



## PROJECT DELIVERABLE REPORT



### Project Title:

Advanced personalised, multi-scale computer models preventing osteoarthritis  
 SC1-PM-17-2017 - Personalised computer models and in-silico systems for well-being

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<b>Project coordinator</b>	University of Nicosia (UNIC)
<b>Tel:</b>	+357 22 841 528
<b>Fax:</b>	+357 22 357481
<b>Email:</b>	<a href="mailto:felekkis.k@unic.ac.cy">felekkis.k@unic.ac.cy</a> & <a href="mailto:giannaki.c@unic.ac.cy">giannaki.c@unic.ac.cy</a>
<b>Project web site address</b>	<a href="http://www.oactive.eu">www.oactive.eu</a>

**Revision History**

<b>Version</b>	<b>Date</b>	<b>Responsible</b>	<b>Description/Remarks/Reason for changes</b>
1.0	2020/2/27	Axia Innovation	First Draft
1.1.	2020/2/28	UNIC	Review of first draft
1.2.	2020/2/28	LEITAT	Review of first draft
1.3	2020/1/29	UNIC	Review final draft

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## **1 Summary**

This report refers to Deliverable 10.2, which relates to the OActive Work Package (WP) 10 “Dissemination and exploitation routes”, and specifically Task 10.5. Organizing the OACTIVE Workshop and training Sessions. Therefore this report describes: i) the purposes of the two planned Training Sessions I and II , ii) an analysis step by step from the organization point of view, the content and the realization of the sessions; and iii) the feedback from the consortium and the end users respectively on the content, the preparation and the execution of the training sessions planned within the GA.

## 2 Introduction

The presented Report on Deliverable D10.2: Training seminars summarises the training activities organized under the OActive project. Firstly, the process of technology and knowledge transfer was therefore supported by the appropriate focused training of partners. In order to ensure the wide-scale uptake of knowledge and technology generated within the sector, the partners involved structured dedicated training programs for the internal staff. In addition, the efficient transfer of knowledge and expertise from the RTD partners to the rest of the Consortium was also executed. Furthermore, the second training session was organised operating as a driver for the training of future end users.

The main objective of the reported training sessions was to support the prevention, diagnosis as well as delayed progression of OA by providing to key stakeholders (public and private) a background knowledge and awareness on the technologies OActive is using.

The Workshops' target groups involved the representatives of health sector (hospitals, doctors, health related associations), research organization and academia, OA patients, policy makers, stakeholders, investors as well as the general public,

Therefore, the training team has organised two sessions: one training session (and feedback) targeting to technology providers and a second one for elaborating the work performed and the possibilities for end users. The description of such activities is provided below.

### 2.1 Purpose and Scope

#### 2.1.1 Objectives

The main objective of the Training seminars was to transfer the knowledge acquired under the OActive project to all the interested groups in order to highlight the benefits of the technologies involved and the processes followed during the project to the quality of life of the patients. Under OActive the proposed solution takes a unique, holistic approach to patient-specific predictive model development by extracting and integrating knowledge from scientific research, clinical experiences, observations and available patient data using advanced analytic techniques. Since the Project successfully connects innovative methodologies, including tissue engineering, biomarkers' analysis, mechanistic modelling, deep learning and augmented reality, there was a high interest from all participants, and it was indicated that in many cases there was a lack of awareness about these technologies. Therefore, having better understanding of the technology and its advantages (gained thanks to the training activities) will:

- understand the risk factors for the development and progression of OA
- provide personalised interventions
- simulate and predict optimal treatments, better diagnostics, and improved patient outcomes
- help patients' improved quality of life
- inform health industry on alternative practices
- improve healthcare by transforming and accelerating the OA diagnosis and prediction
- offer both clinical assessment and rehabilitation options, through Augmented reality (AR) practices
- expand & improve the currently limited opportunities for rehabilitation scenarios
- enhance primitive spatial and temporal training scenarios
- addresses staff and facility limitations as well as human factors

### 2.1.2 Target groups

The main target groups, to whom the training seminars were oriented, involved the representatives of hospitals, rehabilitation centers, medical care centers, medical institutes, health service providers, physicians, caregivers, companies in the health field or/and in the ICT field, general public OA patients and their families, elderly, athletes, medical organisations, orthopaedic associations, regulatory authorities, NGOs, non-profit organizations, public initiatives, medical and ICT universities and research centers, participants in related EU projects, research societies, interested in early diagnosis and prediction of diseases or interested in computer based modelling and simulation tools technologies, cognitive systems or human interfaces.

