

# OActive

## NEWSLETTER

Advanced  
Personalised,  
Multi-Scale  
Computer  
Models  
Preventing  
Osteoarthritis

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The Consortium

Issue 3: November 2019

Welcome to the M24 issue  
of the OActive Newsletter!

Join us at:



OActiveProject



This project has received  
funding from the European  
Union's Horizon 2020  
research and innovation  
programme under the  
Grant Agreement  
No. 777159.



The OActive project focuses on the development of advanced, personalised, multi-scale computer models for combating OsteoArthritis. The VISION of the OActive consortium is to improve radically the healthcare of people with osteoarthritis of the knee.

Osteoarthritis is a degenerative disease of the cartilage and the other tissues in the joints and is the most common form of arthritis that causes pain, limits mobility and reduces independence and quality of life in millions of people in Europe and around the world. Increasingly, it is not only older people in their 60s or 70s that are affected, but younger individuals, including athletes, in many cases years after a knee injury or after the end of their competitive career.

Osteoarthritis is a complex disease in which various biological, social and even environmental factors are involved, in addition to genetics and family history of disease. Although we understand the roles of the main modifiable or nonmodifiable risk factors in the development and progression of osteoarthritis, there is no exploration of the interaction and

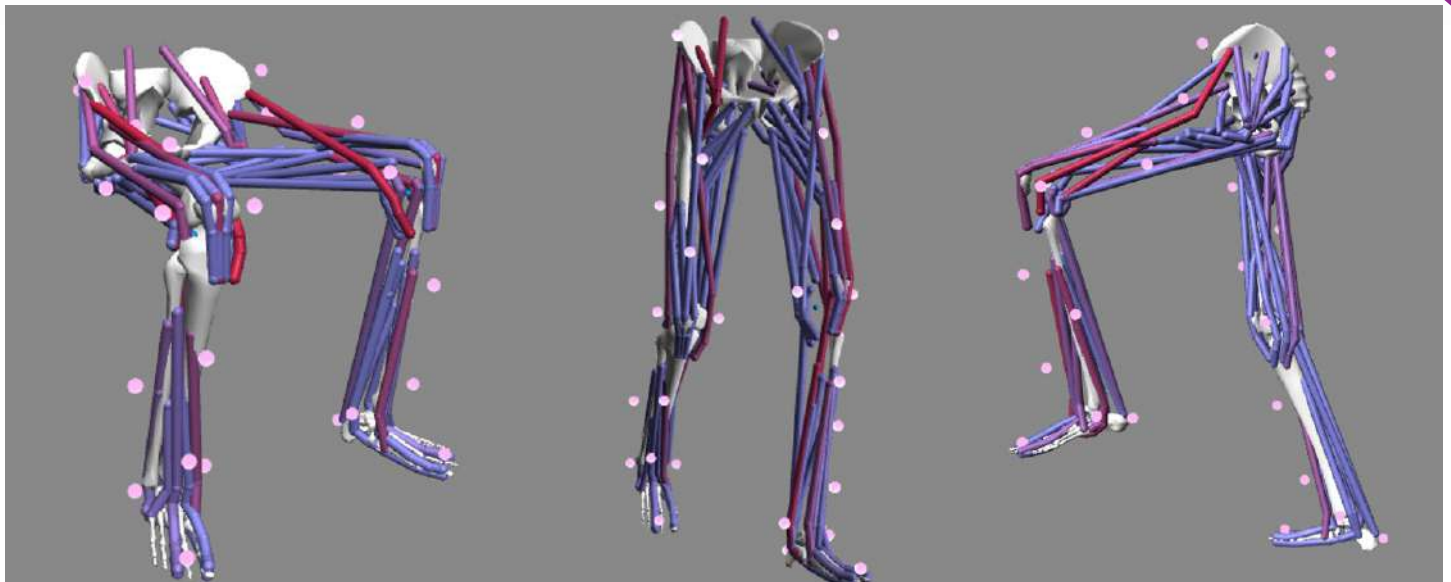
integration of the many different influences from different domains such as environmental, social, economic, and lifestyle factors, and their links to medical, physiological, and biological indicators for the different tissues affected in the joint and throughout the body, in a patient-specific manner.

