Robin Fearon

Robin Fearon is features editor for a veterinary science journal and has also worked as editor for the *WhatsOnUK* guides as well as writing for the *Daily Mirror*, *Muzik*, *Tatler* and *TNT Magazine*.

A simulated world

Virtual reality is bringing scientific data, historic sites and adventure travel to life

Virtual environments are using immersive systems and users' desktops to create greater scope for their application in science, training and entertainment. *Robin Fearon* investigates how UK researchers are exploiting the potential of virtual reality

Go back 15 years and you would have struggled to hold a conversation with anyone about virtual reality. Only vague notions about interactive graphics made their way into the mainstream and it all looked incredibly complicated. Today we exist side by side with the virtual world and millions tap into its power every day.

Industry has long been wise to the power of virtual environments. Big companies and institutes use virtual reality (VR) to create digital visualisations of brains or building plans. They use it to simulate war zones in order to drill soldiers and to treat post-traumatic stress. They train surgeons and fire fighters, even astronauts, using VR. It's a story about possibilities.

Multiple applications

Roger Hubbold, research group leader at the University of Manchester's Advanced Interfaces Group (AIG), has seen it all. As professor of virtual environments, his group has developed visualisation software for bioscientists that searches for keywords in

scientific papers then uses the data to bring it to life on the screen, allowing the user to recreate the same experiment.

AIG's 'phantom limb' project draws interest from medical experts and amputees across the globe for its use in therapy. By wearing a VR headset with a graphical representation of the missing limb, users see their body with the limb attached and are able to control it in virtual space to relieve the pain. 'We get requests to use it where nothing else has worked,' says Professor Hubbold. 'It is remarkably effective.'

These projects are building blocks in a world where the virtual and the real are interconnected. In fact, VR gives users real power to influence the world. Look at any city skyline – many modern buildings started life as 3D graphic models. 'Right now we are working with a firm of architects to assess the impact of changing building designs,' says Hubbold.

'Building virtual representations of real places is still a big challenge. The Daedalus

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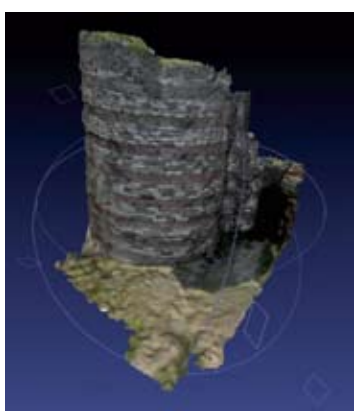
Project at AIG has particular interest to cultural heritage sites where you may want to build a visitor centre next to an existing ancient site, and you want to assess the visual impact. The problem is modelling the existing site and exploring it in 3D,' continues Hubbold. Daedalus has parallels with online tools such as Google Streetview and Microsoft's Photosynth project, which takes thousands of pictures from the web of well-known locations, such as Notre Dame Cathedral, and stitches them together to create a 3D effect. 'It is meant to function as an online virtual-tourism tool.'

Francho Melendez, a PhD student from Spain, works on Daedalus to make improvements to its system of 3D reproductions from two-dimensional images. 'We take lots of pictures of the building's exterior and then try to reproduce that in 3D with different lighting conditions,' he says. 'It is really useful for architects but it is also useful in any kind of media production because you can render quick models for movies and special effects. It was developed for use with listed buildings but we want to keep the remit as broad as possible. Of course, you could model it manually but it takes a long time. This process is much quicker,' he comments.

