireland totalled €39 million. By 2007 this had increased to €226 million, an increase of approximately 580%. Interestingly, Ireland appears to have weathered the fundraising storm brought about by the financial crisis better than neighbouring UK and Europe. Equity investment continued to rise in 2009 in Ireland, totalling €288 million, increasing by over 18% on 2008 investments of €243 million. Across Europe equity investment activity has slowed. According to the European Venture Capital Association the amount invested by equity firms fell by 27% in 2008 to €54.4 billion and reached only €23 billion in 2009.

Ireland has created a strong domestic equity industry over the past decade and the industry has experienced strong growth. Equity is an important source of funding for new, innovative businesses. The ability to weather the current downturn and uncertainty across fi-

nancial markets is remarkable. The European Commission recently stated that the current financial crisis, difficulties in accessing bank finance and a rapidly deteriorating European economy have heightened the need to establish an adequate equity source of financing for European innovative enterprises. It is crucial that the Irish equity market continues to attract capital from investors in order to ensure that innovative businesses have access to the funding they need to start and grow.

## Conclusion

According to the Global Entrepreneurship Monitor, Ireland has become one of the most entrepreneurial countries in the world. In addition, recessions often present great opportunity for innovative sectors of the economy. Entrepreneurs tend to emerge, with redundancies and downsizing providing experienced professionals who decide to start their own business. This can result in a new generation of start-ups which, according to Enterprise Ireland, are critical for future growth. However, businesses can only develop and grow if they have access to finance. The process of raising capital is complex and those outside the industry can have difficulty understanding financing options. With the Irish economy reeling from the banking crisis and property crash it is pertinent that sources of funding currently available to businesses are understood and investigated. Equity finance has become an increasingly prevalent method of financing businesses in Ireland and worldwide. The Irish equity industry has grown tremendously since the mid-1990s. Television shows such as 'Dragons' Den' highlight the growing popularity of equity financing. In the current economic climate, equity capital provides entrepreneurs with an opportunity to generate investment and seed capital to establish their business. There has been limited examination of the funding of businesses in Ireland. This research examines the financing of Irish businesses, providing a more in-depth understanding of the complexities of the Irish market for finance.

Jane Power is a student in the Department of Economics under the supervision of Dr. Bernadette Power and Dr. Geraldine Ryan. The author would like to acknowledge funding from the Irish Research Council for the Humanities and Social Sciences (IRCHSS)

# The digital age: an exploration of the influence of media on children's lives

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## Introduction

This research looks at how technology, and in particular visual media (television, Internet and video games), has influenced the lives of young children. In the last two decades the amount of children's media usage time has increased significantly, which affects their play, learning, interactions and development, particularly as consumers. To date there has been no in depth analysis of the nature of children's interactions with media and, this has led to the development of the following research questions:

- How are children affected by the technology they use?
- How many hours and what kinds of media are predominantly used by children?
- How and what kind of products are marketed to children?
- What is the effect of marketing on children?
- How has the role of children as consumers changed?

Children for the purposes of this article will be defined as between 0-10 years of age, due to the fact that research has shown that children do not fully understand the meaning of adverts; that they can coerce and persuade the viewer to buy something, until around nine years of age.

## Children and the Media

Contemporary childhood is characterised by early and frequent media use, preparing children for lifelong relationships with communication technologies. The home environment is an important and vital context as parents make technology available and play a role in socialising children to use media in specific ways. A wide variety of television channels are now available on digital television, including many channels aimed at even the youngest of children. Many of these channels broadcast programmes until the late hours of the evening and some run for twenty four hours of the day, seven days a week. Studies have shown that many children now have television sets in their bedroom and are therefore



watching television for many hours in the evening before going to bed. This can have an impact on their performance in school the next day, with many teachers reporting that children in their class have poor concentration and are very tired if they have been watching television until late at night. Children, however, are not just watching *child-specific* television channels; many children will watch television with their parents or older siblings and thus have access to programme content that is not suitable for their age group.

Due to the increase in recent years in media aimed directly at infants and toddlers, and the accompanying advertising, the youngest members of society are being exposed to more forms of visual media (television, video games and Internet) than ever before. Pre-school age children are uniquely susceptible to advertising, as children in this age group have problems distinguishing television programmes from commercials and also find it difficult to separate between reality and what they see on television, even if a programme is animated. Pre-schoolers are likely to view advertisements as objective statement of facts, that is, unbiased pieces of information designed to tell them about a toy or food product and they lack the ability to comprehend an advertisement's intention to sell. Contemporary children are very media savvy and live their lives surrounded by an increasing amount of digital, interactive media. It is our responsibility as parents, educators and carers to prepare them for this world but also to protect them from the undue influence of unscrupulous marketing. The primary aim of all marketing is to generate revenue and there are some seriously ethical questions which need to be addressed in relation to the nature, type and volume of media messages targeted at young children.

## **Types of Media Used by Children**

Television still remains the favourite and most widely used medium among children and television viewing time has not been displaced by other media. In fact, the time children spend watching television has stayed the same but time spent with media as a whole has increased with children now become regular Internet users and video game players. The Internet is now widely available in most homes, and the majority of children are competent computer users. If used, correctly, the Internet can be a fantastic tool in educating children and is used in many cases as a homework aid. However, the Internet does not have a rating system like television programmes, films and video games, and therefore it is very difficult to police what content is available and it is very easy for children to gain access to unsavoury and unsuitable material.

Video games, once the preserve of amusement arcades, are now commonplace in many homes. A European wide rating scale, *The Pan European Game Information* (PEGI), exists for video games, but research has shown that the majority of children do not play video games suitable for their age group. It was discovered that this was due to lack of parental awareness or knowledge of the rating scale for video games, as well as peer pressure

among children themselves to have the latest popular game. Many parents cited pressure from their children as a reason for purchasing the latest video game. Whilst there are some educational video games available, the majority of games that appeal to children contain some elements of violence and/or anti-social behaviour. There are, however, positive effects of video games provided that they are the correct kind of video games – ones that stimulate cognitive, physical and creative development.

