DORSET
Local Enterprise Partnership

Orthopaedic Research Institute (ORI)

Phase 1

End of Project Report

July 2019

Project Summary

The prime purpose of the project was to establish a research centre of excellence in orthopaedics at Bournemouth University, to grow Dorset's Orthopaedic Development and Innovation Accelerator Cluster of innovative businesses in this field.

The project was originally called ODIAC: The Orthopaedic Development and Innovation Accelerator Cluster, which was later renamed to ORI: Orthopaedic Research Institute.

This funding was spent on the necessary equipment, apparatus and instrumentation to develop the required facilities to support the business plan for the newly formed Orthopaedic Research Institute at Bournemouth University. It helped to provide world-class research facilities in which to conduct orthopaedic research at the university. In the first instance, funding was primarily spent on equipment for use in the new gait and motion laboratory

Dorset LEP allocated £700K of Dorset Growth Deal funding to fund in-part the Institute's required state of the art building and facility. This is central to the growth of the institute, and to having a facility that is attractive for industry partners to fund applied research projects. It is these projects, attracting industry research funding, which will generate the potential vibrant orthopaedic cluster. Growth Deal funds purchased capital equipment for:

1) Gait and motion laboratory
2) Surgical skills virtual reality laboratory

Contract signed	July 2015
Project start date	October 2015
Project completion date	October 2016

Review of Business Case

A proposal was submitted in the call for projects for Growth Deal 1. As part of the due diligence assessment before projects were put forward to Government the project was assessed and received a BCR of 184. In accordance with the paper presented to the Dorset LEP board in October 2014, £700k was allocated to the Orthopaedic Research Institute.

Governance

This project reported straight to Dorset LEP Board through the programme management team.

Change Request

There were no change requests for this project.

Planned Outputs and Outcomes

Outputs:

- To purchase the necessary equipment, apparatus and instrumentation to develop the required facilities to support the business plan for the Orthopaedic Research Institute at Bournemouth University.
- Establish a research centre of excellence in orthopaedics at Bournemouth University and launch the new gait and motion laboratory in which to conduct orthopaedic research at the university.

Outcomes:

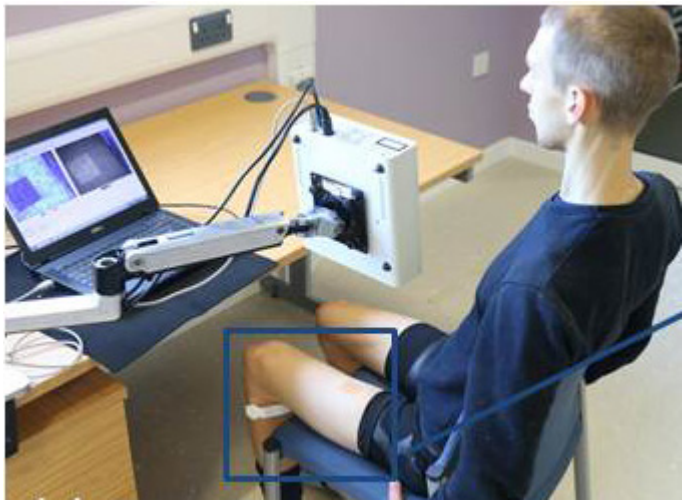
- Provide state of the art research facilities, access to clinical trials and the clinical expertise needed to accelerate innovative orthopaedic products to the marketplace.
- A unique regional resource that will attract the clustering of local, regional and international companies to deliver the local economic growth aims.
- By 2020 ORI will generate up to £100M investment and up to 500 jobs.

Achievement of Outputs

In October 2015 the Institute was launched, and the following equipment was purchased with the local growth fund:

Laser Speckle Contrast Imager

The Laser Speckle Contrast Imager is a full field blood perfusion imaging system that was purchased in April 2016. It uses the laser speckle contrast technique to show real-time, high resolution blood flow images. This has been used to attract and complete projects with industry partners such as Firstkind Limited, and The Technology Partnership (TTP). ORI has also formulated novel evaluation techniques that utilise this equipment, and which have been recognised internationally (Bahadori et al, 2017a; Bahadori et al, 2017b).



OSSIM Sim-K total knee replacement virtual reality simulator

A virtual reality simulator for total knee replacement, was added to the lab in May 2016. ORI has since collaborated and received additional research grant funding from the manufacturer to evaluate, validate and develop the equipment. This work has been published within the peer-reviewed literature (Newman et al, 2018; Bahadori et al, 2018). ORI's collaboration with OSSIM Technologies, has also directly led to the development of software and hardware upgrades, and ORI had acted as a European reference site for the North American manufacturer, hosting visiting surgeons, and also training local surgeons.