### 2.1.3 Topics and Instructors

The training workshops' agendas and training material were prepared by OActive project partners. During individual training sessions (which were held in english languages), particular topics were presented, representing different working groups of the consortium:

- Clinical trials and serum biomarkers
- Environmental biomarkers
- Tissue Engineering
- Multiscale mechanistic modelling and Gait Analysis
- Big data and deep learning
- Augmented reality

The presenters of the first training session were: University of Nicosia, LEITAT, ANIMUS Center, SMARTEX, RIMED, CERTH, LJMU, CETRI, University of Patras and KU Leuven. All training presentations were shared among the partners and the attendees, and they are kept in a freedcamp account managed by the coordination team.

The presenters of the second training session will be completed in month 36.

### 2.1.4 Number of participants

The number of participants that attended the first Training Session were 23. The participations derived from the internal staff of the entities comprising the consortium and their attendance aimed at familiarising with the technologies across the implementation of all WPs of the project.

### 3 Training Session I

#### 3.1 Preparation prior to the meeting

The internal meeting was organized among the project team with the outer goal of better understanding and overview of the technologies that have been developed by partners related to biomarkers and tissue engineering, as well as smart technologies used based on mechanistic modelling, big data analytics and their further applications. To enhance the attempt, a promotional material (Figure 1) was circulated to trigger the partners to participate and assist the efficient transfer of knowledge.

**Enhancing the communication between RTD and Computational partners through interactive training towards the effective attraction of patient participation.**

**The challenge: “Show me your world”**  
To ensure the best understanding and the efficient transfer of knowledge among RTD and computational partners a training session will be structured to bridge the two different worlds giving an opportunity of communication without the limits of OActive project’s roles and results.

**The solution: “Explain with simple words”**  
The partners will have the opportunity to present shortly significant simple concepts of their scientific “world” to the rest of the consortium. It is essential that the partners can involve internal staff that might plan to be educated in relevant fields. The training seminar will be divided in two sessions (a) the interactive training and (b) the interactive discussion as shown below.

**Section 1: Interactive Training**  
Enhancing the communication between RTD and Computational partners

**Section 2: Interactive Discussion**  
To identify suitable and effective manners to attract patient participation

**The value: “Now I know!”**  
The expected result of the training is that the partners will increase their understanding and awareness of the general concepts of clinical research part as well as computational. Within the training it is planned that a possible schedule of the next training session will be developed which is aimed to the end user’s aided to enhance their understanding of how suitable and effective are the products of the Oactive projects.

**How: “Yes I will help!”**  
You are invited to share your thoughts, doubts, ideas on the content as well as your contribution to the training session via a **questionnaire** prepared by AXIA. The overall training will last 3-4 hours maximum.

**OActive**

*Figure 1: Internal Promotional Material*

With the view to acquire all the suggestions and needs AXIA developed a questionnaire to make the internal training most beneficial from either the perspective of the trainee or the trainer. The questionnaire was divided in 2 sections as presented in Figure 2 covering via several questions the needs, the thoughts and the expectations of the partners.

The figure displays two screenshots of a web-based questionnaire. The top-left screenshot shows the 'Trainee Section' with the OActive logo and a title '[OActive] Training session scheduling'. It includes an introductory paragraph, a list of RTD and CD partners, and three required text input fields for name, organization, and email. The top-right screenshot shows a list of expertise areas with radio buttons and a 'Next' button. The bottom-left screenshot shows the 'Trainer Section' with a title '[OActive] Training session scheduling' and a 'Trainer Section' header. It contains a required text input for learning preferences, a list of specification areas with radio buttons, and three required text input fields for background knowledge and learning needs. The bottom-right screenshot shows a list of learning methods with checkboxes and three required text input fields for partner knowledge and learning needs. Navigation buttons 'Back' and 'Next' are visible at the bottom of the Trainee section.

Figure 2a: Questionnaire (Part 1, 2)



According to your given answers, please indicate a possible contribution of your organization (presentation, demonstration etc.)

Your answer \_\_\_\_\_

How much time will you need to present your work?