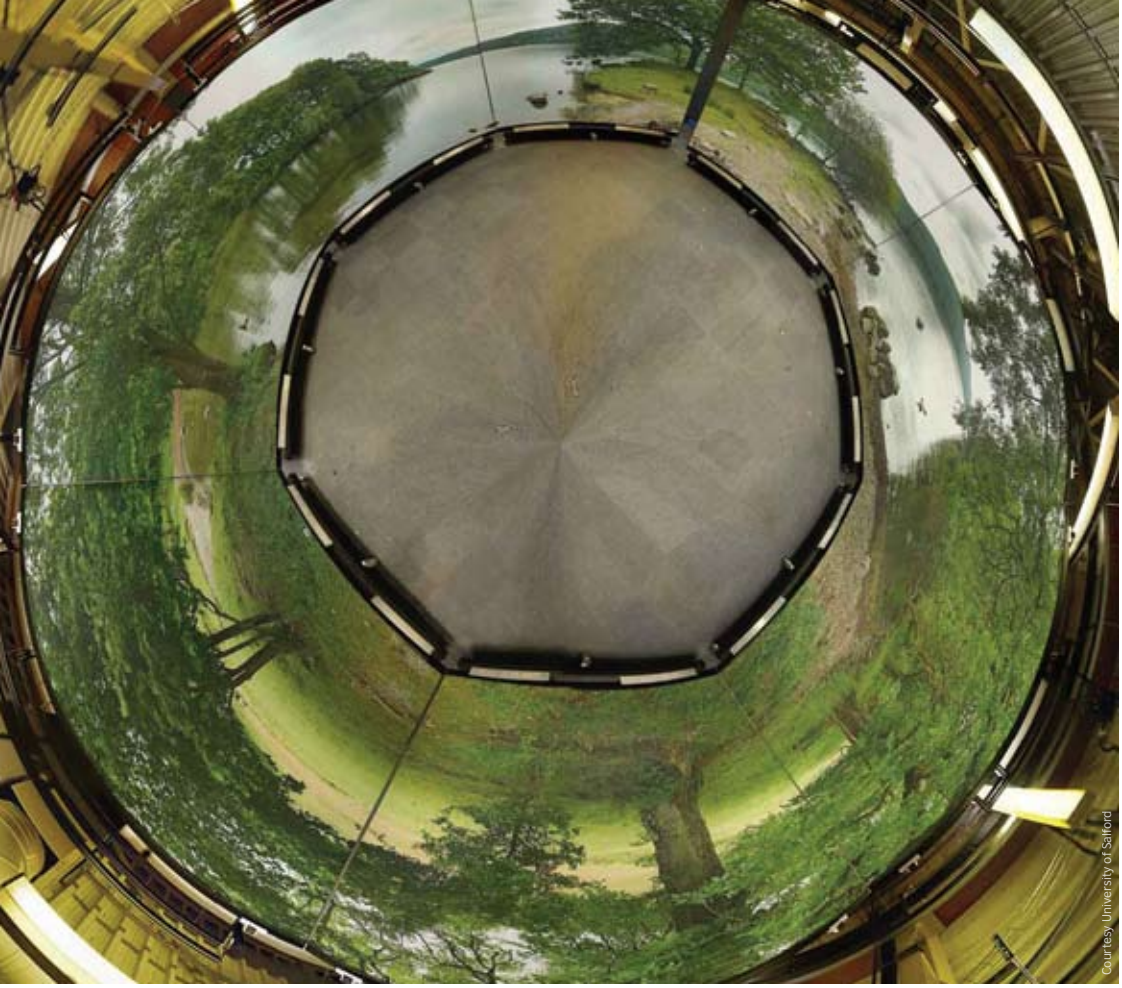
Total virtuality

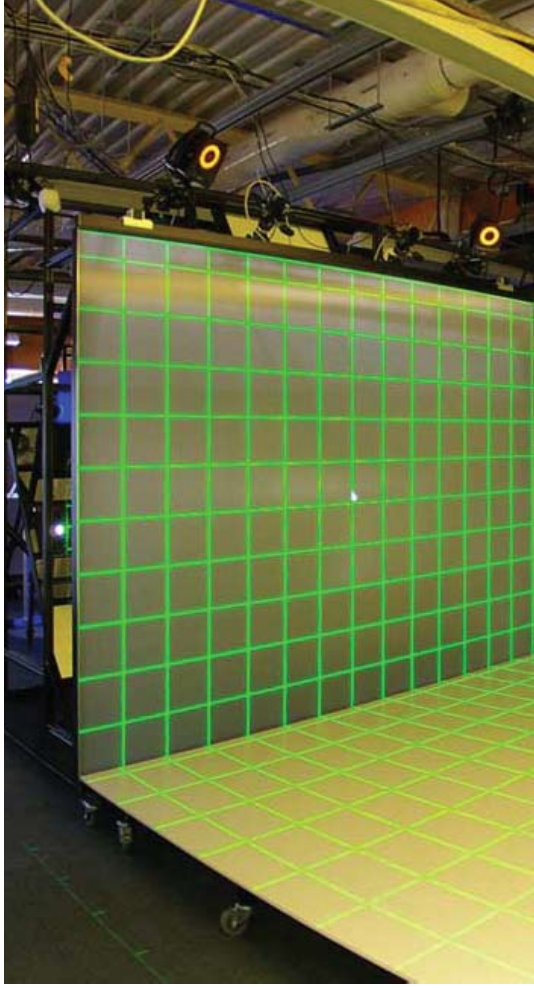
The problem with VR in the past was a reliance on clunky hardware. Developers used (and still use) 'immersive' systems with bulky headsets, tracking devices and data gloves. People stood in 'caves' – five- or six-sided rooms – using projection systems to create a totally enclosed virtual world. But out of that research came the concept of 'avatars' – digital representations of people – and now avatars are commonplace thanks to online role-playing games like Second Life.



Top left Reconfigurable octagonal projection system at the University of Salford

Above As part of the Daedalus project, Yoros Tower in Turkey was created from photographs





Left Octave system viewed from above

Above Calibration in five-wall mode at the University of Salford

Now that virtual worlds are available on desktop and laptop systems, it has democratised the technology, taking it out of research institutes and into everyday life. Dr Sue Cobb is director of the Virtual Reality Applications Research Team (VIRART) at the University of Nottingham. She believes that desktop systems are essential in VR because they are affordable and practical solutions in the real-world scenarios her team tackles.

VIRART's projects include helping special-needs students to do everything from crossing the road to making a cup of tea. Students with learning disabilities use the virtual environment to practise life skills then reproduce them in reality. The group also has tools to help autistic children practice social skills.

'We present the 3D environment on an ordinary PC or laptop because if we are aiming to provide this to schools they would not buy expensive immersive systems,' says Dr Cobb. 'Because it is digital space you can build whatever you want. You can simulate life as it really is or you can build new worlds that don't follow the same rules. What purpose that serves is open to interpretation. We work in clinics and classrooms and we can't be too futuristic because it would not have any place there at this time. Our ideal is that at the end of any project the technology stays where it is needed and they use it.'