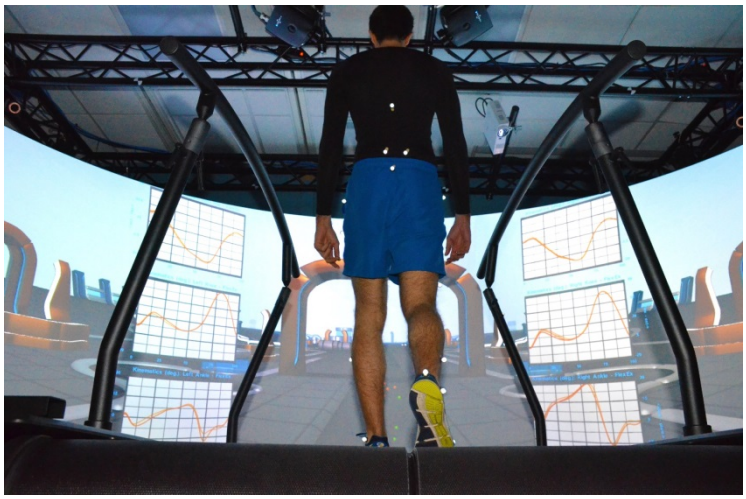
Virtamed virtual reality arthroscopy simulator

A virtual reality knee arthroscopy surgery simulator was delivered in May 2016. The system was demonstrated at Bournemouth University's Festivals of Learning in 2016, 2017 and 2018, and members of the public were invited to carry out basic surgical tasks. Further Anterior Cruciate Ligament (ACL), shoulder and hip modules have been delivered since (September 2016); and validation studies have been published on the ACL and hip modules (Antonis et al, 2019; Gallagher et al, 2019). A virtual reality workshop was held on 29th Nov 2017 introducing local surgeons to training on the virtual reality surgical simulators. ORI is now an international reference centre for Virtamed. Prof Middleton has provided direct advice and expertise on the development of their hip arthroscopy simulator, and ORI has collaborated with the company to appear at international conferences, and also within their direct marketing material.

Motek GRAIL (Gait real-time analysis interactive lab)

The MOTEK Forcelink GRAIL system analyses gait in real-time) was installed in July 2016, becoming one of three in the UK, and one of 23 in the world. The GRAIL was officially

launched on 17th October 2016 and the press coverage included: Bournemouth Echo, Heart Hampshire radio, Blackmore Vale Magazine and News Medical. ORI has since been awarded funding by Stryker (£216,000) to evaluate robotic hip replacement surgery, using the GRAIL and Primus (below) as an integral part of the assessments. This project, funded by one of the largest multi-national orthopaedic companies, was won under competition from sites around the world, and would not have been secured without the GRAIL gait analysis system. It marks an important milestone, and precedent for future studies an international investment into ORI and the region.



Primus RS (BTE Systems)

The Primus RS was also installed in July 2016, and is world leading muscle testing equipment. The system evaluates muscle performance through isometric, isokinetic and isotonic testing in real time. It allows for nearly limitless configurations to allow for isolated muscle evaluations such as quadriceps - knee extension, hamstrings – knee flexion, etc). It is part of the assessment for the Stryker funded study of robotic hip replacement outcomes.

Other lab equipment

Studies using other lab equipment funded by the Local Growth Fund have also been published. These include a study in early 2017 comparing joint angle measurement using the Microsoft Kinect system with the GRAIL (Bahadori et al, 2018); and a study in 2016 comparing bed exercises with functional exercises (Gavin et al, 2018).

ORI industry collaborations

ORI has achieved an international reputation with orthopaedic industry partners in just 3 years. This is evidenced not only by ORI's publications and grant funding, but also by ORI's international presence at multiple international conferences, and also by the number of meetings and visits from senior members of orthopaedic industry partners. This level of exposure, and also breadth of contacts is impressive.

Outcomes

- 2015/2016 Jobs created: 2 roles created for Professor Middleton and Associate Professor Tom Wainwright.
- 2016/2017 Jobs created: 3 full-time roles created for Research Development Manager, Lab Manager/Technician and Research Assistant, and 5 orthopaedic research fellows working part-time.
- TTP Ventus launched 2017, supported by research in 2016 by ORI.