Your answer \_\_\_\_\_

Please suggest possible items to be presented (including ideas for other partners as well). \*

Your answer \_\_\_\_\_

Back Next

**Interactive Discussion related questions**

Can you suggest a list of issues to be discussed in order to structure a training session related to the end users? \*

Your answer \_\_\_\_\_

Would you like to discuss in this session possible ways to raise awareness and participation of patients to the data collection process? \*

Yes,

No

Back Next

*Figure 2b: Questionnaire (Part 3)*

The participation of the consortium to the online questionnaire provided the appropriate information to set up a structured agenda for the Training. The program was divided in three sections categorizing the partners’ work to the respective working groups. From each working group a lead partner would be the responsible to present on behalf of all the group the material that was prepared for the training.

*Table 1. Training Agenda*

Time	Agenda Item	Responsible
<b>INTRODUCTION SECTION</b>		
09.00	Short Introduction	Coordinator
<b>BIOMARKERS &amp; TISSUE ENGINNERING</b>		
09.15	WG1.Clinical trials and serum biomarkers	HULAFE, UNIC, ANIMUS, LEITAT
09.50	WG2.Environmental biomarkers	SMARTEX, CERTH, KULEUVEN
10:25	WG3. Tissue Engineering	RIMED
<b>11:00-11:15 Coffee Break (15 minutes)</b>		
<b>MECHANISTIC MODELING</b>		
11.15	WG4. Multiscale mechanistic modelling and Gait Analysis	LJMU, CERTH
<b>11:50-12:00 Coffee Break (10 minutes)</b>		
<b>BIG DATA &amp; AUMENT REALITY</b>		
12.00	WG5. Big data and deep learning	CERTH, CETRI
12.35	WG6. Augmented reality	UPAT
<b>ROUND TABLE</b>		
13.10	Discussion	All

As the period of the organisation of the training coincided with the 24M meeting of the Consortium it was decided at the regular monthly teleconference to have the training session within the frames of the 24M that was planned to be host at Ri.Med premises in Palermo on 25<sup>th</sup> and 26<sup>th</sup> of November. The Training was arranged at the second day of the meeting on 26<sup>th</sup> to give the opportunity to the participants to exploit and explore the content that would be covered at the Training Session as a separate activity with no links to the progress OActive's meeting. For this purpose Ri.Med team prepared a dissemination flyer containing the overall program of the both days including the special Training Session (Figure 3.)

**Fondazione Ri.MED**  
25<sup>th</sup>|26<sup>th</sup> NOVEMBER 2019  
PALERMO, ITALY

# 24 Month Meeting OActive

**PARTNERS**

- UNIVERSITY OF NICOSIA
- CERTH
- UNIVERSITY OF PATRAS
- SMARTEX
- KU LEUVEN
- CETRI
- LEITET
- Fondazione Ri.MED
- time lex
- ASIK INNOVATION
- ANIMUS
- Instituto de Investigación Sanitaria La Fe

**25<sup>th</sup> November**

9.30 WELCOME AND OPENING REMARKS BY THE HOST ORGANIZATION - Ri.MED

**STATUS UPDATE**

9.40 AGENDA OVERVIEW-MANAGEMENT, ADMINISTRATIVE AND OTHER ISSUES (WPI) - UNIC  
10.10 PROJECT WORK, PLAN AND NEXT DELIVERABLES-PRESENTATION FROM THE TECHNICAL MANAGER - CERTH, UNIC  
10.30 DISSEMINATION AND EXPLOITATION ACTIVITIES - CETRI, AXIA

11.00 **COFFEE BREAK**

**TECHNICAL SESSION - Part 1**

11.20 DISCUSSION IN GROUPS (BIOMECHANICS - BIOMEDICAL GROUP)  
Presentation of the work performed and future plans by all partners

12.30 **LUNCH BREAK Ri.MED**

**TECHNICAL SESSION - Part 2**

13.30 DISCUSSION IN GROUPS (BIOMECHANICS- BIOMEDICAL GROUP)  
Presentation of the work performed and future plans by all partners

