

Impact case study (REF3)

Institution: University of Glasgow (UofG)		
Unit of Assessment: 30 Philosophy		
Title of case study: Using immersive technology research and collaboration to catalyse creation and development of an SME		
Period when the underpinning research was undertaken: 2016–ongoing		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Fiona Macpherson	Professor of Philosophy	2004–present
Neil McDonnell	LKAS Fellow for Virtual and Augmented Reality	2016–present
Nathan Wildman	University Lecturer	2016–2017
Adam Carter	Reader in Philosophy	2017–present
Period when the claimed impact occurred: 2016–31 st December 2020		
Is this case study continued from a case study submitted in 2014? N		
<p>1. Summary of the impact</p> <p>UofG research into Virtual Reality (VR) and its pedagogical value helped create and transform tech start-up business Sublime Digital, leading to rapid growth and over GBP700,000 government investment for design and delivery of 10 VR learning environments and their innovative data-gathering platforms. Responding to Covid-19 constraints, this UofG/Sublime project, <i>Mobius</i>, shifted from teaching in VR labs to project <i>Edify</i>, enabling delivery of a VR experience without students needing VR equipment, using software like Zoom. <i>Edify</i> attracted GBP1.3 million additional investment, further transforming Sublime, and was rolled out in Autumn 2020 to 26 UK HEIs and 27 HEIs across 5 continents. Sublime sold 60 commercial licences by the end of 2020.</p>		
<p>2. Underpinning research</p> <p>Since 2016, Fiona Macpherson and Neil McDonnell, with contributions from colleagues Adam Carter and Nathan Wildman, have built a body of research into the features and benefits of Virtual Reality Experiences (VREs). This research addresses the nature and value of VREs: what they are, how real the objects encountered there are; and conferred benefits such as skills acquisition – without the disadvantages or barriers that the equivalent real-life experience would bring. These insights into the perceptual and metaphysical ‘reality’ of VR have clear application in teaching contexts, which in turn has allowed testing of the concepts.</p> <p>Generalising from concrete examples, McDonnell has researched features of VREs and a conceptual framework describing how VR can be fruitfully utilised [e.g. 3.1]. VR enables access to places that are impossible to go (e.g. because of danger, scale, distance), and activities that are impossible to do (e.g. because of the laws of physics), without the cost or consequences. McDonnell then applies metaphysics to argue that causal structures encoded in VREs allow users to genuinely learn and acquire skill [e.g. 3.2]. His fictionalist position is that virtual objects are not genuinely real, meaning that these benefits accrue, again without the ordinary causal consequences. McDonnell and Wildman [e.g. 3.3] argue that fictionalism is compatible with virtual objects having a value, not through their reality but rather through the VREs they provoke.</p> <p>Macpherson [e.g. 3.4–3.5] directly applies her work on the philosophy of illusion and hallucination to explore the nature of perception in VR, arguing against the two dominant views of VREs: (1) that they are completely illusory or hallucinatory, or (2) that they are completely accurate perception of a virtual world. Macpherson argues that in some VREs properties can be genuinely perceived, without the perception of real objects that possess them.</p>		

In VR it is possible to see the properties of an object as it interacts with the body, for example, without access to that object. Finally, and resonating with these conclusions, Carter examines the role that technology, like VR, can have on the acquisition of cognitive capacities, and argues that, despite threats to intellectual autonomy, educational benefits can accrue through its use [e.g. 3.6].

The body of work supports the central, philosophically justified insight that the distinctive power of VR is its ability to enable people to perceive and do otherwise impractical or impossible things, without the usual costs or consequences. A key insight of this research is that VR offers the opportunity for genuine perceptual experience, learning and skills acquisition, which Macpherson and McDonnell began to investigate in connection with the challenges of HE teaching, inspiring a longstanding collaboration with industry tech specialists. The framework they have developed led to applied examples such as the virtual physics laboratory, which enables users to change the laws of gravity while conducting experiments. The virtual hillside of Arran (Figure 1) allows geology students to repeatedly practise measuring unique rock formations, otherwise impractical due to cost, distance, and physical access. And the virtual molecule viewer makes users the same size as any protein molecule from open-access scientific databases, including Covid-19, allowing them to rotate it, see its otherwise undetectable features, and interactively investigate its properties.

