

Institution: Ravensbourne University London		
Unit of Assessment: 32. Art and Design: History, Practice and Theory		
Title of case study: Learning Technology Research Centre Projects 2014-2020		
Period when the underpinning research was undertaken: 2015- 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Carl Hayden-Smith Jazz Rasool	Role(s) (e.g. job title): Director of LTRC Senior Research Fellow	Period(s) employed by submitting HEI: January 2015-present
Period when the claimed impact occurred: 2015- 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact (indicative maximum 100 words)

This case study draws on a series of funded projects undertaken by Smith and Rasool for the Learning Technology Research Centre (LTRC) at Ravensbourne University London (RUL), underpinning the University's engagement with Mixed, Augmented and Extended Reality (MR/AR/XR) in teaching, research and industrial environments. The impact of Smith and Rasool's work has been identified under three key areas:

1. **Practitioners, commerce and the economy:** - creation of a spinout business (WEKIT ECS), adoption of new technologies by Medical Realities, job creation and revenue growth (DoubleMe).
2. **Understanding, learning and participation** – course design and delivery (AR-FOR-EU, Hobs Academy) and international socio-economic impact (mEQUITY and mRidge).
3. **Influence on public policy and standards** - IEEE standard established through WEKIT, impact on Creative Industries recognised by CORDIS

2. Underpinning research (indicative maximum 500 words)

LTRC's work is based on earlier research conducted by Carl Smith at London Metropolitan University that provided the basis for the **Cr-EAM** project (initiated 2013 at LMU; moved to Ravensbourne in 2014). Funded at 1,000,000 EUR from FP7, this was a 7-partner project to roadmap the Creative Industries, for which Ravensbourne provided the Architecture input and were promoted to roadmapping managers halfway through the project. [1]

The 2015 paper "An Overview of Capturing Live Experience with Virtual and Augmented Reality" by M. Fominykh, F. Wild, C. Smith, V. Alvarez and M. Morozov set out the areas that would be investigated in WEKIT and successive AR projects. [2]

This led to Smith and Rasool's work on the Wearable Experience for Knowledge Intensive Training (**WEKIT**) project (11 partners, 2017-19, funded within Horizon 2020) that investigated the development of new interfaces for wearable technology to enhance training for industrial applications. The Ravensbourne team led on the making of a smart garment and associated sensors and the training methodologies associated with this approach. The project was tested with several European partners, most notably at ALTEC on behalf of the European Space Agency (ESA). A spin-out company, WEKIT ECS (<https://wekit-ecs.com>), has recently succeeded in the first round of the XPrize. The WEKIT platform also led to a new IEEE standard for augmented reality ARLEM. [3]

As a result of partnerships formed during Cr-EAM, two ERASMUS+ projects emerged with the University of Plovdiv in Bulgaria and the University of Jordan: **mEQUITY** and **mRIDGE** (2017-19 and 2018-2020). These developed augmented technologies for use by disadvantaged and disabled students in several settings, including refugee camps in Palestine, and the research was influential within these areas. [4, 5]

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Along with WEKIT partners at Oxford Brookes University, Ravensbourne worked with the University of Molde in Norway to deliver the **AR-FOR-EU (CodeReality)** project. AR-FOR-EU was born from the work achieved in the Horizon 2020 [WEKIT](#) project, which pioneered the codification of theories of use, and good practices, for using AR and wearables for industrial training, for experience management and to augment performance. AR-FOR-EU built on, and extended these aspects, in the context of open access to the AR body of knowledge (BoK) and using that BoK for curriculum development and related areas. AR4EU and WEKIT are synergistic: together, they have brought about the diffusion and adoption of a new way of thinking about how and where to use AR; and how to apply and extend relevant learning theories and best practices.

The **CodeReality** project then led to a new £470k funded project with the London Legacy Development Corporation (LLDC) to establish the Hobs Academy a free, 12-week evening course to rapidly upskill school leavers, NEETs, the unemployed and those seeking new work, in the area of 3D printing, 3D modelling and AR/VR. As a result of COVID-19 this was moved entirely online and has been running successfully since the start of 2020. The Hobs 3D company, who are the partners in this project, specialise in the construction industry and the industry board guiding the project has many representatives from this area. [6]

3. References to the research (indicative maximum of six references)

[1] Carl Smith, Jazz Rasool: "Strategic road mapping for Europe's Creative industries: the EU Cre-AM project", in Ritz, Martin et al.: *Konferenzband EVA Berlin 2015. Elektronische Medien & Kunst, Kultur und Historie: 22*. Berliner Veranstaltung der internationalen EVA-Serie: Electronic Media and Visual Arts, herausgegeben von Andreas Bienert et al., Heidelberg: arthistoricum.net, 2016 (2015) (EVA Berlin, Band 22).

