A life in science

Damian Murphy Music technologist

Left: *Damian setting up microphones for measuring the acoustics of a decommissioned nuclear reactor hall deep beneath the city of Stockholm*

Above: *Damian listening back to these virtual environments in the recording studio at York University*

Dr Damian Murphy is a Lecturer in Music Technology in the Department of Electronics, University of York. His work involves the physical modelling and acoustics of buildings and environments, both real and virtual.

I focused on sciences for my A-levels at school – maths, physics and chemistry – and went on to study maths at university. Here I became aware of a subject that captured my interest like no other: music technology. This is the science and technology associated with music, acoustics, audio and sound. When I thought back to the day my guitar teacher brought an electric guitar and portable recording studio into school I realised this career was meant for me. At 16, I built my own electric guitar for my GCSE craft, design and technology course. It won me a prize, but I admit it was nowhere near as good as the home-made guitar belonging to that well known ex-physicist turned musician, Brian May of Queen.

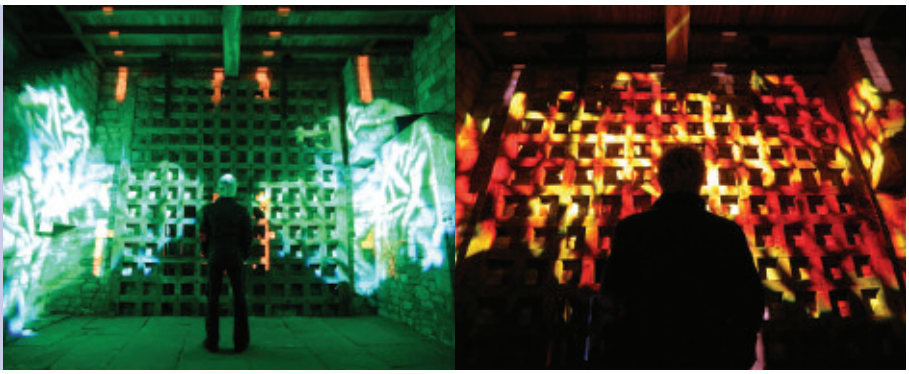
Studying sound

During my final year at university I applied for the MA/MSc Music Technology course at York University – the first such course in the UK and still one of the few available. I started the following year. The course gave me a thorough grounding in electronics, signal processing, acoustics and computer science, all as applied to music, composition and recording. My final project involved using maths and physics to synthesise the sound of strings and membranes, in what is known in the field as **physical modelling**. Compared with the synthesisers of the time, this new method created sounds with a previously unheard realism and naturalness.

I went on to do a PhD, looking at how these fundamental ideas could be applied to modelling the acoustics of a room. I am still exploring how to physically model sound-wave propagation within a space (Figure 1). Most other models approximate the complex behaviour by copying the way in which a ray

Box 1 *A Sense of Place*

One of the most important things about my work for me is that the results obtained from the maths and science used day to day to solve problems in acoustics and audio are used to create music. *A Sense of Place* was a sound and light art installation on which I collaborated with other artists. It recreated the measured acoustics of York Minster in a much smaller and more enclosed environment.