The OActive project intends to make a significant leap forward by adopting a multi-scale holistic approach where patient-specific information from various levels, including cell, tissue, organ and whole body will be integrated and combined with information from other sources such as biochemical/ inflammatory biomarkers, behaviour and social/ environmental risk factors to generate robust predictors for new personalised interventions for delaying the onset and slowing down the progression of OA.

## Insights to WP3, WP7 and WP8

### WP3

### Multiscale mechanistic modelling



### SCOPE

The objective of WP3 is to develop in silico multiscale biomechanical models of healthy and knee joints with OA that are scalable to different individuals (anthropometry, gender and age), that incorporate subject-specific joint and tissue level experimental mechanics.

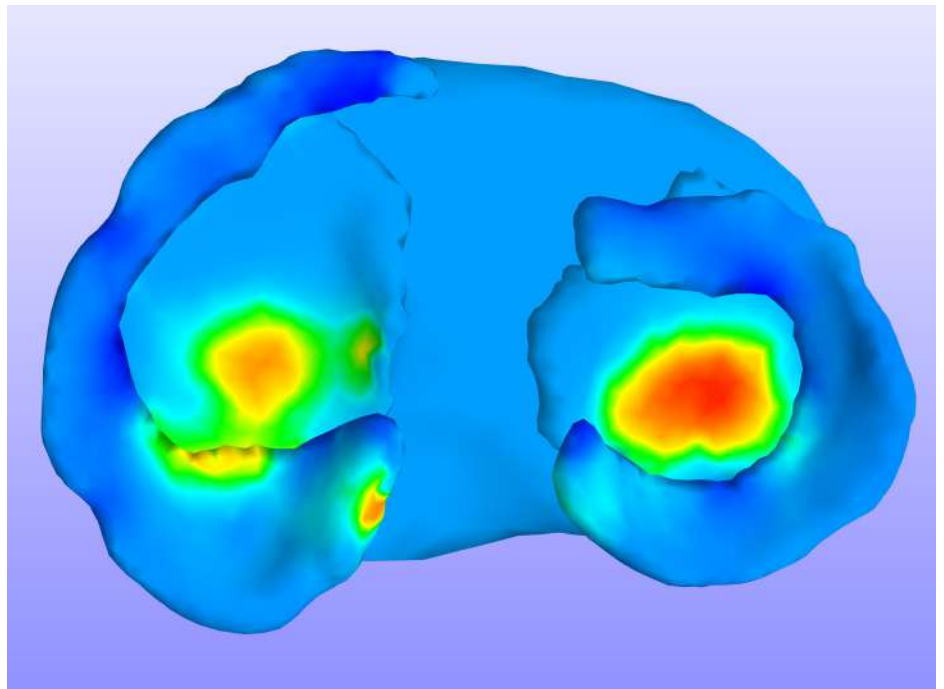
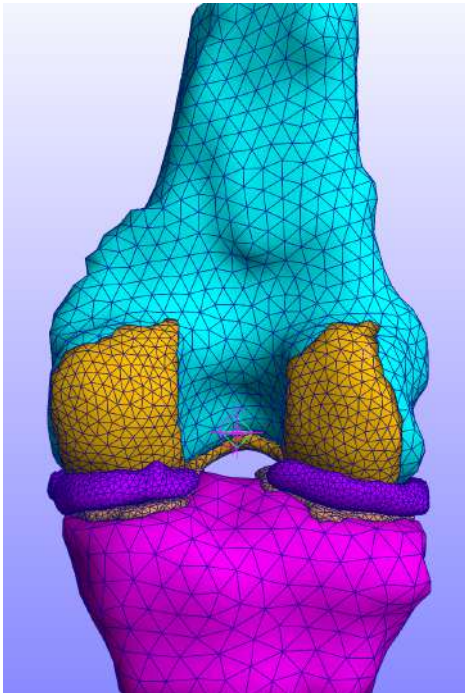
### BY FAR