Research has shown that many children are now media *multi-taskers* – using more than one medium at the same time. Media has also become convergent with many television programmes offering special episodes or competitions online. The attraction of television is the fact that it is ever evolving with recent advancements including digital and high definition television features. Another issue relating to media use is the lack of knowledge that adults possess about the medium. Children are essentially, *digital natives*, and other adults including their parents and teachers, digital immigrants. Digital natives have a very different style of learning, one in which they learn by doing rather than by following a set of sequential steps. They feel that *digital immigrants* speak a different language to them.

Technology offers extraordinary opportunities for all of society including children and young people. The Internet allows for global exploration which can also bring risks – the online world paralleling but also in some ways diverging from the offline world, and video gaming offers a range of interactive experiences to children; however, some of these are designed for adults. Many parents believe that it is no longer safe to leave their children play outside, however many dangers, termed *stranger dangers*, are being brought into the home through the technologies that children use.

The Internet and video games are very popular with children and offer a range of opportunities, for fun, learning and development. However, there are concerns over potentially inappropriate material, which range from content through to contact and conduct of children in the digital world. Children need to be empowered to keep themselves safe. Media can have many positive consequences too; however, it needs to be used correctly. Television documentaries and websites can afford the opportunity to learn a lot on different, sometimes obscure topics. Video games, provided they are the correct type of video game, can also aid children's learning. Many also argue that the media allows children to act out real life situations without the fear of danger or repercussions and that it allows a role play for real life within a secure environment. In the 21<sup>st</sup> century it is vital that children are media literate and familiar with technology. However, the role of parents and teachers is to show children how to use these media in a responsible way. This can be difficult due to the generational divide.

## Children as Consumers

The role that children play within the marketplace has evolved greatly in the last two decades. Previously, children were not regarded as active participants within the consumer process and marketers focused their attention on parents and guardians — the gatekeepers of the family purse — when promoting and selling children's products. A shift has occurred, however, and during the last twenty years children have come to be recognised as consumers in their own right, independent of their parents. This is due, in part, to the influence that the media and in particular, advertising, has had on the lives of children. The aim of marketers is to create *cradle to grave customers* and establish brands that children feel they cannot live without; to create something that is so important in the lives of children that they *must have it*, or if they do not have it they will be set aside as different from their peers. Proponents of marketing to children believe that they are *the brightest stars in the consumer constellation*.

Children are now regarded as occupying three distinct markets: the current market, future market and influence market. Research has shown that children now receive more pocket money than ever before and make more independent purchases, thereby making them a lucrative current market. In their aim to create the aforementioned *cradle to grave market*, marketers try to ensure that they attract children to brands or products that they may need in the future. This is done through savvy advertising and product placement. The *influence* market is probably the most important from a marketer's point of view. Various studies have reported that children have had influence on grand scale purchases such as family holidays or the family car. At a smaller level, children most definitely have influence over food purchases for the family and this has been linked in many studies to the influence of advertising

## The Study

This study utilised qualitative and quantitative research methods. Focus Groups were carried out with children, in 2nd and 4th classes, in Cork city, in order to ascertain their views on the impact that media has on their daily lives. A nationwide questionnaire was also distributed to a randomly stratified selection of teachers of 2nd and 4th class. The questionnaire was piloted locally.

The data is currently being analysed; however, some preliminary findings show that children are very media aware and spend a vast amount of time engaging with digital media. Television, for children in this study, remains the favourite medium; however, a substantial amount of time is also spent using the Internet and video games. Many children are also media multi-taskers. Teachers felt that the *media education* strand of the Social, Political and Health Education (SPHE) curriculum was sufficient, however they felt they were

constrained in their teaching by lack of time and resources. They also felt that ultimate responsibility for media monitoring and education lay with parents. The parents in this study were concerned about the amount of time their children spent using media and often felt that it was to the detriment of other activities, such as playing with older siblings or exercising. They also found it extremely difficult to monitor and in some cases control their children's media use. Both parents and teachers acknowledged that children were now savvy consumers, with teachers in particular commenting on the emphasis children now placed on material possessions. The majority of parents revealed that their children had a lot of influence on family purchases.

This research looked at how technology, and in particular visual media, has influenced the lives of young children. It has considered how young children, termed *digital natives* live in the contemporary technologically advanced world and how best we can support them in their development. In our rapidly changing and ever developing technological world we have a responsibility to ensure our children are educated to use media safely and well. We must educate ourselves so that we can take part in and monitor children's media use. It is very important for our children's future physical and cognitive health that there is a balance between media based activities and other play based pursuits.

Patricia Radley is a PhD student in the School of Education, under the supervision of Dr. Mary Horgan, Director, Early Years and Childhood Studies, School of Education, UCC.

# Mobile tools for building maintenance

**Paul Stack**

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## Mobile Computing in Facility Management

Imagine the ability to monitor and control your building systems from your mobile phone. With advances in Information Technology, the integration of mobile devices with building management and automation systems is rarely exploited.

Mobile solutions are currently being designed for personal communication and collection of information for various applications. The integration of mobile devices with inventory and stock systems, of which an example would be to check if spare parts are available for repair of a building system, like a pump, or if the part needs to be ordered. My research involves the use of building performance information, collected from sensors, meters and actuators for controlling building equipment, to support maintenance engineers and improve their decision-making process.

This research is part of a project named ITOBO (Information and Communication Technology for Sustainable and Optimised Building Operation). ITOBO focuses on applying optimised maintenance procedures based on building performance levels and delve into aspects of building control. ITOBO, the Science Foundation Ireland (SFI) Strategic Research Cluster for Sustainable and Optimised Building Operation, is undertaking research in Information and Communication Technology that will enable us to develop a holistic, methodological framework for life-cycle-oriented information management, and decision support in the construction and energy-management sectors. The specific goal is to develop an anticipating (smart) building that operates on an energy-efficient and user-friendly basis while reducing its maintenance costs.