15.00 **COFFEE BREAK**

15.10 **GENERAL DISCUSSION AND CLOSING REMARKS**

15.30 TOUR OF Ri.MED PREMISES

17.00 **END OF THE DAY**

20.00 **DINNER**

**26<sup>th</sup> November: Training Session I**

**INTRODUCTION SECTION**

9.00 SHORT INTRODUCTION  
Coordinator

9.15 WG1. CLINICAL TRIALS AND SERUM BIOMARKERS  
Rowan Messinger & Christos Papanicolytaou

9.50 WG2. ENVIRONMENTAL BIOMARKERS  
Giuliana De Toma

10.25 WG3. TISSUE ENGINEERING  
Roberto Di Geronzi

11.00 **COFFEE BREAK**

**MECHANISTIC MODELING**

11.15 WG4. MULTISCALE MECHANISTIC MODELLING AND GAIT ANALYSIS  
David Barfoot & Dimitris Tsapras

11.50 **COFFEE BREAK**

**BIG DATA & AUGMENTED REALITY**

12.00 WG5. BIG DATA AND DEEP LEARNING  
Dimitrios A. CETRI

12.35 WG6. AUGMENTED REALITY  
Giorgos Giarmatzis

13.10 **ROUND TABLE AND WRAP UP**

**OActive HORIZON 2020**

Figure 3: Meeting Agenda

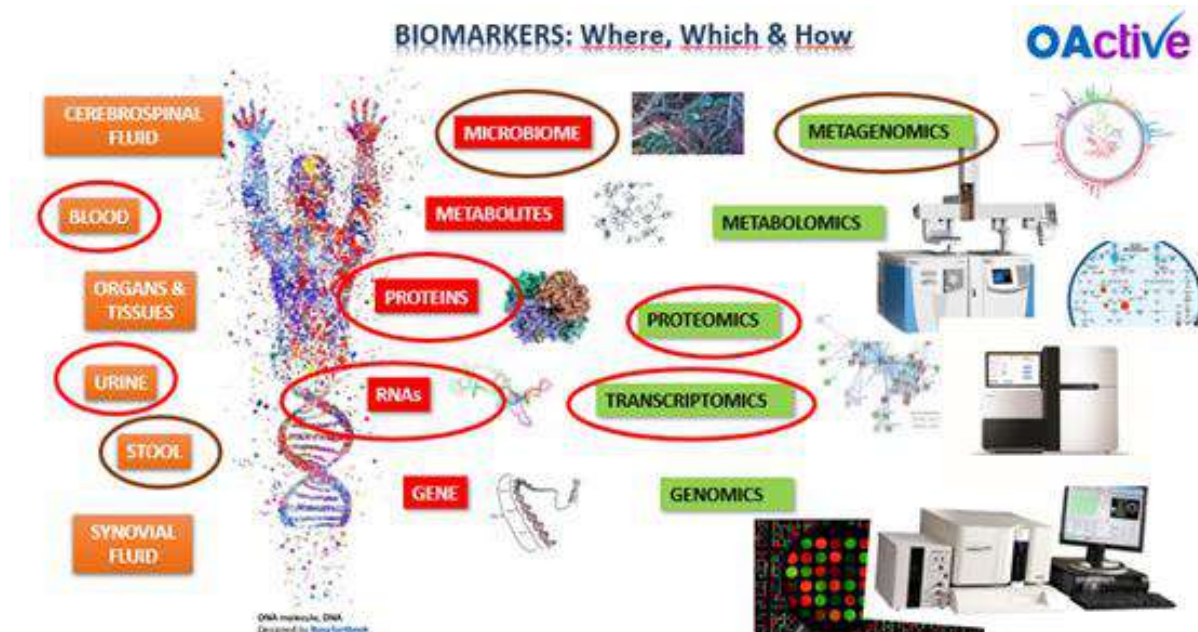
### 3.2 Presentation during the meeting

During the meeting an introduction was given from the coordinator on the content of what the training working groups will cover. The session was insightful, interactive and triggered the interest of all the participants to get involved actively. The anointed trainers brought all the useful material and devices to communicate best their technological advancements. Figure 4 summarizes some of the activities of the team using the devices demonstrated during the meeting. An additional 10 minutes at the end of each presentation of the session was given to address all questions, all concerns and suggestions.



*Figure 4: Activities of the OActive team during the interactive Training Session*

The following Figure includes some slides of the respective presentations provided by the project partners.



### BIOMARKERS: Microbiome



Specific compositions of the microbial community are associated with health and disease and suggest that the detailed characterization, function and variation of the microbiome will reveal important commensal host-microbe as well as microbe-microbe interactions with diagnostic, therapeutic and preventive implications.