ORI submitted a bid to Growth Deal 3 for phase 2 of the project to create a global gateway. Government approved Dorset LEP's Growth Deal bid and awarded £19.5m in February 2017; with an additional £950k for ORI to enhance Bournemouth University (BU) ORI facilities and to fund additional equipment. ORI facility and equipment aids to provide training for UK and overseas surgeons and other high-value healthcare professionals and to deliver training in conjunction with industry. This will accelerate global reach of ground-breaking Orthopaedic Research at Bournemouth University and a presence in the BU Global hub in China, India, the ASEAN hub and in Eastern Europe.

Outcomes from this project continue to be monitored in respect of this project and phase 2.

Benefits Realised to date

The Orthopaedic Research Institute (ORI) at Bournemouth University works with patients, the health service, colleagues at the university, the local community, and industry partners to prevent and treat osteoarthritis. It's led by Professor Robert Middleton and Associate Professor Tom Wainwright, who believe that in the future, no one should suffer from arthritis. Their research areas include: robotic hip surgery, enhanced recovery after surgery, non-surgical management of osteoarthritis, virtual reality surgical training, the ORI Gait Lab and facilitating the development of new technologies.

- Enhanced Recovery After Surgery (ERAS) is a new, comprehensive, multidisciplinary, multimodal approach to improving care in patients undergoing surgery. It is a radical change from business as usual and challenges the status quo and surgical tradition. It works by the "aggregation of marginal gains"; by improving each step of the surgical pathway to improve surgical outcomes.
- Cycling Against Hip Pain (CHAIN) – The programme provided a combination of education and static cycling, designed to improve mobility and increase people's confidence in managing their condition. It brought together a range of local partners in a unique and innovative partnership to provide the programme. The programme was a Finalist in UK Active Flame Award for Health Partnership of the Year awards, and has since been published and presented internationally to wide acclaim.
- Virtual reality surgical training – Professor Middleton and Associate Professor Wainwright have collaborated with colleagues from the Faculty of Science & Technology at Bournemouth University to publish a review of the current literature on virtual reality based training in orthopaedic surgery. Further work on the use of virtual reality training simulators in orthopaedics continues within ORI and with academic partners from the BU National Centre for Computer Animation (NCCA), and also leading industry partners.
- Helping to develop new technologies – The gekoTM device is a battery powered, disposable, neuromuscular electro-stimulation device designed to increase blood circulation in the veins of the leg.
- The ORI Gait Lab is a world-class facility utilising the Motekforce Link GRAIL system that uses an instrumented dual-belt treadmill, Vicon motion-capture system and synchronized virtual reality (VR) environment next to three video cameras and electromyography.
- ORI's work is international; they work with a range of stakeholders, institutes and industry partners. Based on their research, they aim to improve patient outcomes both locally and nationally, influence professional practice. On a national scale, they work to influence changes to policy, standards, treatment guidelines and patient

expectations through the dissemination of their research. This will be expanded in Phase 2.

- As well as developing interventions to help patients recover from surgery and manage their conditions, ORI also work with a number of global orthopaedic companies to test and run clinical trials on the latest orthopaedic technology.

Additional benefits:

- Benefits to the community: As part of Festival of Learning June 2016, members of the public carried out basic surgical tasks on the knee arthroplasty virtual reality simulator. Professor Middleton used the Sawbones teaching equipment as part of a talk on hip anatomy to Dorset GPs.
- ORI continues to work on a number of publications, some highlights are in Appendix 1.

Review of Project Objectives

RAG Review of Objectives	Status	Comments
Time		The project started and completed on time.
Cost		The project came in on budget.
Quality		The Gait Lab was completed to a high specification including purchased equipment.
Scope		The scope of the project did not change.
Benefits		Additional benefits were delivered as part of this project.
Risk		All risks were mitigated through the life of the project.

Lessons learned

- Procurement of specialist, unique and potentially world-leading equipment is subject to single source tender and discussions with procurement team should start early.
- Additional timing is needed when working on the procurement of equipment, to ensure that equipment can be delivered, collaborated and approved and paid for within the timescales.

Conclusion

A new world-class orthopaedic gait analysis laboratory - the 'GRAIL' (gait real-time analysis interactive laboratory) - and state-of-the-art virtual reality training equipment have been installed at Bournemouth University's Orthopaedic Research Institute thanks to a £700,000 local growth fund investment secured by Dorset Local Enterprise Partnership as part of the Phase 1 of the project.

Since the completion of ORI Phase 1, Dorset LEP awarded an additional £950k to enhance Bournemouth University ORI facilities and to fund additional equipment. Outcomes from Phase 1 continue to be monitored and case studies for both phases will be produced in a due course.