Through the utilisation of data warehousing methods for collecting processing and analysing data from multiple sources, built on the flow of data from both the existing Building Management Systems (BMS) and an additional Wireless Sensor Network (WSN) deployment, a basis is provided to extract relevant aggregated building performance data for a maintenance management system. In order to deploy such a system, the Environmental Research Institute (ERI) Building, which is owned by UCC, is being used as our living laboratory.

The ERI Building incorporates green technologies for heating and generation of hot water for occupant requirements. Renewable technologies for renewable energy from solar and

geothermal heat require specialised maintenance routines for inspection, cleaning and repair in order to optimise operations and conserve energy. The mobile application for providing building performance and maintenance information must define a schema for these systems, their components, relevant performance measures for building operatives to identify inefficiencies, associated maintenance routines and maintenance task history. This information schema provides a basis for the context of the mobile maintenance solution.

Currently in Facility Management (FM), practices include scheduled maintenance and corrective maintenance tasks. These tasks involve inspection, repair and replacement activities to be performed by maintenance engineers. The engineer has to inspect what caused the problem, diagnose what may be the solution for this problem and, finally, implement a solution.

Over time, through the storage of electronic records of maintenance activities, a history profile of building equipment will be available to support further FM tasks within the recorded building(s). Allied with this history profile and coupled with building performance data, a maintenance engineer will be able to perform FM tasks far more effectively and save on energy wastage and overall maintenance costs. My research aims to address these issues by introducing a software platform to support the provision of building maintenance and performance data to facility managers and building engineers for more energy- and cost-efficient maintenance activities.

## **Data Representation of Building Performance**

The essential interaction and representation of building performance and maintenance information for stakeholders. Data must be presented clearly and unambiguously so the user can precisely interpret and trust what they see. Early attempts at displaying energy consumption data involved the use of graphs to inform the user of trends within their building systems. The onus is on the software application to display a message, an alert via sound in the form of audio alarms, or send email/text message to users in a manner that is acceptable and intuitive.

With respect to data representation, there is also the ability to provide a deeper insight into the operations of the building plant through the proper use of graphical methods. Tufte proposes a number of guidelines for graphs that depict building performance. These include the use of a grey grid outline for graphs, labelling which is clear and helpful; the maximum number of data streams recommended is six and font should be SansSerif.

An example of the user interfaces developed is presented in Figure 1. This view supports the graphical representation of energy consumption data, such as electricity, gas and water consumption. Peaks in energy consumption can easily be identified but the user can select

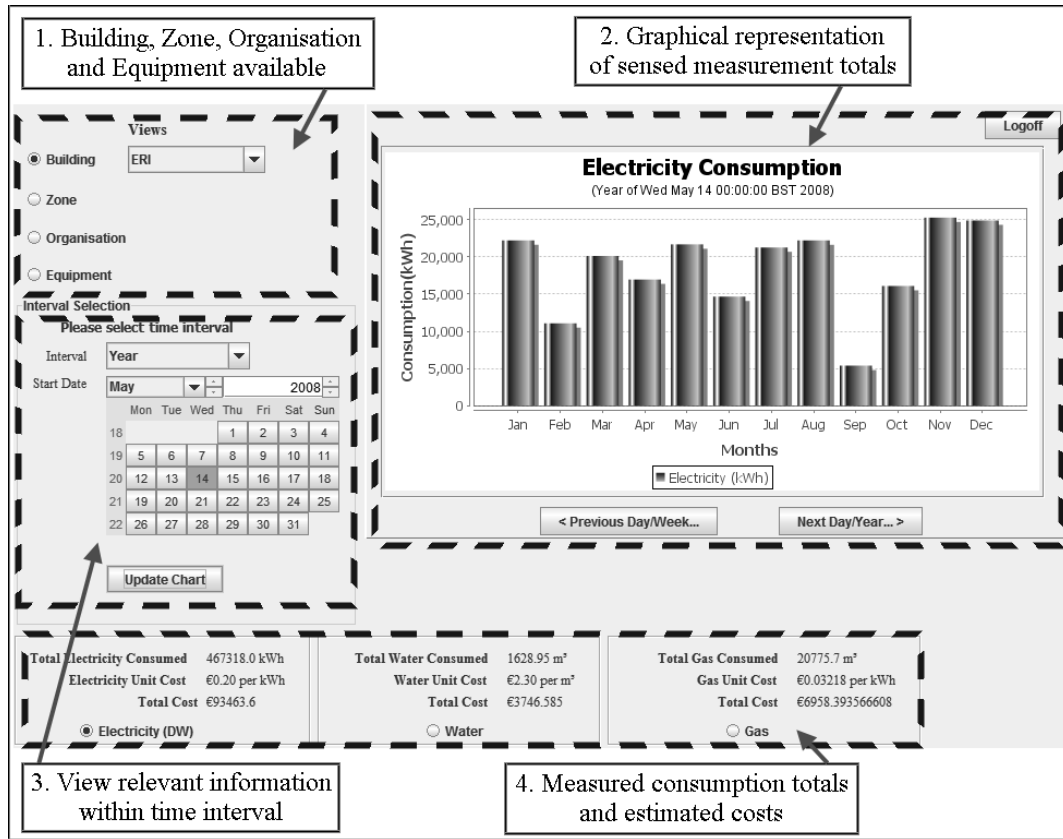


Figure 1: Building Engineer View displaying Electricity Consumption of ERI in 2008

a specific time interval to further evaluate the causes of excess consumption. Basic cost calculations are displayed that can enable an energy manager or a facility manager to improve planning for future budgets. Also, the view can be further refined to check on the different buildings that are being managed by the user and the building equipment being maintained by a maintenance engineer.

The resulting communication of information for Facility and Energy Management in buildings integrates multiple people in a variety of distinct technical roles with their individual responsibilities in respect to energy consumption. It assists energy managers in utilising building resources more efficiently and cost-effectively, as well as integrating the building occupants to allow them to be more environmentally-aware in their building resources usage.