Work has been undertaken to develop subject specific biomechanical models for different groups of subjects: healthy young, healthy elderly and osteoarthritic elderly. This work involves the creation of 3D models of the

knee for each of these subject groups. These are being combined with subject specific joint loading parameters to run finite element simulations and evaluate subject specific cartilage stresses during real-life loading regimes. Evaluation of subject specific joint loading for patients recruited in other centres (as well as pre-existing data) has also been undertaken using pipelines developed in WP3. Joint loading is being evaluated for three different tasks: sit to stand, walking and step-up. So far, subject data for 63 patients has been processed, with more to come in the next few months.

## IMPACT

This package of work will be important for providing joint loading information to inform the neural network approaches being carried out as part of other work packages. It will also help the wider scientific community by providing musculoskeletal and finite element models that can be used to evaluate similar data elsewhere.



## WP7

### Personalised interventions through augmented reality

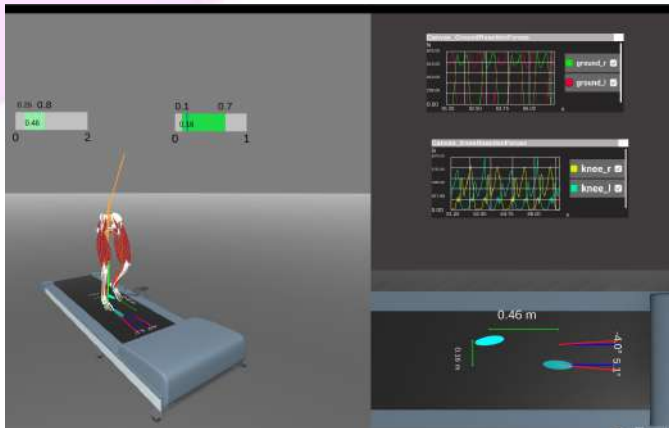
## SCOPE

The main aim of WP7 is to create an augmented reality gait retraining platform where musculoskeletal modeling will be used to calculate kinematics, kinetics and

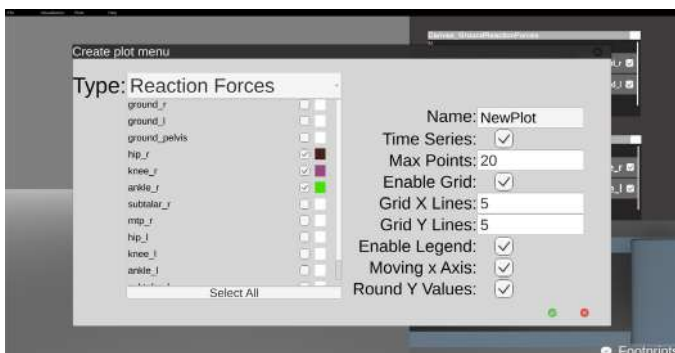
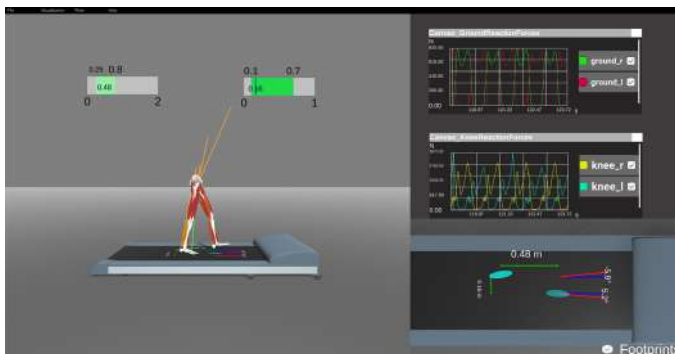
joint loads and visual feedback to enhance the user's gait adaptation - all in real-time conditions.