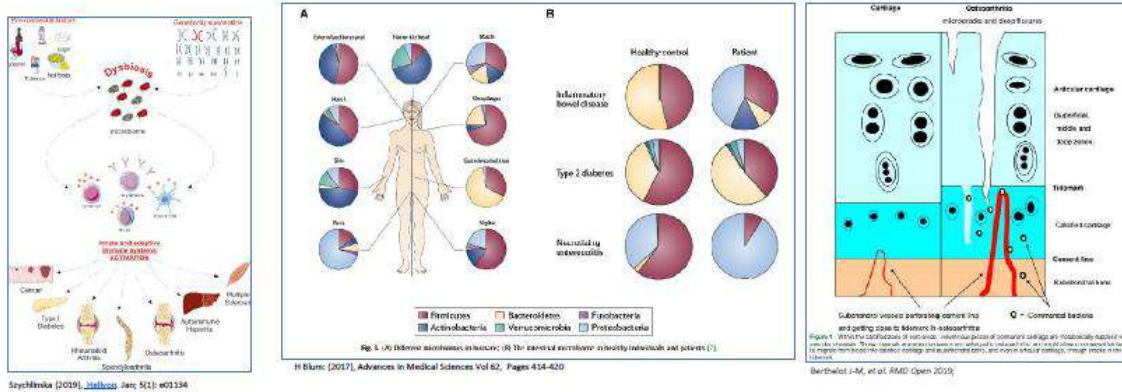
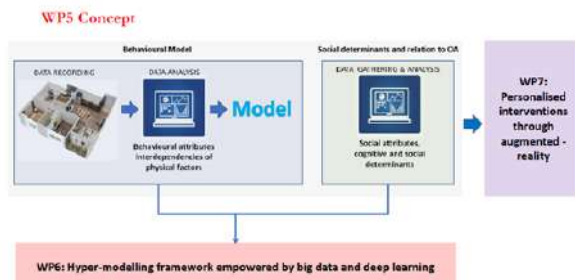


Figure 5: Indicative presentation slides presented during training Session I of OActive regarding biomarkers



**T 5.1: Design and development of OACTIVE wearable sensors**

**Controlled condition monitoring**  
Up to 6 IMUs

**Electronics for multiple devices acquisition**  
IMU 9250 by InvenSense (9 DOF)  
Bluetooth 2.1 wireless transmission  
Data transmitted: Quaternion, 3 Accelerometer, 3 Gyroscope, 3 Magnetometer  
Sampling frequency IMU 100Hz  
Rechargeable battery 650 mAh  
Sleeves (MAX 6) paired with a single master  
Case and package optimized for handling and comfort when worn

**T 5.1: Design and development of OACTIVE wearable sensors**

**IMUs wearable system: textile, garment & accessories**

1 Viability study	2 Sensor's functionality study	3 Integrative study	4 Prototype study
RESEARCH OBJECTIVES			
Model and pattern of the prototype			
Cutting of the fabric components of the prototype			
Manufacturing			
Testing: laboratory evaluation, usability test			
Changes of the model according users feedback			

**T 5.1: Design and development of OACTIVE wearable sensors**

**Remote monitoring**

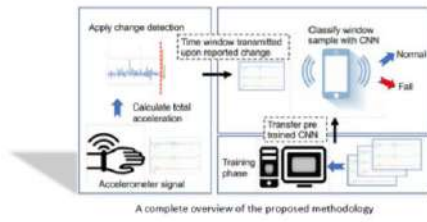
**Electronic for single devices acquisition**  
IMU 9250 by InvenSense (9 DOF)  
Raw Data acquired and stored on board: Quaternion, 3 Accelerometer, 3 Gyroscope, 3 Magnetometer  
Data extrapolated on board: Activity Classification (laying/standing, walking, running), Activity Intensity, Pace Counter  
Sampling frequency IMU 25Hz  
Software for data export in CSV format

A) Mode switch B) Reset hole C) Micro USB

**Task 5.2: User behaviour analysis**



**WORKFLOW OF THE FALL DETECTION SYSTEM**



**Task 5.3: Social determinants and relation to OA**



Definition “variables that are not outcomes of studies, but need to be recognized (and measured) to understand the study results. This includes potential confounders and effect modifiers...” (outcome measures in rheumatology, OMERACT.org)



KUL – KU Leuven Musculoskeletal Rehabilitation Research Unit

*Figure 6: Indicative presentation slides presented during training Session I of OActive regarding Behaviour modelling and environmental biomarkers*