### Building Performance Context Information for Mobile Devices

Following the presentation of building performance data, a mobile device is to be used to facilitate the building operative view. In order to provide building performance and maintenance data to mobile devices, a suitable information structure must be designed

to achieve a robust mobile application, with timely delivery of relevant data to building operative.

Applications within mobile devices can greatly benefit from the integration of context information in order to create a more effective user experience. Context rules were defined to provide an overall structure to the FM application. Access to relevant building performance and maintenance information is displayed to the user in a timely and effective manner depending on the user role and the location that the user works from. Other elements may include the type of device and the time that the user accesses the system, which also govern the data presented to the user.

To address the context of a FM domain application, four main aspects were evaluated in relation to the system user, maintenance location, user device and time of access.

#### **1. User Context**

Using predefined roles to classify system users, building operators are presented with user interfaces that are specifically designed for their day to day activities. The view of maintenance task information is complemented by relevant performance measures of the equipment they are maintaining. Each user is provided with a customisable menu system to enable quick access to core work screens.

#### **2. Location Context**

Users are presented with information about the location(s) they manage or inhabit. Building performance and maintenance data may be collected from multiple sites so user will want to view specific location information, from zone level conditions to building level energy consumption.

#### **3. Device Context**

Depending on the type of device, the user can access data over different networks, with differing screen dimensions and device data processing and memory restrictions. Catering for devices such as mobile phones and laptops is enabled through abstraction and hierarchies of building performance and maintenance information. With a user of a laptop, large graphs can be displayed, while a mobile phone user requires summary information.

#### **4. Time Context**

Users are presented with up to date information on the performance of their relevant building(s) when they log into the system. Quick access to timely data will assist the user in reviewing and analysing their facility more effectively. Monthly, weekly and daily information should be automatically collated and analysed automatically according to user requirements.

Figure 2 presents the Building Operative view to compare the performance of the heat pump, solar and underfloor heating circuits over a selected period of time. Other options will be available to cater for options such as heat pump coefficient of performance to other measures of defining heat pump performance levels, such as power consumption



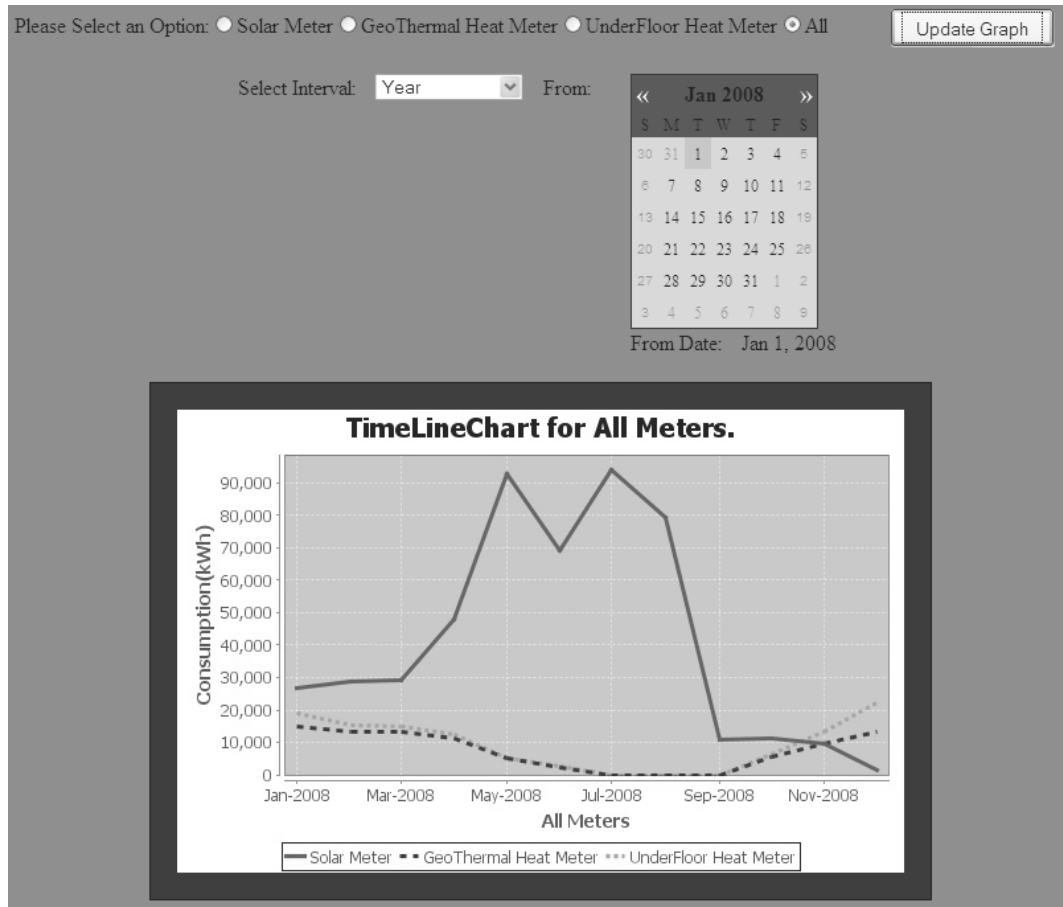


Figure 2: Building Performance View — Comparison of Energy Generation from Solar and Geothermal sources and Energy Consumption of Underfloor Heating in ERI for 2008

rate. They can enter the time interval they are interested in viewing, a diagram will be displayed, and the Building Operative can view normal or irregular performance of the selected building component.

In summary, a Web-based platform has been developed to support the provision of context-sensitive data to mobile clients to assist the decision-making processes of maintenance engineers. Providing building component performance and maintenance history gives a building operative, who is unfamiliar with system being maintained, an overview of problems and repairs on the device or system. With the availability of context-defined information, maintenance data is easier to access and easier understood compared to traditional BMSs.