## BY FAR

By far, previous work on hardware and software requirements has been concluded, optimization of real-time musculoskeletal modeling is finalized and a prototype gait retraining scenario is ready for implementation in a motion analysis lab, in



Visualization of walking data in Unity accompanied with ground reaction forces and knee joint reaction forces, walking stride indicators and 2 bar indicators for intuitive user feedback(dummy data)



New Plot creation from whole list of reaction forces so that the expert can create plot collections of all available measurements.

collaboration with ANIMUS and CERTH. Usage of IMUs is to be implemented as well and test the validity of the measurements against motion capture data.

Different visual cues are selected for visualization, ranging from kinematic representation of the musculoskeletal system (e.g., bodies and muscles) to simple 2D graphs and 3D glyphs (e.g., knee forces on the musculoskeletal model).

## IMPACT

The testing and finalization of the real-time gait retraining scenario will lead to the development of the AR platform and the different game versions. Thus, the final aim of WP7 will be reached. Applications of such platforms are immense, offering real-time data during exercise interventions, to be used from clinicians, doctors and researchers. Depending on the research question, knowledge on kinematics/kinetics and contact loads “on the fly” from various patient populations can provide a meaningful insight to patient-specific motion strategy and the designing of the best suitable treatment/intervention.

## WP8

## Cellular-Tissue level validation

### SCOPE

This WP will connect the specific cellular responses of cartilage and bone with diagnostic indicators such as soluble biomarkers and imaging data, thus providing information on one additional scale for the holistic modelling approach.

### BY FAR

Healthy and OA human tissues has been successfully collected. Further to this native tissue supplementing female hormones have been cultured to define their role in the remodeling bone process, in order to clarify their influence on the OA evolution. An engineered osteochondral model has been realized to be additionally used to develop in vitro OA model.

### IMPACT

The work will clarify the mechanism underneath to the develop of the osteoarthritis, with a focus on the role of soluble markers. Moreover, this study will give information about the response of osteochondral tissue to rehabilitative movements.



### Innovation Radar Tech for Society 2019

#### Team behind the innovation



#### About The innovation Radar Prize

The Innovation Radar (IR) is a European Commission initiative to identify high potential innovations and innovators in EU-funded research and innovation projects. Our partners from University of Patras made it to the top 3 in the category of Tech for Society where recognizing technologies impacting society and citizens are presented

#### The innovation

The scope of our innovation is twofold.

We are interested in predicting the severity of osteoarthritis and then derive a personalized intervention strategy to delay the progression of the disease. This attempt is based on automatic methods for creating multi-scale subject-specific finite element models of the knee from magnetic resonance images. These models are further constrained from experimentally measured kinematics and externally applied forces in order to simulate more complex movement behaviors like gait. Through simulation, we can identify the loading of the soft tissues

and decide how to change the habits of individuals through gait retraining and augmented reality. To facilitate the latter, we must be able to monitor and analyze the performance of the subject in real-time and provide the appropriate feedback. To this end, we have also developed methods for performing kinematics and dynamics analysis to predict the internal state of the subject (muscle forces, joint loadings, etc.) in real-time. The maturity of these technologies is in a prototype level, with plans for further validation, evaluation and commercialization.

## “Out of the lab. Into the market”

We think that there are two major outcomes related to our work within the OActive project. The first is related to the subject-specific modeling, simulation and analysis of the knee mechanics, which is of baseline research nature with long term goals targeting not only to osteoarthritis but planning of surgeries for anterior ligament reconstruction and knee replacement through simulation. The second is related to the development of a modular framework for extracting meaningful quantities from experimental measurements and musculoskeletal models in real-time. This can facilitate application in the broad field of rehabilitation, ergonomics, control of

exoskeleton and assistive devices.

Our plan is to create a minimum viable product of this technology before the end of the project and to provide feedback for future product development. Tools towards this goal will be VC investments and EC instruments like the FTTI.