<https://doi.org/10.11588/arthistoricum.157.197> [Cr-EAM]

[2] [An Overview of Capturing Live Experience with Virtual and Augmented Reality](#)

Mikhail Fominykh, Fridolin Wild, Carl Smith, Victor Alvarez, Mikhail Morozov
P298 – 305 DOI 10.3233/978-1-61499-530-2-298, in *Workshop Proceedings of the 11th International Conference on Intelligent Environments*, ed. Davy Preuveneers, (IOS Press, 2015) ISBN 978-1-61499-530-2

[3] Ravagnolo, Liliana & Helin, Kaj & Musso, Ivano & Sapone, Rosa & Vizzi, Carlo & Wild, Fridolin & Vovk, Alla & Limbu, Bibeg & Ransley, Mark & Smith, Carl & Rasool, Jazz. (2019). "[Enhancing Crew Training for Exploration Missions: The Wekit Experience](#)", from 70th International Astronautical Congress, IAC 2019 [WEKIT]

[4] Rasool, Jazz and Smith, Carl H (2019) "[Improving Higher Education Quality in Jordan Using Mobile Technologies](#) for Better Socio-economic Diversity Integration of Disadvantaged Groups Using a Mobile Multimedia/Augmented Reality Workflow." In: *EAI International Conference on Technology, Innovation, Entrepreneurship and Education: TIE 2017*. Lecture Notes in Electrical Engineering, 532 . Springer Nature. ISBN 978-3-030-02242-6 [MEQUITY]

[5] *mRIDGE: Using mobile technology to improve policy Reform for Inclusion of Disadvantaged Groups in Education* N. Mileva et al (Plovdiv, 2017), ISBN 978-619-7134-55-1, http://mridge.dipseil.net/getdissf.php?fn=mRIDGE_Book%2Fbook_mridge_online.pdf

[6] Designing Interfaces for Creative Learning Environments Using the Transreality Storyboarding Framework in *BDE 2020: Proceedings of the 2020 2nd International Conference on Big Data Engineering*, May 2020 Pages 118–125 <https://doi.org/10.1145/3404512.3404530> [AR-FOR-EU]

4. Details of the impact (indicative maximum 750 words)

1. Practitioners, Commerce and the Economy:

WEKIT ECS has recently (**S1**) been accepted as one of 10 Qualified Teams, from 118 teams from 20 countries, in the \$5M XPRIZE Rapid Re-skilling Competition. The team will develop a Neuro-

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Adaptive Mixed Reality Training platform (REAP) to place 350 participants into full-time jobs, re-skilling solutions for individuals most vulnerable to employment loss in the United States.

ALTEC SpA [2] – through the WEKIT project, LTRC developed a wearable sensor for astronaut trainees, enabling measurement of the affective state of the learner including stress but also concentration. Real-time measurement of the affective state enabled a redesign of instruction sets to overcome the challenge faced by users. *“LTRC’s contribution was significant for the development of the concept, hardware and software, and the integration of sensors, allowing content to be analysed and processes improved.”* (S2)

DoubleMe – established in 2014, DoubleMe first collaborated with LTRC in 2016, resulting in production of a one-of-a-kind HoloPortal (S3), laying the foundation for a \$500K Venture Capitalist investment for 8% of the company. The relationship with LTRC allowed DoubleMe to develop products for UK and overseas markets and to enter new markets, such as a HoloDash for cars, a technology that was shared with Kia, Audi and Ferrari. DoubleMe now employs 43 people and sees revenues of \$3m per annum, up from \$250k when the company first engaged with LTRC. Collaborative development of the HoloPortal have allowed the company to engage major Telco companies, including BT, Vodafone and O2. *“I can honestly say that our company growth is based on our interactions, knowledge sharing and product development with LTRC.”* (DoubleMe CEO)

Medical Realities – LTRC research has facilitated development of the world’s first end-to-end immersive platform for the healthcare industry (S4), with Medical Realities employing 360-degree video, MR/VR/AR and hologram systems designed by LTRC to trial immersive training for medical students/professionals and, indeed, patient consultations, with acceptance of such methods driven by the Covid-19 pandemic. Development of the system has involved a partnership of universities (including RUL), healthcare companies (Roche), ICT providers (Samsung), and medical institutions (Barts Hospital).