Paul Stack is a student in the IRUSE Cork, Department of Civil and Environmental Engineering under the supervision of Karsten Menzel. The author would like to acknowledge funding of Science Foundation Ireland (SFI). Thanks to my supervisor Karsten Menzel and colleagues Zixiang Cong, Luke Allan, Yang Gao, Hang Yin, Yue Wang, Ena Tobin, Farhan Manzoor, Ammar Ahmed, Ufuk Gokce, Umut Gokce, Jason Quinlan, Paul Healy, Brendan Walsh, Donal Browne, Michal Otreba, Agnieszka Gdowska and Patryk Otreba.

# **Dutch, the Iron Lady and Latin America. The Anglo-American Special Relationship in Latin America under Reagan and Thatcher**

**Sally-Ann Treharne**

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Margaret Thatcher and Ronald Reagan made a formidable team in the international political environment of the 1980s. Their close working and indeed personal relationship shaped the future of Western European defence, facilitated the eventual fall of Communism, and brought international recognition to the Anglo-American Special Relationship. It was a testimony to a joint commitment to a renewal in transatlantic relations following a lull in the 1970s. Both leaders had vastly different personalities with Mrs. Thatcher often portrayed as Reagan's proverbial 'poodle' in such satirical shows as the infamous Spitting Image. However, in reality the relationship was in many ways led by the British Prime Minister who was willing to assert her considerable influence over her American counterpart at any given opportunity. The relationship ore, was indeed 'Special'. It went beyond the normal political protocol associated with bilateral cooperation and consultation. It was a relationship that endured many highs and lows during their simultaneous leaderships. It was an association based upon a mutual respect and admiration and a close familiarity that frequently impelled both leaders to forego their own national interests in order to safeguard the coveted Special Relationship. This was often, to the dismay of close advisers and administration officials. It is this unique and intangible bond which was invariably tested by numerous obstacles that makes analysis of the Anglo-American Special Relationship such a fascinating and challenging topic of research.

My dissertation focuses upon the Special Relationship under these influential world leaders. It assesses the impact of both Thatcher and Reagan's differing domestic and foreign policy objectives in the Latin American and South Atlantic region upon a renewal in close transatlantic relations on their accession to power. This region was of considerable importance to a Reagan administration that sought to roll back the perceived Communist threat in its own 'back-yard'. In order to deter the Soviet Union and Cuba from gaining a foothold in fragile countries in this politically volatile region the United States was prepared to undertake unilateral action which was often of dubious legality and covert in its nature. In contrast, the United Kingdom sought to distance itself from the region by promoting decolonization and self-government. At times, these differing foreign policy objectives clashed when both the United Kingdom's and American strategic hemispheric interests were threatened by the actions of the other. Although both leaders were united in their anti-Communist rhetoric, the region ultimately brought to the fore significant ob-

stacles which threatened to invalidate the relationship. Most notable were the cases of: the Falklands War in 1982, the US invasion of Grenada, a member of the British Commonwealth, in October 1983, the contentious Anglo-Guatemalan dispute over the territorial integrity of Belize and the infamous US involvement in Nicaragua. These cases and others challenged the strength of the Special Relationship and highlighted a political asymmetry which was detrimental to the future of Anglo-American relations.

## **Case Studies in Anglo-American interests in the South Atlantic and Latin America: The Falklands War and Grenada**

The Argentine invasion of South Georgia and the Falkland islands, after decades of protracted negotiations with the British, resulted in a conflict of interest for the Reagan administration. The United States was placed in the unenviable position of having to choose between two allies. On one hand Argentina provided the US with a non-Communist ally in the Latin American region. On the other the United Kingdom was a close ideological ally with whom the US had a well –documented, shared history. Mrs. Thatcher expected her American ally to support the British in the war and was disappointed when the US decided initially to remain neutral. My research assesses the crisis and Mrs. Thatcher’s attempts to convert the Reagan administration to the British point of view. It addresses the US Secretary of State, Alexander Haig’s mediation efforts, in what was termed ‘shuttle-diplomacy’ to resolve the issue and provides an in-depth analysis of Anglo-American consultation during this time.

The US invasion of Grenada was yet another obstacle in the path of continued and improved Anglo-American relations in the early 1980s. The decision by President Reagan to intervene in the internal affairs of one of the Queen’s dominions and to deliberately decide not to tell Margaret Thatcher of his plans resulted in a significant blow to the Special Relationship. The dissertation addresses the consequences of this decision upon the renewal in transatlantic relations. It also analyses the circumstances leading up to the invasion, particularly with regards to the legality of the invasion and Anglo-American consultation.

### **Belize and Nicaragua**

Yet another area of concern to the Special Relationship was the Anglo-Guatemalan dispute over the territorial integrity of Belize during the leaderships of Ronald Reagan and Margaret Thatcher. Guatemala had claimed the territory of Belize for centuries and the British were not prepared to cede on the issue despite the fact that Belize was looking for full independence from the United Kingdom. In the 1980s Britain agreed to grant independence to Belize within the confines of the British Commonwealth. Guatemala however, was not

prepared to recognise this and made sporadic threats to invade Belize. The Reagan administration decided to become actively involved in mediating the dispute but it would appear that it had its own strategic hemispheric interests in mind. The dissertation critically assesses these interests in order to determine their impact upon the Special Relationship and to determine their strategic importance to the government of Ronald Reagan.

Nicaragua was an area of considerable interest to the Reagan administration. It resulted in a very public condemnation of the US methods of assisting counterrevolutionaries which came to light in the infamous Iran-Contra scandal of November 1986 onwards. The research focuses upon Mrs. Thatcher's views of American unilateral action in the country. In looking at these and other issues that crossed over in to the Anglo-American sphere, such as, - the Laker Airways dispute and the Westland affair, the dissertation hopes to address the misconception that Mrs. Thatcher was in some way politically subservient to her American counterpart. It is necessary therefore, to provide a detailed analysis of Anglo-American Relations during the 1980s in order to highlight the importance of the above mentioned obstacles in the Latin American and South Atlantic region. In doing so, it will determine the validity of such a widely used term as the Special Relationship. It will also determine the joint commitment that both Reagan and Thatcher had to this relationship by striving to improve relations despite these many obstacles.