## The innovators: To know us better!

The Electrical and Computer Engineering Department, one of the founding departments in 1967 of the University of Patras focuses on educational and research activities on Telecommunications and Information Technology, Electronics and Computer Systems, Automatic Control and Power Systems. The Visualization and Virtual Reality Group (VVR) was established in 2012 by Associate Professor Konstantinos Moustakas and is one of the eight separate research groups of the Wire Communications and Information Processing Laboratory (WCL-IT). VVR focuses on basic and applied research in the fields of Biomedical Engineering, Virtual Physiological Humans, Visual Computing and Virtual Reality and has been in the latest years the recipient of several awards in the respective fields for its research output.



## Boosting Collaboration

Three projects proposed innovative approaches to increase capabilities in the medicine sector by using the latest developments in computational modeling, artificial intelligence and big data. These projects have coordinated together forming the cluster in order to coordinate potential synergies and actions between them.



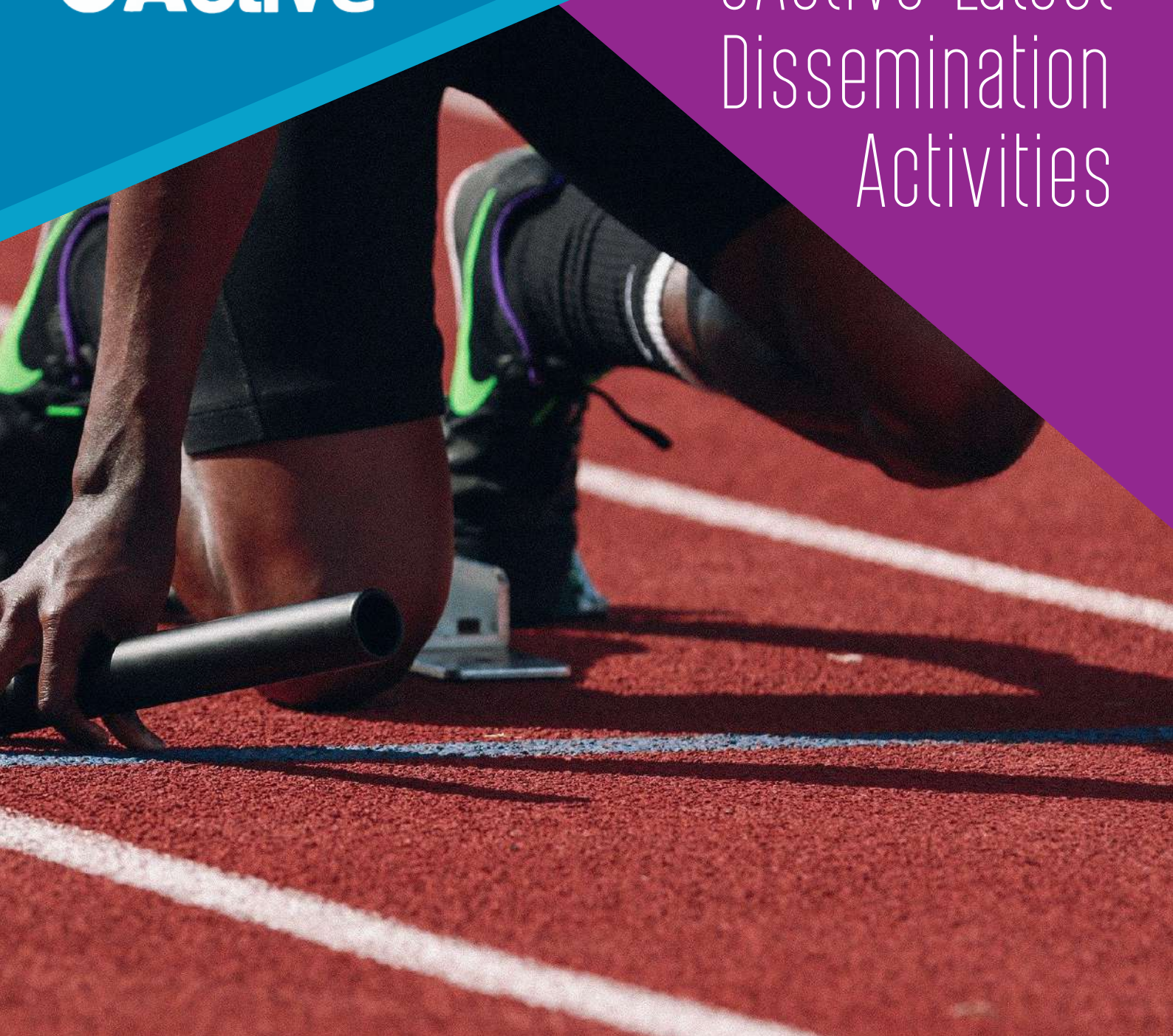
InSilc is an EU funded project under the framework of HORIZON 2020 that targets the development of an in-silico clinical trial (ISCT) platform for designing, developing and assessing drug-eluting bioresorbable vascular scaffolds (BVS), by building on the comprehensive biological and biomedical knowledge and advanced modelling approaches.