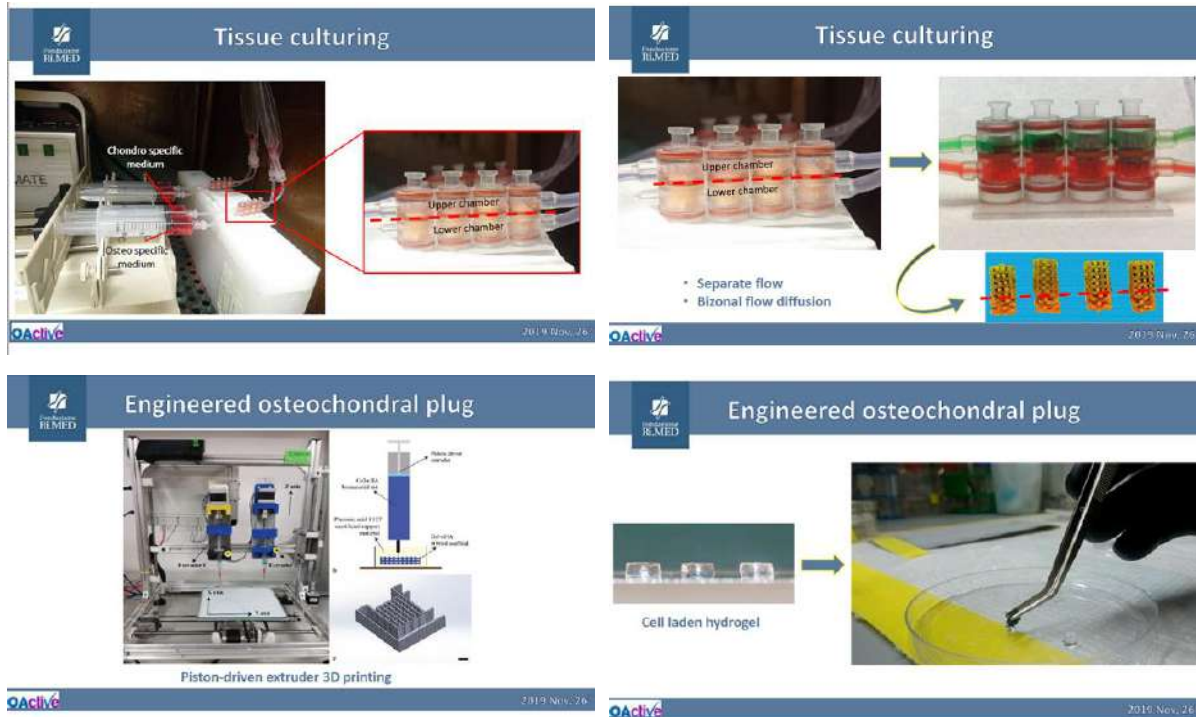
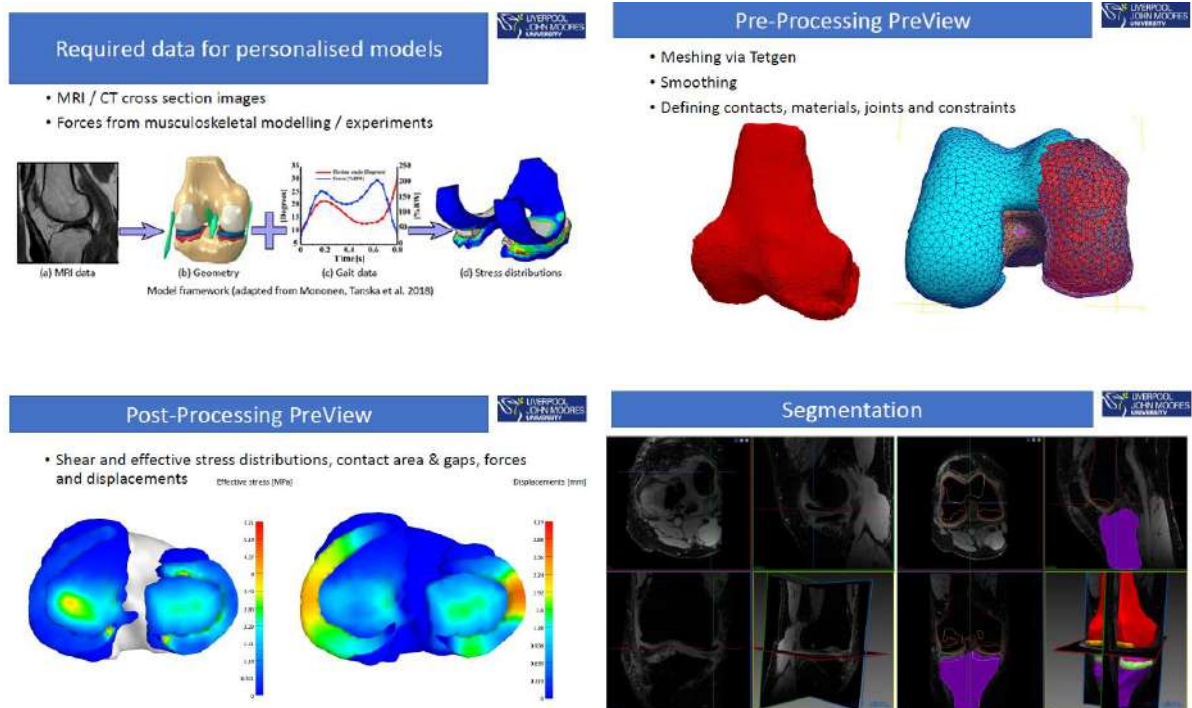


