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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

Multiplier Event on the Experiencing of e-Learning Platform for Biomechatronics,

hosted by Bizzcom s.r.o. company, in Bucany, Slovakia
13th September 2023

This results was realised with the EEA Financial Mechanism 2014-2021 financial support. Its content (text, photos, videos) does not reflect the official opinion of the Programme Operator, the National Contact Point and the Financial Mechanism Office. Responsibility for the information and views expressed therein lies entirely with the author(s)

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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

- **Assoc. Prof.dr.eng. Razvan Pacurar**
- Department of Manufacturing Engineering,
- Faculty of Industrial Engineering, Robotics & Production Management, TUCN, RO
- Coordinator of the SEE - 21-COP-0019 – EMERALD project

MULTIPLIER EVENT – 13 SEPTEMBER 2023 – BUCANY (SLOVAKIA)

This project has been funded with support from the SEE 2014-2015 financial mechanism. Its content (text, photo, video) reflects the views only of the authors and not the official opinion of the Program operator, national contact point or Financial Mechanism Office.

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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

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EMERALD: European network for 3D printing of biomimetic mechatronic systems
EEA & Norway Grant - Contract No. 21-COP-0019

MULTIPLIER EVENT on Experiencing of e-learning platform for bio-mechatronics

organized by BIZZCOM s.r.o. company, Slovakia

– Event agenda- 13th of September 2023

	Session 1 – EMERALD e-learning platform for bio-mechatronics
8:30	Registration of participants to the Multiplier Event
9:00	Opening and Welcome ceremony: Branislav Rabara – Director of BIZZCOM s.r.o. company (Slovakia)
9:15	EMERALD project overall presentation – progress, actions, KPIs, perspectives / details about the event – Associate Prof. Răzvan Păcurar (Technical University of Cluj-Napoca, Romania)
9:30	EMERALD main concept of the EMERALD e-learning platform for bio-mechatronics - Associate Prof. Răzvan Păcurar (Technical University of Cluj-Napoca, Romania)
9:45	EMERALD – e-learning platform for bio-mechatronics – presenting of CAD / CAE virtual laboratory room e-learning facilities - (Associate Prof. Răzvan Păcurar – Technical University of Cluj-Napoca - Romania)
10:15	EMERALD – e-learning platform for bio-mechatronics – presenting of 3D scanning and 3D printing virtual laboratory rooms e-learning facilities - (Associate Prof. Filip Gorski – Poznan University of Technology - Poland)
10:30	EMERALD – e-learning platform for bio-mechatronics – presenting of Testing and Materials characteristics virtual laboratory room e-learning facilities - (Associate Prof. Diana Băilă – University Politehnica Bucharest - Romania)
10:45	EMERALD – e-learning platform for bio-mechatronics – presenting of Sensoring, Programming and Assembling virtual laboratory rooms e-learning facilities - (Prof. Filippo Sanfilippo – University of Agder - Norway)
11:00	EMERALD – e-learning platform for bio-mechatronics – presenting of VR / AR virtual laboratory room e-learning facilities - (Martin Zelenay – BIZZCOM - Slovakia)
11:15	Conclusions about the content and future perspectives on improving the use of the EMERALD – e-learning platform for bio-mechatronics/ realizing of bio-mechatronics systems to support people with special needs (amputated arms) (Technical University of Cluj-Napoca, Romania)
11:30	Coffee break / Press conference

AGENDA

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	Session 2 – Experiencing the – EMERALD e-learning platform for bio-mechatronics / VR / AR / MR experience
12:00	Opening of the session and organizing aspects related to the EMERALD e-learning platform for bio-mechatronics experiencing / dividing in groups (Martin Zelenay – BIZZCOM (Slovakia)
12:15	Experiencing the virtual rooms of the EMERALD e-learning platform for bio-mechatronics (testing on the computer) / Experiencing of VR applications using VR googles / Experiencing AR applications using tablets /collection of feedbacks (all partners + participants to the Multiplier Event)
13:15	Conclusions about the experiencing of the EMERALD e-learning platform for bio-mechatronics and discussions related to feedbacks /aspects that are still necessary to be improved in the e-learning platform / round table discussions (Martin Zelenay – BIZZCOM (Slovakia)
13:45	Comments and discussions on the possibility of joining different projects / consortium / EU Networks - Branislav Rabara – Director of BIZZCOM s.r.o. company (Slovakia)
14:15	Closing words / ending of Multiplier Event
14:30	Lunch break

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Content

1. **Main aims and details of the EMERALD project.**
2. **Main activities of the EMERALD project. General presentations of the Intellectual Outputs. Most important KPIs of the EMERALD project.**
3. **Main actions of the EMERALD project. Summarizing of the planned actions**

1. Main aims and details of the EMERALD project

EMERALD project – EEA grants financed in the frame of SEE mechanism

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The National Agency for Community Programmes in the Fields of Education and Vocational Training

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Selection Results – Cooperation projects

Round 2021 – APPROVED

No.	Reference number	Project title	Project Promoter	Town	Partner in Donor State	Final score	Requested budget (EUR)	Approved budget (EUR)
1	21-COP-0019	European network for 3D printing of biomimetic mechatronic systems	Universitatea Tehnica din Cluj-Napoca	Cluj-Napoca	University of Agder, NO	115	199,950	198,810
2	21-COP-0004	Bringing Real Life into Virtual Classrooms	Universitatea de Vest din Timisoara	Timisoara	Norwegian University of Science and Technology, NO	110	94,237	89,353

Total Budget: 198.810 EUR

Total Duration: 2 years

Starting date: 15.02.2022

Ending date: 30.09.2023

Coordinator

TECHNICAL UNIVERSITY OF CLUJ-NAPOCA ROMANIA

TU Cluj-Napoca (RO)