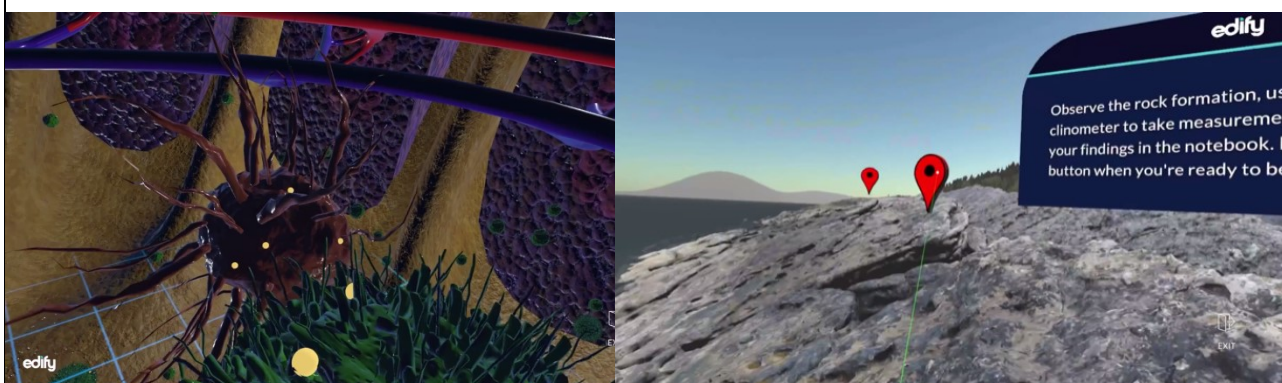


Figure 1: Cells interacting in VR (left) and the hillside of Arran (right)

3. References to the research

- 3.1 McDonnell, N. 2019. Immersive technology and medical visualisation: a user's guide. In: Rea, P. (ed.) *Biomedical Visualisation*. Series: Advances in experimental medicine and biology, 1156. Springer, pp. 123–134. <http://eprints.gla.ac.uk/184498/>
- 3.2 McDonnell, N. and Wildman, N. 2019. Virtual Reality: Digital or Fictional, *Disputatio*, 11(55), pp. 371–397. <http://eprints.gla.ac.uk/175089/>
- 3.3 Wildman, N. and McDonnell, N. (2020) The Puzzle of Virtual Theft, *Analysis*, 80(3), pp. 493–499. <http://eprints.gla.ac.uk/210232/>
- 3.4 Macpherson, F. and Batty, C. 2016. Redefining Illusion and Hallucination in Light of New Cases, *Philosophical Issues*, 26: 263–296 <http://eprints.gla.ac.uk/117973/>
- 3.5 Macpherson. 2020. Is Virtual Reality Experience, Veridical, Illusory or Hallucinatory? A Complex Answer Based on a New Theory of Illusion and Hallucination and the Nature of the Technology Used to Create Virtual Reality. (Working Paper.) <http://eprints.gla.ac.uk/226457/>
- 3.6 [Carter, J. A.](#) 2017. Intellectual autonomy, epistemic dependence and cognitive enhancement. *Synthese*, 197(7), pp. 2937–2961. <http://eprints.gla.ac.uk/146903/>

Quality: These publications (except 3.5) are in peer-reviewed journals, and the body of work is expected to meet or exceed the 2* threshold.

4. Details of the impact

The impacts arising from this UofG research comprise a significant contribution to innovation and entrepreneurial activity, including:

- the creation, development and expansion of SME Sublime Digital Ltd
- improved access for that company to finance opportunities
- the design and delivery of new products and services, and
- changed technologies adopted.

4.1 Catalysing creation of new business Sublime Digital Ltd

Macpherson and McDonnell held several workshops in 2017 with industry experts from tech company Soluis to discuss their ideas for applying their research into the nature of VR to the creation and manipulation of actual virtual environments and interfaces. Sublime Digital was created on the back of this, and in 2020 its Chief Operating Officer commented: *'Sublime Digital was incorporated in May 2018, in part as a by-product of a coming together of ideas and expertise between Soluis staff and McDonnell and Macpherson at a Knowledge Exchange Workshop. That workshop led directly to the preparation of an Innovate UK funding application for Project Mobius, led by Sublime and in partnership with the University of Glasgow'* [5.1].

The successful Innovate UK grant bid won total costs of GBP911,000 over three years from October 2018, a major sum for a very small company as Sublime was at the time (having only six staff) [5.2]. Sublime's VP for Industry [5.3] commented that *'the design, execution and grant acquisition for this project would not have been possible without the research expertise of our partners in Philosophy'*. As a direct result of Project *Mobius* and this investment, Sublime's business and its priorities shifted to focus on this workstream, and an additional six jobs were created (3D artists, UI/UX developers, and commercial staff). [5.1, 5.3].

Through Project *Mobius*, Sublime and Macpherson and McDonnell created an outline design for a hosting platform for VR learning environments. A valuable innovation was its facility to collect VR sensor data to infer user engagement and learning in real-time, enabling the ongoing refinement of learning environments, something Sublime has now adopted in their overall approach as a business [5.1].

4.2 Project *Mobius*: design and delivery of new platform and teaching environments

Mobius produced a bespoke platform for 10 VR teaching environments covering a range of subjects, designed to teach students wearing VR headsets in a lab. In November 2017, Macpherson and McDonnell organised a UofG competition calling for VR teaching ideas, advised applicants, worked with Sublime to select the 10 best, and supported the successful applicants and Sublime to build and enhance their designs. These VR learning environments represent significant intellectual property (IP) that was in 2020 transferred to sole Sublime ownership [5.4].

In addition, together with Sublime, Macpherson and McDonnell designed one permanent VR teaching lab and another 'pop-up' high-capacity lab, the designs for which were made available for other institutions to adopt. The permanent lab was established at a cost of GBP36,000 from UofG plus a commitment to on-going costs of ~GBP30,000 per year over four years [5.5].