Cost-effective alternative

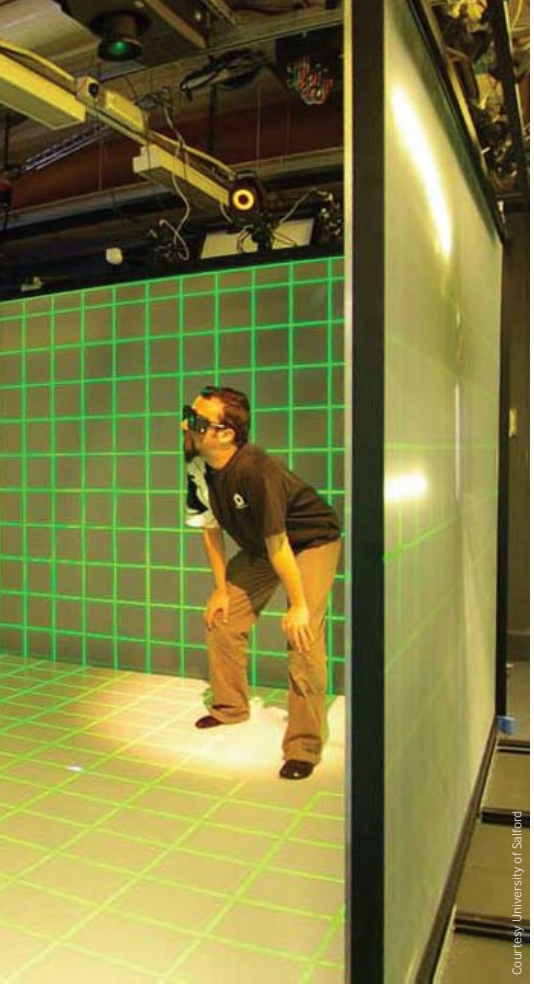
It's a practical viewpoint and one that Hubbold agrees with to an extent. His group stopped using immersive systems because of the cost and discomfort for users. 'We stopped using head-mounted displays because the quality is not up to the job,' he says. 'Engineers wear them and say they're great for the first couple of minutes, then complain about how hot they are. We also worked with Sharp for years on stereo-projection systems. They are used mostly in the automotive and aerospace industry, but they are expensive,' he adds.

'You could walk around a model at the design stage and look for problems and see how to do maintenance. We stopped doing it because of the sheer cost in time and money of keeping large installations up and running,' says Hubbold. 'We have refocused a lot of what we do on the desktop or laptops because it is more affordable.'

It is a moot point that not everyone in the VR research community is willing to concede. There is an alternative movement pushing for improvements in headset and projector technology so that we can all enjoy the benefits at home.

Understanding users

John O'Hare is technical director of the Centre for Virtual Environments at the University of Salford. His group wants to bring VR into everyday life using displays mounted on the walls of offices and homes. 'The perfect simile is like the "holodeck" out of Star Trek,' he says. 'The BBC started this research because they wanted to look at the living room of the future. When displays and computers are embedded everywhere, the idea is that you will be able to turn round and talk to your friend who is


Courtesy University of Salford

watching the same football match with you on TV, but they are in Australia,' he says.

'The real aim of VR systems is to get a stereo image into the head of the user. For that you need left- and right-eye projection. Auto-stereoscopic systems will evolve to track what both eyes are doing. We could even see laser-tracking devices in mobile phones to project images onto the back of the eye, in which case you can overlay images anywhere at any time.'

Virtual reality may have found its way into business through design, training or engineering, but the mass market for it is in games and entertainment. There is a complete spectrum of game possibilities with a mix of virtual and real-world play. Researchers call it the 'virtuality continuum' with real world at one end and virtual at the other. For people like Steve Benford, professor of collaborative computing at the University of Nottingham, VR is essentially about fantasy and immersion in a world that is different, but similar to, reality.

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'I don't see games and art as being a sideshow, I think it is what VR is all about,' he states boldly. 'We created a game called "Can you see me now" and toured it across 20 cities worldwide. People had to log in to a virtual world online – a city – and they played a game of chase, but the people chasing them were running through the streets of the actual city with GPS trackers. At one level we did it because we believe in art and entertainment and their cultural applications, but it is also a good way of experimenting with ideas that will eventually become mainstream.'

Stimulating the senses

Entertainment may drive us towards better technology but there are some challenges to come. VR systems that deliver more than visual and audio reproduction need much more investigation. 'The ability to deliver touch is limited,' says Professor Benford. 'In the other senses it is much worse.'