## **Accessing material in the United Kingdom and the United States**

As the focus of the research is contemporary history this brings with it some significant difficulties. It has proved somewhat problematic to gain access to all the relevant materials needed to provide a comprehensive analysis of the Anglo-American Special Relationship. It has been a challenge to gather the necessary information in particular in the United Kingdom. UK government rules dictate a thirty year gap between the historical events and the releasing of documentation pertaining to those events such as Prime Ministerial papers. A Freedom of Information Act (FOIA) request can be made for material, but this is a slow and often frustrating procedure. Therefore, it is often necessary to rely upon public records such as Parliamentary Bills, Commands, debates in the House of Commons and reports for example, as sources of information. These can be difficult and often time-consuming to navigate, but they are unfortunately, a necessary evil in the research process.

Margaret Thatcher's papers are located at the Churchill Archives Centre in Cambridge and have provided a limited amount of information due to the Thirty Year Rule. Consequently, one must look at other actors in her Cabinet at the time in order to gain an insight into the Thatcher government, its domestic and foreign policy objectives and, of course, its relationship with the Reagan administration. These include Nicholas Ridley, former Financial Secretary of the Treasury and Secretary of State for Transport, the Environment,

and Trade and Industry, John Nott, the Secretary of State for Defence and the leader of the opposition, Neil Kinnock. All of their personal papers provide interesting and revealing information on the Thatcher government and its policies during this period of time. These papers along with interviews of Mrs. Thatcher's close advisers and confidants such as Charles Powell, Mrs. Thatcher's Foreign Affairs Private Secretary during her leadership and Bernard Ingham, the Prime Minister's Chief Press Secretary, build a picture of her Premiership and of the woman herself. These interviews therefore, have been invaluable to the development of my research.

### **The importance of US archival research**

Greater access to primary documents is available in the United States principally, in the Ronald Reagan Presidential Library in Simi Valley, California. It is here that most of the information with the exception of some documents still deemed to be too sensitive in nature, are held with regards to the Reagan administration. There is a wealth of documents located in innumerable files that have to be slowly sifted through under the watchful eye of an ever-present archivist. These files although labeled, have yet to be indexed which ensures days if not weeks of back-breaking research. However, the pay-off is undoubtedly the little pieces of information found in White House cables, situation room messages or reports, that help tie your research together. The archives also provide significant material on the Thatcher government which is unavailable for access in the United Kingdom such as Prime Ministerial cables, messages and intergovernmental correspondence. Consequently, the Ronald Reagan Presidential Library archives have been an invaluable source during the research process. Gathering such information is both time consuming and expensive yet, it is ultimately very rewarding as it enables your research and argument to strengthen and develop in a clear and consistent manner. Thankfully, some financial assistance is available from the School of History in the form of competitions for travel bursaries. These bursaries proved invaluable as the Presidential Library in Simi Valley does not provide grants to overseas research students. Doctoral students in the arts, social sciences and humanities are not generally well resourced and have to depend substantially on personal funding. Therefore, the departmental travel bursaries were of significant help to me during the research process.

The Special Relationship under Margaret Thatcher and Ronald Reagan has been well documented by many noted academics and historians. Nonetheless, the Latin American and South Atlantic region has been completely overlooked as a vantage-point from which to assess this unusual bilateral relationship. This neglect ensures that preconceived notions about Anglo-American relations in the region that prevailed during the period in question can be tested against the evidence. The Special Relationship helped shape the policies of both leaders during a time of great political uncertainty. It was at times, besieged by obstacles emanating from the turbulent Latin American region. Individual strategic interests

in the hemisphere threatened at times to overshadow and possibly destroy both leader's tentative efforts to renew and strengthen Anglo-American relations. Yet the close working and personal relationship between President Reagan and Prime Minister Thatcher survived and indeed, flourished during this important period of Cold War history. Moreover, it is this commitment and desire to improve bilateral relations, to strengthen communication and cooperation in the face of often competing foreign policy objectives that makes the Anglo-American Special Relationship such a compelling area of research.

Sally-Ann Treharne is a final year PhD student in the School of History under the supervision of Dr. Mervyn O'Driscoll

# Building Management System to support building renovation

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## Introduction

Many publications have concluded that around 40% of the world's energy costs are incurred in buildings. The biggest energy users in a building are facilities which cover 40% to 60% of the total energy cost. In recent years, construction work undertaken in building renovation and rehabilitation has increased considerably. Technical renovations have always brought better building management. Modern technology has a more user friendly interface as well as giving us the successful management of building systems and associated reduced costs. In order to implement more energy efficiency in existing buildings, Building Management System (BMS) and Building Information Modelling (BIM) play important roles in the energy & cost savings of the building's life.

This paper emphasises the use of Information and Communication Technology (ICT) to support and justify essential building renovation that will improve a building's performance and decrease annual energy costs. We will present an introduction to BMS and BIM and energy costs analysis. BIM will not only support the BMS but also can be used to analyse building performance.

## The usage of Building Management System in building

A BMS is a system that not only provides automatic monitoring and control of services such as lighting, plumbing, fire services, heating, cooling and ventilation, but also supports comfort and energy efficiency. The objective of a BMS is to enhance building operational condition monitoring and control. The BMS is often an effective solution to cost conscious building management strategies and it enables employees and occupants of a facility to be more productive. Investing in a BMS can save more than 14% in annual costs measured in lost productivity, according to studies by the Atlanta-based American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). A Building Management System minimizes energy consumption and maximizes indoor comfort. A fully optimized BMS can save energy costs to the extent of 15%–20% as compared to a building without a BMS.