More information can be found in the following link <https://insilc.eu>

Rapid Biomechanics Simulation for Personalized Clinical Design (RAINBOW) is a 'Marie Skłodowska-Curie European Training Network with the objective to realize the full potential of computational medicine and ICT to arrive at patient-specific simulation models that are rapidly set for a particular patient, are easy-to-use by clinical experts and do not require assistance from a technical team.

For more information visit <https://rainbow.ku.dk/>





## **National Biomechanics Day**

University of Huddersfield, uk

'Applied Biomechanics - the application to real life'.

Bill Baltzopoulos presented the keynote including an update of the progress of the musculoskeletal modelling tools in the OACTIVE project

<https://www.bases.org.uk/>



**Patras Innovation  
Quest,**  
12-14 April 2019,  
Patras, Greece

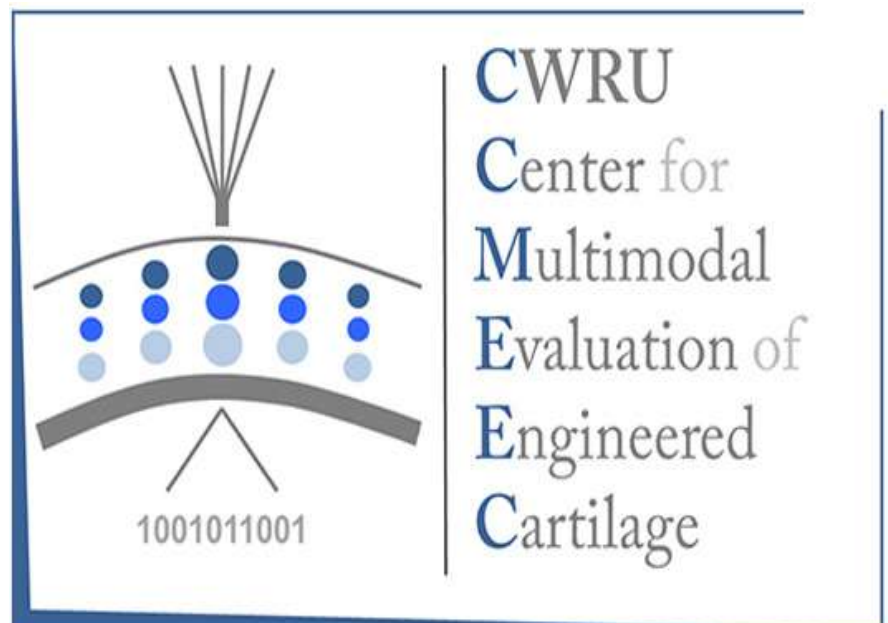
<https://www.patrasiq.gr>

**Investigators' meeting 2019,**  
Center for Multimodal Evaluation  
of Engineered Cartilage (CMEEC)  
Case Western Reserve University,  
Cleveland (OH), USA

20 May 2019

RiMed presented their work  
progress related to Oactive project  
with title "Modelling cartilage  
response to loading in health and  
disease"

<https://ccmeec.case.edu>



## **10th International Conference on Information, Intelligence, Systems and Applications**

15-17 July 2019, PATRAS

<http://iisa2019.upatras.gr>

## **XXVII Congress of the International Society of Biomechanics (ISB2019)**

31 July- 4 Aug. 2019, Calgary, Canada

<https://www.isb2019.com>

International Conference on Biofabrication

**BIOFABRICATION**



## **BIOFABRICATION 2019**

20-22 October 2019 Columbus, OH,  
USA.