Gordon Page, former chairman, Dorset Local Enterprise Partnership said: "BUORI is a leading edge research facility. Its work will deliver more effective treatments for osteoarthritis as well as attract multinational global orthopaedic businesses to Dorset. This is good news not only for people whose lives will be enriched by better orthopaedic treatments but also for the economy. We are delighted to have secured the capital investment through our local growth fund to support this innovative and pioneering project."

Professor John Fletcher, former Pro Vice-Chancellor of Research and Innovation at Bournemouth University commented, "We are delighted that support from the Dorset LEP has allowed ORI to install new, state-of-the-art training equipment. This will bring great benefits to the students and qualified professionals being trained, as well as enhancing ORI's research activities. The enhancement of our medical science research is a key priority in our regional strategy. This is also a great example of the philosophy which resides at the heart of Bournemouth University's work – making a difference by integrating our research, education and professional practice – as we believe that each benefits and reinforces the other. We are very pleased to be bringing new facilities to BU that will benefit people in Dorset and beyond."

Professor Rob Middleton, head of ORI, said, "Thanks to the capital grant from Dorset LEP, ORI now has world-class research and training facilities here in Bournemouth. Our virtual reality training simulators allow us to train surgeons in the ORI labs, where in the past they would be going through a learning curve on real patients. It's a big advance and we're generating huge interest from around the country and abroad.

"The gait lab allows researchers from across BU faculties to study human motion to improve sporting performance and treat injury and arthritis. Its unique contribution for studying joint replacements and their outcomes has attracted over 30 national and international companies to visit ORI over the last year. I am pleased to say that nine companies have now signed agreements and partnerships to work with ORI. Without Dorset LEP's support we could not have attracted this work to Bournemouth."

Lorna Carver, Dorset LEP director said: "The Orthopaedic Research Institute is a leading edge research facility. Its work will not only deliver more effective treatments for osteoarthritis but will attract key local and international investors into Dorset. This is good news not only for people whose lives will be enriched by better orthopaedic treatments but also for the economy. We are delighted to have found the capital investment through our local growth fund to support this pioneering project."

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https://dorsetlep.co.uk/delivery/local-delivery-the-growth-deal/orthopaedic-research-institute-phase-1/

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Appendix 1 – Publications

Wainwright, T.W., Immins,T. and Middleton, R.G., (2015) A cycling and education programme to promote self-management and to increase functional ability in patients with osteoarthritis of the hip. Osteoarthritis and Cartilage, 23 (2), 372.

Howie, D.W., Holubowycz , O.T., Middleton, R. and Grp, L.A.S., (2012) Large Femoral Heads Decrease the Incidence of Dislocation After Total Hip Arthroplasty A Randomized Controlled *Trial.Journal of Bone and Joint Surgery-* American Volume, 94A (12),1095- 1102.

Wainwright, T. and Middleton, R., (2010) An orthopaedic enhanced recovery pathway. *Current Anaesthesia and Critical Care,* 21 (3), 114-120.

Antonis J, Bahadori S, Gallagher K, Immins T, Wainwright TW, Middleton R. Validation of the Anterior Cruciate Ligament (ACL) Module of the VirtaMed Virtual Reality Arthroscopy Trainer. Surg Technol Int 2019 June 18;35.

Bahadori S, Davenport P, Immins T, Wainwright TW. Validation of joint angle measurements: Comparison of a novel low cost marker-less system with an industry standard three dimensional marker-based system. Annals of Physical and Rehabilitation Medicine 2018;61:e439.

Bahadori S, Immins T, Wainwright TW. A novel approach to overcome artifact when using a laser speckle contrast imaging system for alternating speeds of blood circulation. JOVE 2017a;126:1-6.

Bahadori, S., Immins, T., Wainwright, T. The effect of calf neuromuscular electrical stimulation and intermittent pneumatic compression on thigh microcirculation. Micro Res 2017b. 111, 37-41.

Gallagher K, Bahadori S, Antonis J, Immins T, Wainwright TW, Middleton R. Validation of the hip arthroscopy module of the VirtaMed virtual reality arthroscopy trainer. Surg Technol Int 2019 May 15;34:430-6.

Gavin JP, Immins T, Burgess LC, and Wainwright TW. Functional sit-to-stands evoke greater neuromuscular activation than Orthopaedic bed exercises in healthy older adults. Isokinetics and Exercise Science 2018;26(2):139-148.

Newman S, Gulati V, Bahadori S, Wainwright T, Middleton R. Content and Face Validity Assessment of the Sim-K Haptic Feedback Enhanced Total Knee Replacement Virtual Reality Simulator. The Internet Journal of Orthopedic Surgery. 2018 Volume 27 Number 1.