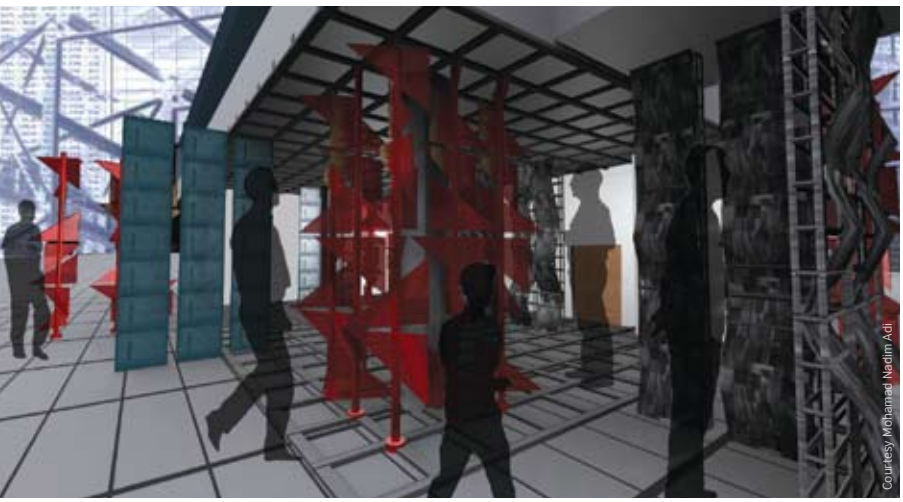
Step up to the plate the 'virtual cocoon' project. Devised as a joint project between the universities of York, Warwick, Bangor, Bradford and Brighton plus industry partners, the aim is to develop a prototype VR helmet that can stimulate all five senses. The developers label it 'real virtuality'. One of its threads is to deliver the sensations experienced driving around a wildlife reserve in South Africa. Yet another idea is to create a virtual ancient Rome. It is a spin on the virtual tourism aspect of Photosynth, an interactive way to share your photos in 3D, but with much more depth and potentially massive educational and even environmental impact.

'Virtual tourism is eco-friendly,' says Warwick's project leader, Professor Alan Chalmers. 'We should not be travelling


AFP/Getty Images

Above A recruiter participating in a virtual job fair on Second Life

Below Interactive design testing in a virtual environment



so much because it damages areas of the planet. This project is socially inclusive in that it allows more people to go to game parks and provides a business model for their upkeep, because we believe that many people would pay for this experience online.'

The prototype has been commissioned using UK Research Council funding. Professor Chalmers says the safari vehicle will have two cameras for eyes, two 3D microphones for ears, an electronic nose for smell and devices such as thermometers and accelerometers to deliver tactile senses. This will all be transmitted over a network and reproduced in the cocoon. Your reactions to it will be monitored and transmitted back to the remote unit. 'There will be lots of other applications, I'm sure, which is why we are developing these tools so other people can tell us what they want,' adds Chalmers.

York's research coordinator on the cocoon project, Jude Brereton, says these first few steps open up a vista of future research, but cost is an issue they cannot ignore. 'You always find that the first version of anything is costly – though we reckon an entry-level device might only cost £1,500. They are normally taken up by early-adopters, then the technology becomes cheaper, more mass-produced and spreads throughout society,' she says. 'But as long as it is user driven it will be successful.

'Eventually VR systems will be as ubiquitous as a mobile phone and as portable – everyone will want to have one,' Brereton continues. 'People want to interact with each other not just the machine. If we get it right people will not just be interacting with a simulated world, they will be interacting with their family sitting next to them on the sofa or on the other side of the world.'

With the evolution of interactive gaming consoles such as the Wii, we already have the potential for sensing and tracking users in their own homes. Bigger more immersive screens and displays will enhance the interactive virtual experience. Give it a few more years and five-sense virtuality could be commonplace. VR's only limit, it seems, is our imagination ■

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Further information

Advanced Interfaces Group,
The University of Manchester
http://aig.cs.man.ac.uk

Centre for Virtual Environments,
University of Salford
www.cve.salford.ac.uk

Communications Research Group,
The University of Nottingham
www.crg.cs.nott.ac.uk

Department of Electronics,
University of York
www.elec.york.ac.uk

The Digital Lab,
University of Warwick
http://digital.warwick.ac.uk

Towards Real Virtuality,
EPSRC Research Cluster
www.towardsrealvirtuality.com