Endothelial cells support  
osteogenesis in a vascularized  
3D bioprinted in vitro bone model  
Chiesa I, De Maria C., Lapomarda  
A., Fortunato G. M., Di Gesù R.,  
Montemurro F., Vozzi G., Gottardi R. I,

<https://www.tms.org>

## **Orthopaedic Research Club (ORC) seminars**

28 August 2019 Philadelphia, USA

Riccardo Gottardi present work within  
the frames of the project with title  
“Load and signaling for cartilage  
regeneration”

<https://www.med.upenn.edu>

## **Ri.MED RESEARCH RETREAT**

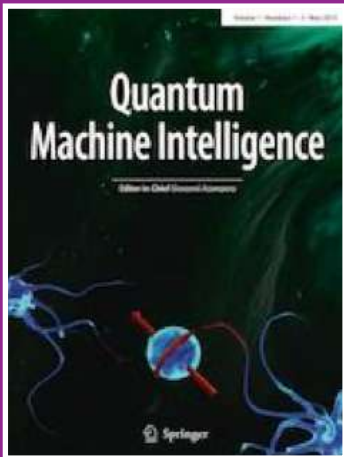
25 October 2019 Palermo, Italy  
Development of an engineered  
vascularized osteochondral  
construct: a tissue engineering  
approach to Osteoarthritis treatment

## **7th International Bio-Medical Scientific Cyprus Congress**

7 – 9 November 2019, Cyprus

<https://euc.ac.cy>

**2019 COLUMBUS**



Application of machine intelligence for osteoarthritis classification: a classical implementation and a quantum perspective

Moustakidis, S., Christodoulou, E., Papageorgiou, E. et al. Quantum Mach. Intell. (2019), DOI



Endothelial cells support osteogenesis in an in vitro vascularized bone model developed by 3D bioprinting

Chiesa, Irene; De Maria, Carmelo; Lapomarda, Anna; Fortunato, Gabriele Maria; Montemurro, Francesca; Di Gesu', Roberto; Tuan, Rocky; Vozzi, Giovanni; Gottardi, Riccardo, Biofabrication (Submitted).



Exploring deep learning capabilities in knee osteoarthritis case study for classification

Christodoulou, E., Moustakidis, S., Papandianos, N., Tsaopoulos, D., Papageorgiou, E.

2-5 DECEMBER 2019, Orlando FL, USA  
TERMIS-AM 2019

<https://www.termis.org>



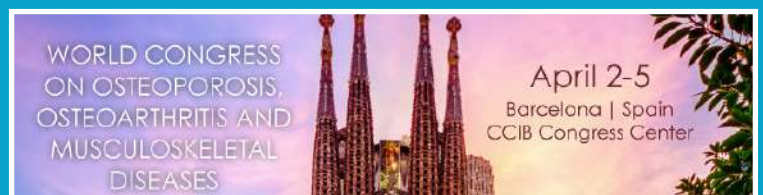
4-7 FEBRUARY 2020, Zurich, Switzerland  
CAMS-Knee OpenSim Workshop

<https://opensim2020.ethz.ch>



2-5 APRIL 2020, Barcelona, Spain  
World Congress on Osteoporosis,  
osteoarthritis & musculoskeletal diseases

[www.wco-iof-esceo.org](http://www.wco-iof-esceo.org)