4.3 Project Edify: Changed technology adopted, further investment and commercial sales

In March 2020, in response to the Covid-19 pandemic, the researchers worked with Sublime to adapt *Mobius* for the new socially-distanced HE landscape. This led to project *Edify*, a platform that makes VR teaching accessible to students using standard mobile/desktop platforms such as Zoom. Only the teacher requires a VR headset, and broadcasts their VR experience to students who can be at home. *Edify* was therefore able to facilitate teaching of a kind that would otherwise have been prevented by the pandemic. The project used a second, global competition to develop a further 16 teaching environments, selected from 152 applications from 54 HEIs across six continents [5.6].

One teaching environment, the VR Diagnostics Lab (Figure 2) allowed students who could no longer be taught on campus to experience a lab environment virtually. Another example is Dr Mark Wong's use of the technology to visualise housing and health inequality trends, which won the [Policy Press Outstanding Teaching Award in 2020](#) for 'excellence in social policy teaching [and] developing of innovative practice in teaching'.



Figure 2: The Diagnostics lab in VR (left) and an example of tasks within the lab (right)

Another highly successful application is the 'virtual molecule viewer', which renders students equal in size to any one of 151,000 molecules from international scientific databases. This allows students to examine Covid-19 molecules in detail, including otherwise undetectable features and properties. The virtual molecule viewer was shortlisted in the [Times Higher Education Awards 2020](#) in the category 'Best Technological or Digital Innovation of the Year'.

One professor reported that 100% of his ~95 students 'agreed' or 'strongly agreed' that using the side-by-side 3D molecular viewing software improved their understanding. He explained that the method: '*overcomes students' previous profound difficulty in understanding and conceptualising the 3D structures of highly complex molecular structures*', adding '*the unique features of the platform have resulted in greatly increased student engagement*' [5.7].

Edify attracted an additional GBP1.3 million in investment from a mix of governmental and business sources including Scottish Enterprise, convertible loans, Innovate UK and the UK Future Fund [5.1]. This additional investment enabled Sublime to create a further 21 new posts (bringing its total workforce to 33), and since March 2020 100% of their activity has been devoted to project *Edify*. With this investment, and the higher education market for VR believed to be worth over GBP1 billion, of a projected GBP7 billion for the wider VR market [5.8], at the end of 2020 the company was valued by Ernst & Young at GBP20 million [5.1]. Sublime

commented that *'without the support and expertise of the philosophy research team, we would have been unable to validate our thinking around the HE market'*.

In its first six months, licences were granted to the 152 HE institutions participating in the competition to use the *Edify* platform for teaching [5.6]. The *Edify* platform was then launched commercially in Autumn 2020, including a general tool for creating VR lessons alongside 20 bespoke VR teaching environments for use in each institution. By end of 2020, 60 commercial licences had been sold in Scotland, England and Australia [5.1]. A December 2020 agreement between Sublime and UofG acknowledged the value of UofG's contribution to project *Edify* at GBP500,000 and committed to a further two years of development [5.4] which, Sublime commented, *'demonstrates both the success of this collaboration to date, and how much we value the ongoing input from McDonnell and Macpherson'* [5.1].

5. Sources to corroborate the impact

- 5.1 Testimonial letter, Sublime Chief Operating Officer [PDF March 2021], corroborating changes to the company resulting from the collaboration with the philosophy researchers, how the company adapted its plans to the pandemic and detailing the resulting further investment in project *Edify* in 2020.
- 5.2 Documentation from Innovate UK confirming and detailing funding [PDF].
See also: <https://gtr.ukri.org/projects?ref=104267>
- 5.3 Testimonial letter, Sublime VP for Industry [PDF January 2020], detailing the origins of the collaboration with UofG and the impacts on the business at that time.
- 5.4 Heads of Terms document negotiated between UofG and Sublime Digital Ltd, dated 18th December 2020. Corroborating the nature of the collaboration between UofG and Sublime, and the resulting significant value generated by the end of 2020.
- 5.5 Details of the VR lab establishment [combined PDF]:
 - a. Email from Property and development manager, UofG, corroborating establishment costs and ongoing rental commitment for lab
 - b. Attached accounting spreadsheet giving detailed breakdown of costs.
- 5.6 Details of the 'Win A Lab' competition [combined PDF]
 - a. List of winners, detailing applications of Edify over various disciplines, institutions and countries. [also available at <https://www.edify.ac/win-a-lab-winners/>]
 - b. List of 152 licences given to 54 subscribing institutions (both Higher and Further Education) including Scotland, Ireland, Malaysia, Malaya, Australia, England, USA, China and Singapore. [Excel spreadsheet saved as PDF]
- 5.7 Sublime Digital information memorandum [PDF, dated January 2021], detailing (with some figures redacted), investment, R&D and market analysis relating to *Edify*.
- 5.8 Results of brief qualitative questionnaire on the use of Edify by UofG staff/students up to 31st December 2020, corroborating student numbers, student engagement benefits, accessibility and efficiency, including the virtual molecule viewer.