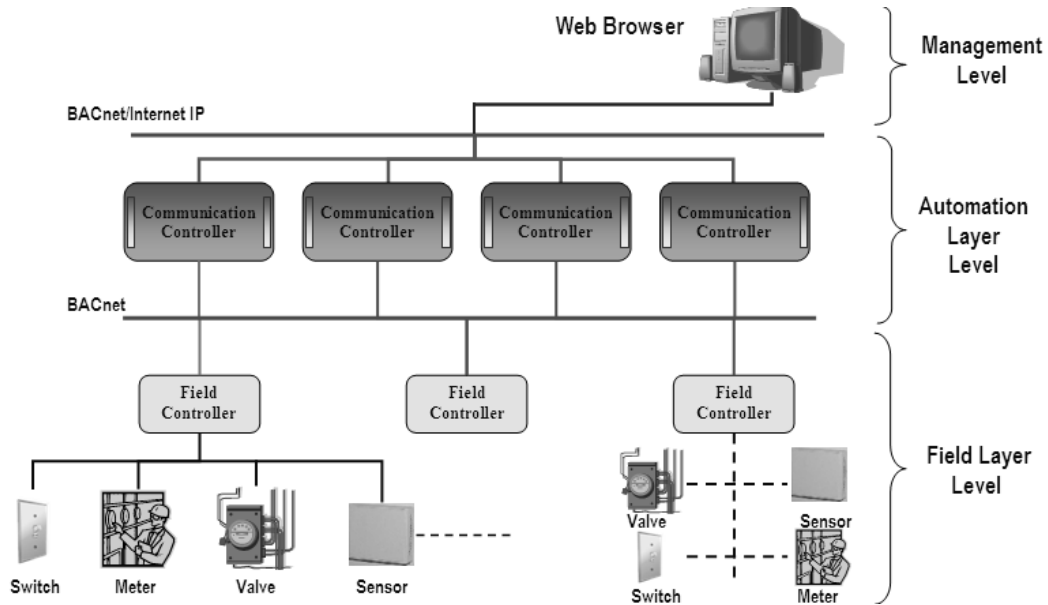


Figure 1: The basic structure of Building Management System

The primary motivation of this paper is to use a BMS to monitor a building’s operation and energy performance. This system can collect real-time data (e.g. temperature, CO2 and humidity etc.) from wired and wireless sensors. Real-time data collection not only provides a clear roadmap about how a building is performing but also delivers data for evaluation & ratification of a three dimensional (3D) model in BIM.

Generally, the BMS term covers all control elements, including hardware, controllers, any linking network and central controllers. A BMS consists of field layer level, automation layer level and management level. In field layer, filed controllers get a single or stimulus and respond from sensors, meters, switches or valves. The function of the automation layer is running and communication. When this layer gets data from filed layer, they transit them to an interface (Web Browser), which can display all information. The basic structure of a Building Management System is shown in Figure 1 as follows:

Our researchers and industry partners have successfully implemented a BMS into the Environmental Research Institute (ERI) building at University College Cork. The ERI is a 3 storey research building containing offices, meeting rooms, laboratories etc. The building’s owner carries out ongoing experiments into the operation of green buildings. In the ERI building the BMS is implemented to tracking various sensors and meters. It is also used for controlling environmental conditions in the building.

A sensor network is the most basic component in a BMS and the accuracy required needs to be specified at design. Building Information Modelling (BIM) provides a big opportunity to design the sensor network and store Sensors specifications.



## Building Information Modelling

BIM is the process of generating and managing building data during the life cycle of the building. Typically it uses 3D, real-time, dynamic building modelling software to increase productivity in building design and construction. It is a mature digital framework that models building components and their relationships.

In this paper, we will present two aspects of BIM application. Firstly, the BIM is always used to design sensors network and store BMS data. Secondly, it is used to make a building performance analysis through energy simulation modelling which can supply assistance to renovate old buildings.

### Define sensors requirements

BIM is an integrated database of coordinated information to which many participants in the design process contribute. It is the most appropriate medium for storing building and performance data to define sensors requirements during the BMS process. Building geometry, HVAC (Heating, Ventilating, and Air Conditioning) systems and lighting system must be instantiated in the BIM. A performance hierarchy that defines the sensor requirements in a building must also be instantiated and are in turn passed to the sensor network design tool. Sensor specifications are stored in the BIM after completion of the sensors network design (See Figure 2).

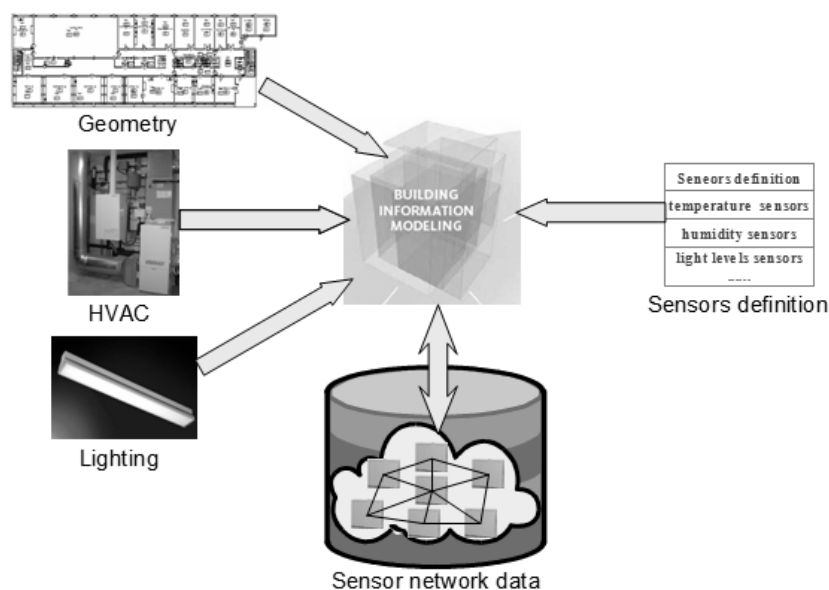


Figure 2: The role of BIM



The simulated Loads Report shows the actual total heating load as 218.7KW for the ERI building. Total energy usage = total heating load  $\times$  operation hours / boiler efficiency. Accordingly, the total energy usage per year is 572,994kWhrs (175kWhrs/m<sup>2</sup>/yr)

Figure 3: A 3D model of the ERI building

### Energy simulation model

In order to successfully improve the building's performance and reduce costs, a sustainable approach to analysis can be developed. BIM offers key information about the building that can be used to analyse its performance. The geometry, HVAC system and lighting system of the virtual building are stored in the BIM as 3D models. The simulation model greatly contributes to the understanding of energy utilization profiles in buildings and the building systems' impact on energy usage. Energy simulation models act as a data source for simulated performance metric generation. The BMS can be used to continuously monitor the building and provide data for calibration of the simulation model.