19-24 MAY 2020, Glasgow, Scotland  
World Biomaterial Congress

<https://wbc2020.org/>



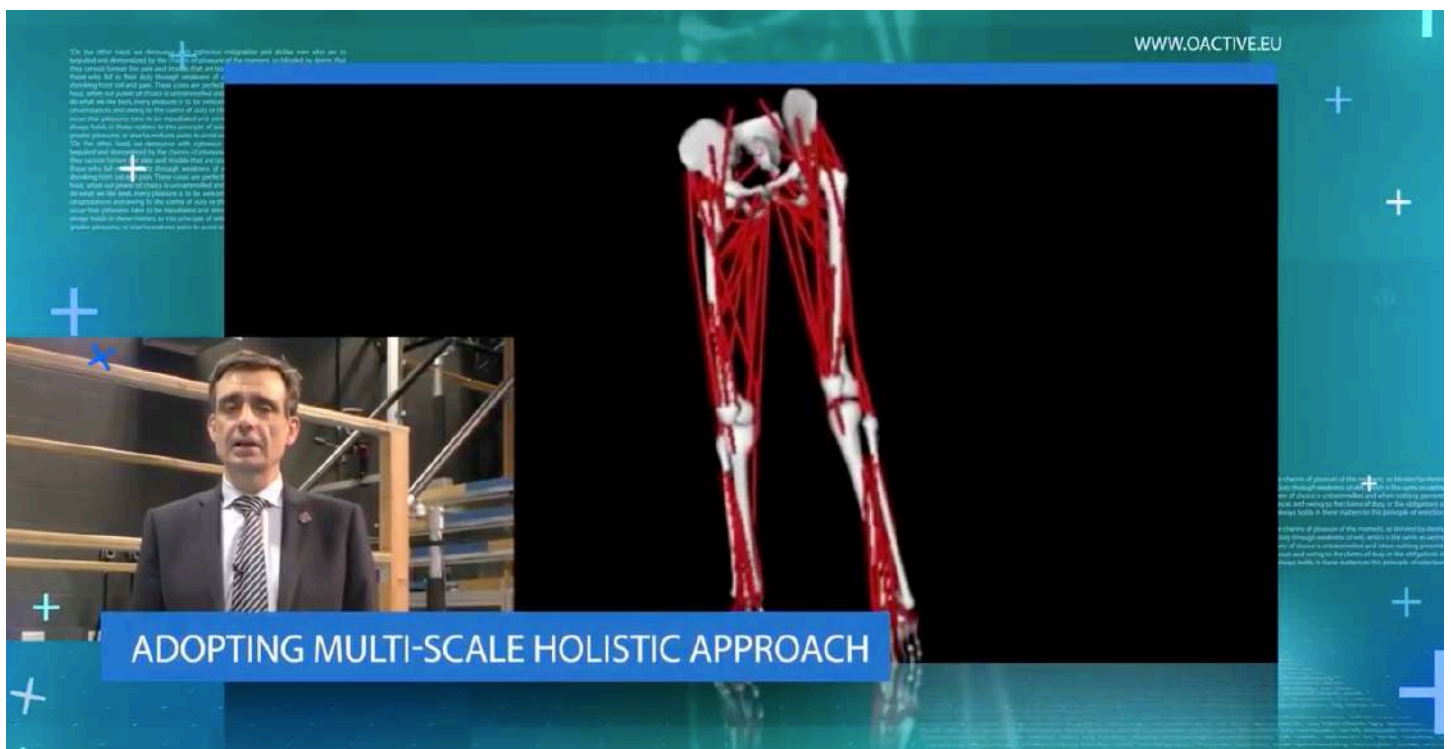
# OActive

# Our YouTube Channel



## OActive on YouTube SUBSCRIBE!!!

<https://www.youtube.com/channel/>



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# The Consortium

Join us at:



# OActive



**13** PARTNERS



**7** COUNTRIES



**3** YEARS



**5M.** FUNDING

## Project Title:

Advanced personalised,  
multi-scale computer models  
preventing osteoarthritis  
SC1-PM-17-2017 – Personalised  
computer models and in-silico  
systems for well-being  
Type of action: Research and  
Innovation action (RIA)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 777159.