Figure 7: Indicative presentation slides presented during training Session I of OActive regarding tissue engineering



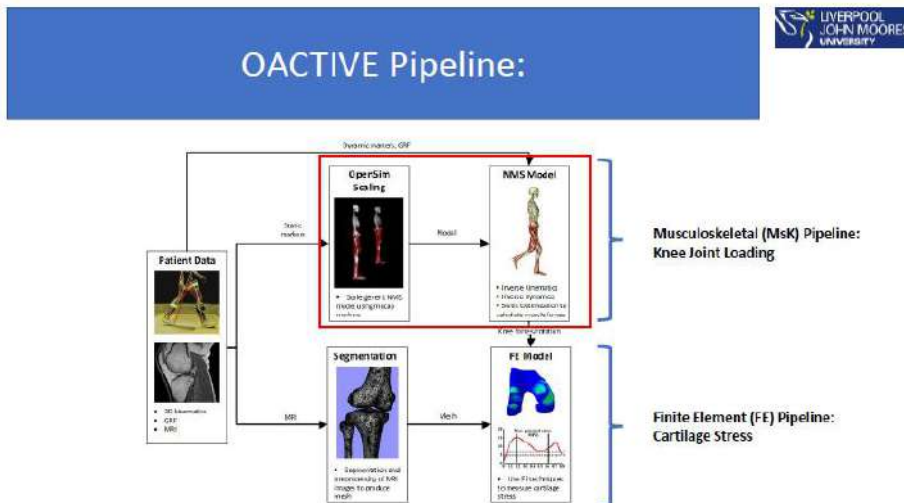
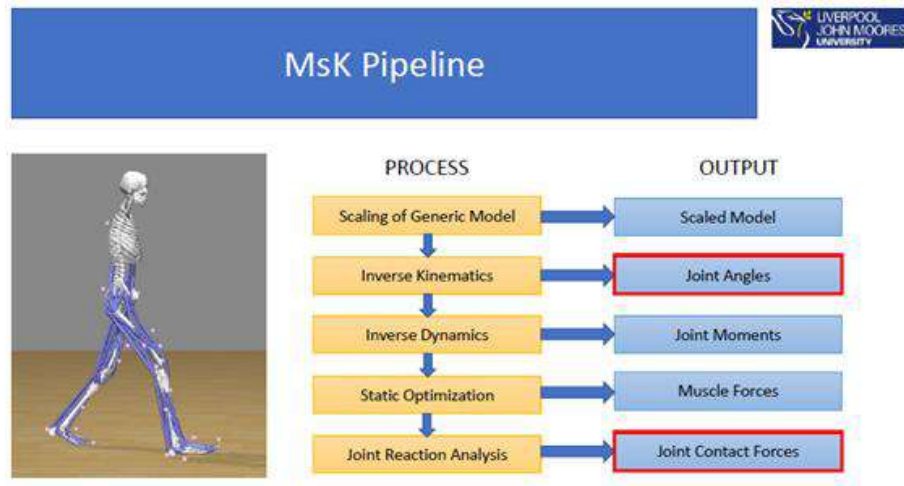
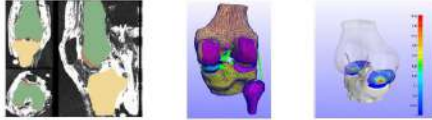