Autodesk Revit Architecture and Revit MEP is one software package to create detailed model. The geometric representation of an existing building can be created in Revit Architecture and the HVAC and light systems can be created in Revit MEP. An additional piece of software (limited IES VE Integrated Environmental Solutions) is embedded within a Revit MEP plug-in to simulate heating and cooling loads on existing model. We can compare actual energy consumption provided by the BMS with energy simulation, allowing a better evaluation & verification of the 3D model in BIM.

We have developed a simulation model of the ERI building. Figure 3 presents the 3D model for energy simulation. After simulation, a report is produced giving details about the heating and cooling loads for each room.

The simulated Loads Report shows the actual total heating load as 218.7KW for the ERI building. Total energy usage = total heating load  $\times$  operation hours / boiler efficiency. Accordingly, the total energy usage per year is 572,994kWhrs (175kWhrs/m<sup>2</sup>/yr) At the same time, we collected energy usage data from the BMS and then calculated that the figure of energy consumption including gas and electricity was 182kWhrs/m<sup>2</sup>/yr. It is clear that results provided by simulation and BMS only a 3 percent difference.

## Energy Cost Analysis

BMS control building system operations automatically and in the most efficient way possible in order to improve energy efficiency and reduce fuel use and costs. The total energy usage and annual cost of the ERI building from heating and electricity are summarised in Figure 4 below. The electricity of the ERI is from wind farm which is connected to the electric power transmission network. Therefore, the site is supplied by renewable power. Finally, Figure 4 also gives some benchmarking criteria provided by TM 22. According to the cost type, the TM 22 benchmarking criteria is 15.6 £/m<sup>2</sup> and 2.4 £/m<sup>2</sup> for Good Practice of electric annual cost and fossil fuel annual cost separately.

A comparison of the above results with benchmarks taken from TM 22 standards is presented in graph below:

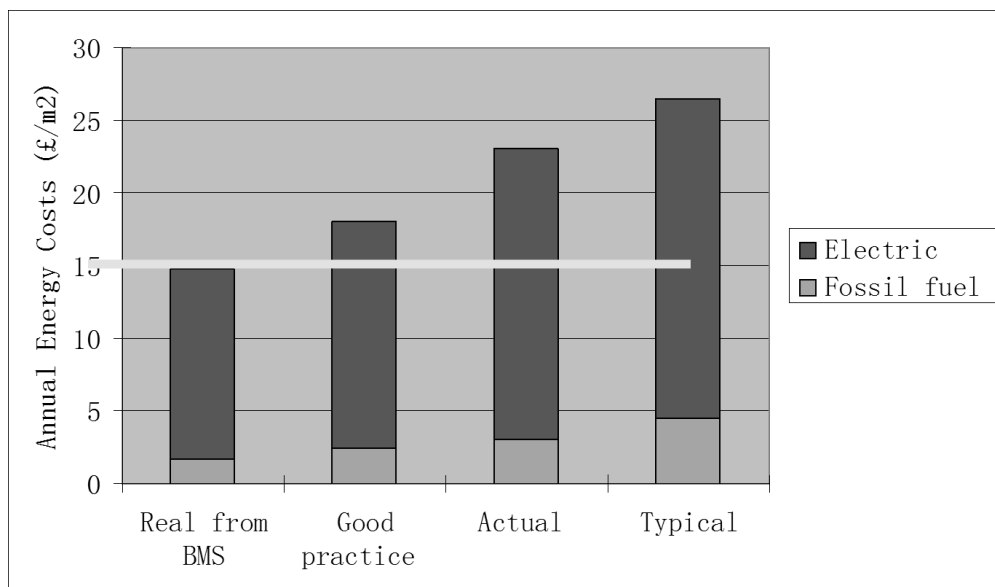


Figure 4: Cost analysis

## Conclusions

There are various smart technologies available nowadays that can help reduce energy consumption and cost of existing buildings. Occupants can install a BMS to automate building functions such as lighting and HVAC system and to allow the facility managers to prevent customer complaints and moreover can reduce the cost of operating the building by 15%–20%. According to the Energy Cost Analysis illustrates that the total cost per annum is 14.8 £/m<sup>2</sup> which is lower than annual costs for good practice according to the benchmark therefore indicating the excellent influence of BMS.

The BMS gives not only historical data but also real time data. The former is important

to owners and facility managers as it gives information relating to trends such as the maintenance required on a piece of machinery or the energy usage of users such as tenants and occupiers. Historical data is also important as it allows costs to be calculated and as accurately budgeted as possible. The latter case, real time data, allows facility managers and owners to make decisions as occasions occur. This is particularly important when considering user comfort. The BIM allows for the easy management of sensors that provide the required data on which decisions are made. It also gives a graphical representation that can be easily understood and utilised by the facility managers and owners. This has been adequately demonstrated in the case of UCC's ERI building.

BMSs have already been implemented in the world, such as Federal Ministry of Finance Building in Berlin, Beijing Bank Headquarters Office Building, Yang and Yamazaki Environment and Energy Building (Y2E2), etc. However, other smart technologies have been to develop for huge energy-saving and carbon-neutral building.

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