2. Understanding, Learning and Participation:

LTRC’s research has influenced the design of inclusive educational methods for a global audience. Improved social welfare through enhanced employment/education opportunities and a reduced gap in academic attainment for ‘marginalised’ students is evidenced by:

AR-FOR-EU (CodeReality) – a £300k Erasmus+ project (2017 to 2020), AR-FOR-EU brought together five internationally-renowned institutions to validate a course offering for teaching AR in HEIs.

The Project Lead states (S5), *“The AR-FOR-EU impact is strongest at the global level, while also providing benefits to society and the economy on local, regional and national levels. The project has produced results that became self-sustaining and are likely to develop further.”*

Hobs Academy – a 2018 collaboration between Hobs 3D at Stratford and the London Legacy Development Corporation (LLDC, established to develop the Olympic Park site) had a focus on tackling social integration and working with the surrounding communities (S6). LTRC won a competitive tender to design and deliver the training contract for the £470k LLDC-funded Hobs Academy, with targets for the two-year programme being to train 120 students by March 2022. By the end of December 2020, 61 students had been through the programme, with over 50% having gone on to access work placements or full-time employment. An offer from international construction company, Mace, to provide work placements directly for three students and a further ten within its supply chain was also received. Head of Socio-Economic Regeneration at LLDC comments, *“This is testimony from a significant company on the value and, indeed, uniqueness of this training, and the skills it gives participants. I know that students hold the course in high regard,*

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it builds skillsets and competencies, and students are more positive about future employment opportunities."

mEQUITY and **mRidge** – international reach is evidenced through collaboration between LTRC and the Universities of Plovdiv (Bulgaria) and Jordan, from which two ERASMUS+ projects were progressed. **mEQUITY (S7)** saw the development of an inclusive curriculum in engineering education based on digital learning resources for mobile devices. The project aimed to improve education provision to high-risk groups whose special needs or socioeconomic status restricted their access to adequate education. Beneficiaries of separate strands of the project included Gaza Camp students suffering from socioeconomic isolation (x38), recent graduates of Jordan University of Science and Technology who were seeing continued unemployment (x7). **Influence on Public Policy and Standards**

LTRC research has had a significant influence on public policy and the development of professional standards in the following ways:

- Development of IEEE 1589-2020 – Smith and Rasool's research, through work with WEKIT, was instrumental in the development of the IEEE Standard for Augmented Reality Learning Experience Model (**S9**), approved in January 2020 under the AR-LEM (Augmented Reality Learning Experience Model) working group.
- The EU's primary route for dissemination 'CORDIS' states (**S10**), "Cr-EAM project recommendations will contribute to current and future EU policy initiatives that aim to strengthen and support the European creative industries. Cr-EAM has made an important contribution through its comprehensive online communities that will continue to encourage and stimulate direct engagement and cooperation between ICT solution providers and creative sector stakeholders."

5. Sources to corroborate the impact (indicative maximum of 10 references)

- S1: <https://reap.digital/>
- S2: Testimonial letter of support - Mission Operations & training Manager, Altec SpA
- S3: Testimonial letter of support - DoubleMe Founder and CEO
- S4: Testimonial letter of support - Medical Realities Founder
- S5: Testimonial letter of support - AR-FOR-EU Project Lead
- S6: Testimonial letter of support - Head of Socio-Economic Regeneration, LLDC
- S7: mEQUITY: http://mequity.dipseil.net/mEQUITY_book_web.pdf
- S8: mRidge project outcome: Book
http://mridge.dipseil.net/getdissf.php?fn=mRIDGE_Book%2Fbook_mridge_online.pdf
- S9: <https://standards.ieee.org/standard/1589-2020.html>
- S10: <https://cordis.europa.eu/article/id/118863-innovative-technological-and-digital-solutions-for-the-european-creative-industries>