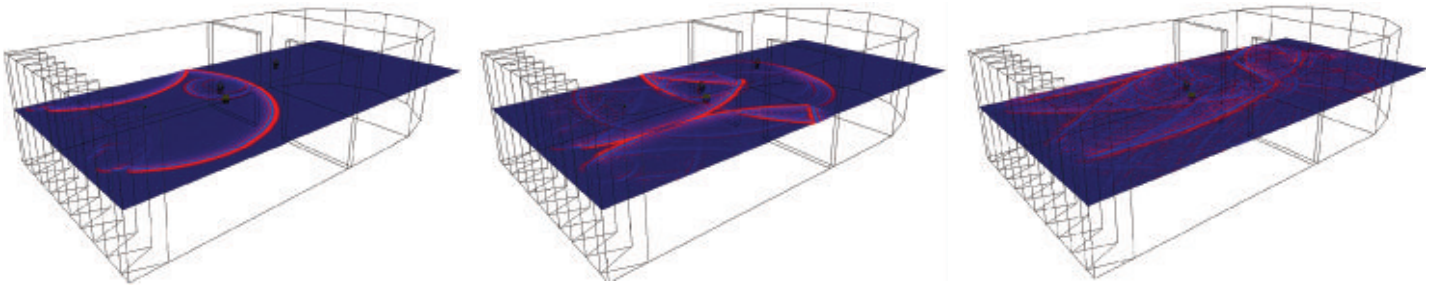


Figure 1 *An example of sound-wave propagation through a computer based virtual model of two (linked) spaces. Notice the reflection, diffraction and interference patterns that arise as a consequence of the underlying wave-based modelling technique*

of light might travel around a room, bouncing off mirrored surfaces. Although this is a good approximation, it is very poor at low frequencies, where isolated resonant frequencies and wave effects such as diffraction are evident. The models I am working on with my team are based on actual wave motion, and so give a truer representation of the acoustic properties of a simulated space.

Virtual spaces

In applied music technology, it is important to listen to the sound heard in various different acoustic environments. This fundamental process is used in nearly all modern music production. Physical models allow sound engineers, composers and computer musicians to use simulation to listen to the way in which a particular environment will shape and influence sounds and music. A simulated space can be tweaked and altered so that the music sounds just right. This opens up a whole new acoustic canvas, allowing access to 'spaces' that no longer exist or are simply impractical to record in. We can construct spaces that are limited only by our imaginations.

Outside of the music industry, this research is proving useful to architects who can listen to how their buildings will sound long before the foundations are laid. This can help them to avoid costly errors. We have presented this work at meetings and conferences around the world in cities including New York, San Diego, Montreal, Stockholm, Madrid and Verona. The team has also been exploring how its work might be applied to a very different acoustic space — the human vocal tract — with a view to synthesising realistic and natural human speech. How close have we got to this? See the links in Box 2.

Acoustic archaeology

My multidisciplinary approach to teaching and research, combining aspects of music and creativity, physics and maths, led to me being appointed as an arts/science research fellow by the Arts and Humanities Research Council and the Arts Council England. Rather than simulating the sound of virtual spaces, this project involved the acoustic measurement of some important architectural and archaeological buildings across the UK.

Once captured, this acoustic information can again be used as part of the music production process — playing back audio tracks in unusual, interesting and beautiful sounding environments without the musicians ever having to be there. The data can also yield information about the buildings themselves, their construction and even how they might have been used by the original owners.

This work has involved me crawling down Neolithic burial chambers in the middle of a winter night in Orkney, climbing up ladders to place microphones in the rafters of churches, and spending the night in Europe's finest Gothic cathedral. I have even worked in a subterranean nuclear reactor hall (happily long-since decommissioned) beneath Stockholm, and will soon experience the lingering smell of over 100 years of chocolate production at Rowntree, in one of York's oldest and most iconic buildings.

Box 2 Useful websites

- Find out more about *A Sense of Place* at: www.boothambar.org.uk and www.renaissanceyork.org.uk
- You can find out more about the acoustic measurement work and the spaces measured so far, as well as listen to their 'sound' at: www.space-net.org.uk/IRs.html
- Listen to what a physically modelled human voice or vocal tract might sound like at: www-users.york.ac.uk/~dtm3/vocaltract/
- More general information about Damian's work is available at: www-users.york.ac.uk/~dtm3/

Brian May of Queen is at present completing the PhD he gave up many years ago to be a rock musician. He has just published a book written with Patrick Moore and Chris Lintott: *BANG! The Complete History of the Universe*.

Answers to Chemicals made from salt, page 17

1A Hydrogen is used to hydrogenate vegetable oils to turn them into margarine.

2B Sodium is used in the manufacture of indigo which is used to dye blue jeans.

3E Sodium hypochlorite solution is known as domestic bleach.

4D TCP is a solution of chlorinated phenol.

5C Sodium hydroxide is used in the manufacture of ceramics.