Figure 8: Indicative presentation slides presented during training Session I of OActive regarding Musculoskeletal (MsK) analysis

### AUTO-SEGMENTATION TOOL

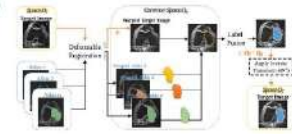


1. Automatic segmentation of a target MRI
2. Geometry refinement for finite element analysis



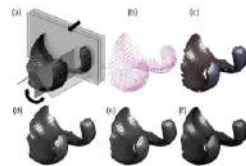
### SEGMENTATION

1. Based on multi-atlas approach
  1. Based on OpenKnee project
  2. Dataset of atlases is registered to achieve spatial correspondence
  3. Label fusion strategy
    1. Local patch search strategy



### MESHING

1. Segmentation produces "noisy" structures
2. Smoothing method removes rough surfaces and irregular components
3. Cartilages are subdivided into layers
4. Geometries are extracted using a geometry sweeping algorithm
5. Suitable for finite element analysis



### RESULTS



Femoral cartilage layers grouped into three zones that permits the assignment of different material properties to model different cellular synthesis

Figure 9: Indicative presentation slides presented during training Session I of OActive regarding the auto-segmentation tool

### INTERFACES - VICON



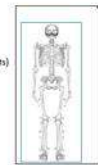
1. Vicon: Motion capture system
  1. Reflective markers placed on anatomical landmarks
  2. Camera with infrared light emitting diodes
  3. Force plates on the floor
  4. Record of X,Y,Z coordinates of markers
  5. Vicon Datastream sdk as communication tool
    - a) IP of the host computer
    - b) Remote use as an option
  6. Streaming data to Opensim



### INTERFACES - OPENSIM



1. Real-time musculoskeletal modeling
  1. Scaling a generic musculoskeletal model
    - a) Static trial
  2. Inverse kinematics (inputs: marker trajectories, outputs: joint angles)
  3. Inverse dynamics (inputs: joint angles/ground reaction forces, outputs: joint moments)
  4. Static optimization (most time consuming)
    - a) Calculation of muscle moment arms before actual calculations
    - b) Decrease iterations for solving the force distribution problem
  5. Joint reaction forces
    - a) Calculation of joint contact forces



### INTERFACES - UNITY



1. Unity: 3D visualization engine
  1. Force visualization
    1. Ground reaction forces from force plates
    2. Reaction forces in the joint level
    3. Vector visualization
  2. Graphical representation of variables
    1. Kinematic/kinetic/force variables



### INTERFACES - AUGMENTED REALITY

1. Score based on performance
  1. Gamification element - Intuitive interaction with the subject
  2. Integration with a virtual reality environment



Figure 10: Indicative presentation slides presented during training Session I of OActive regarding the virtual reality platform



### **3.3 Comments and feedback**

After working together 24 months, our team decided as it was initially planned within the GA to realize a training session that would make all the involved technology providers and scientists to feel more comfortable with the basic concepts of each other's scientific background and their state of the art. The purpose was to boost further effective promotion of the project in events, conferences as well as to further impel collaborations and exploitations of the project results within and out of the project. After and during the presentations each of the project partner took the role of a possible patient with osteoarthritis and had the opportunity to test the services that will be provided to the end users. In general, partners engaged to the content and the feedback during the networking breaks was positive and encouraging. The realization of the Training Session I will set a great start and a good practice to schedule and structure the Session II where the respective actions would have to be addresses towards the end users.

#### **4 Training Session II**

To be completed on month 36.

## **5 Conclusions**

The reported Training Sessions refer to training activities targeting to internal staff of the consortium included entities as well as end users of the technologies developed under the OActive project. All presenters fulfilled their role and met assumed objectives. In total, 2 training sessions were held attended by about representatives of the target groups.

In common opinion of participants, the trainings were evaluated as important events, being the most recent source of information on the possibilities, technologies, purposefulness and the need to raise awareness on advanced personalized interventions for combating OA. The attendees indicated high substantial and organization level of the training workshops.

**ANNEX I:**