Partners from Higher Education institutions

UiA University of Agder

University of Agder (NO)

University POLITEHNICA Bucharest (RO)

Poznan University of Technology (PL)

bizzcom (SK)

Scientific background and experience used to define the main aims and expected outcomes of the EMERALD project

Providing **teaching resources and methods for professors** coming from the Higher Education institutions that are interested to find ways in providing their **students** relevant knowledge, skills and competences in conceiving, developing and realizing of different biomimetic mechatronic systems by 3D printing methods for people with special needs (amputated arms), such as:

- EMERALD **support e-courses** related to the objective (based on one curriculum defined by the EMERALD consortium)
- EMERALD **e-toolkit manual** for digital learning (correlated with the support courses)
- EMERALD **e-learning virtual laboratory** platform for developing, producing and testing of biomimetic mechatronic systems made by 3D printing (in correlation with the support e-courses and the e-toolkit manual)
- EMERALD **e-case studies** for project based learning method used in developing, testing and manufacturing of new types of biomimetic mechatronic systems made by 3D printing technologies for people with special needs (amputated arms)

The advantages of the EMERALD methods will be that the **professors and students will gain knowledge and competences related to the developing, designing, producing of biomimetic mechatronic systems made by 3D printing methods and testing of developed systems that are aimed to support people with special needs (amputated arms) in the end.**

Background of the EMERALD project interdisciplinary domains / interconnections with previous EEA grants

ARMIN ARM NEUROPROSTHESIS EQUIPED WITH ARTIFICIAL SKIN AND SENSC

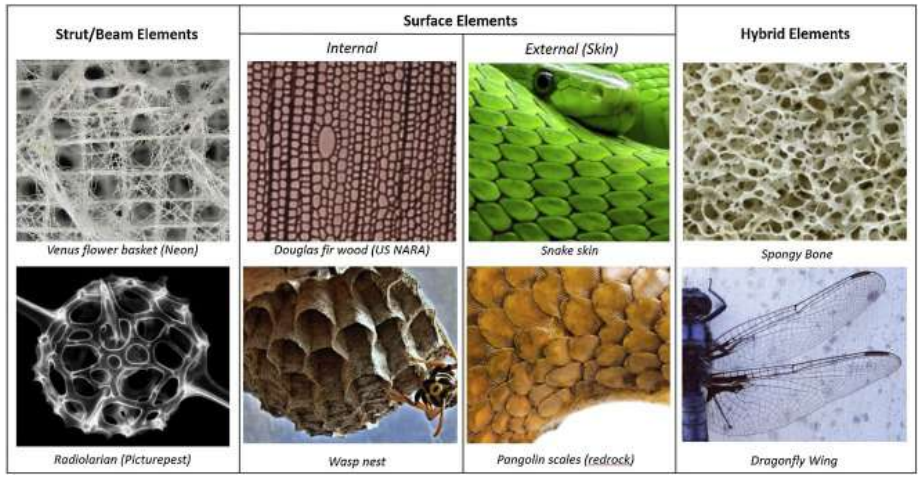
ARM NEUROPROSTHESIS EQUIPED WITH ARTIFICIAL SKIN AND SENSORIAL FEEDBACK - ARMIN

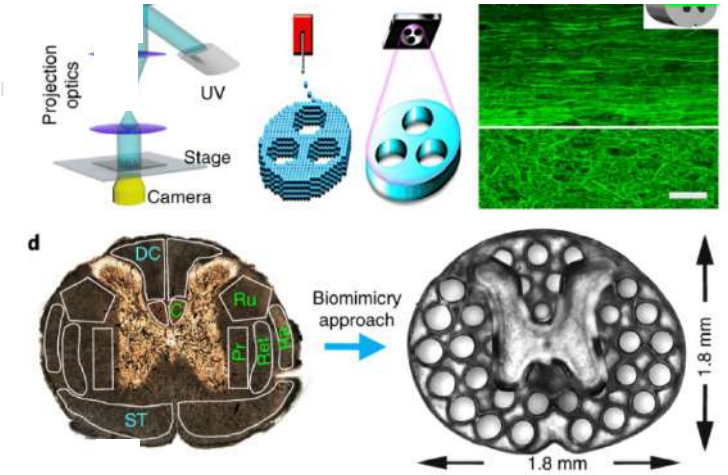
Partners: UPB, National Institute of Microtechnolgy, Clinical Hospital of Floreasca, Medical Science Academy, Areus Technology, University of South-Eastern Norway, budget approx. 1.510.000 euro

The main objective of the project *was to design and fabricate the command and control system of a neuroprosthesis that integrates the motion algorithms with the command and sensory signals. The sensorial feedback system is re-establishing the sensorial function of amputated arms and is able to achieve high precision movements when handling objects with the neuroprosthesis. To design and fabricate a set of regenerative neural bio-interfaces for selecting and stimulating (from ulnar and median nerves), the sensory axons considered being in charge with the transmission of tactile sensations from palm and fingers, before amputation has been developed. These bio-interfaces allow the tactile signals from the fingers and palms of the neuroprosthesis to be transmitted through these sensory axons. In this way the patient actually feels tactile feedback sensations when handling objects with neuroprosthesis. To mount a fully functional neuroprosthesis on the patient stump, it was needed to connected to the peripheral nervous system of the patient.*

For delivering the arm neuroprosthesis prototype (implanted in the patient stump and WiFi connected to the prosthesis hand), most of lost arm and hand functions were achieved by 3D printing.

Background of the EMERALD project
interdisciplinary domains / innovative things that are to be considered

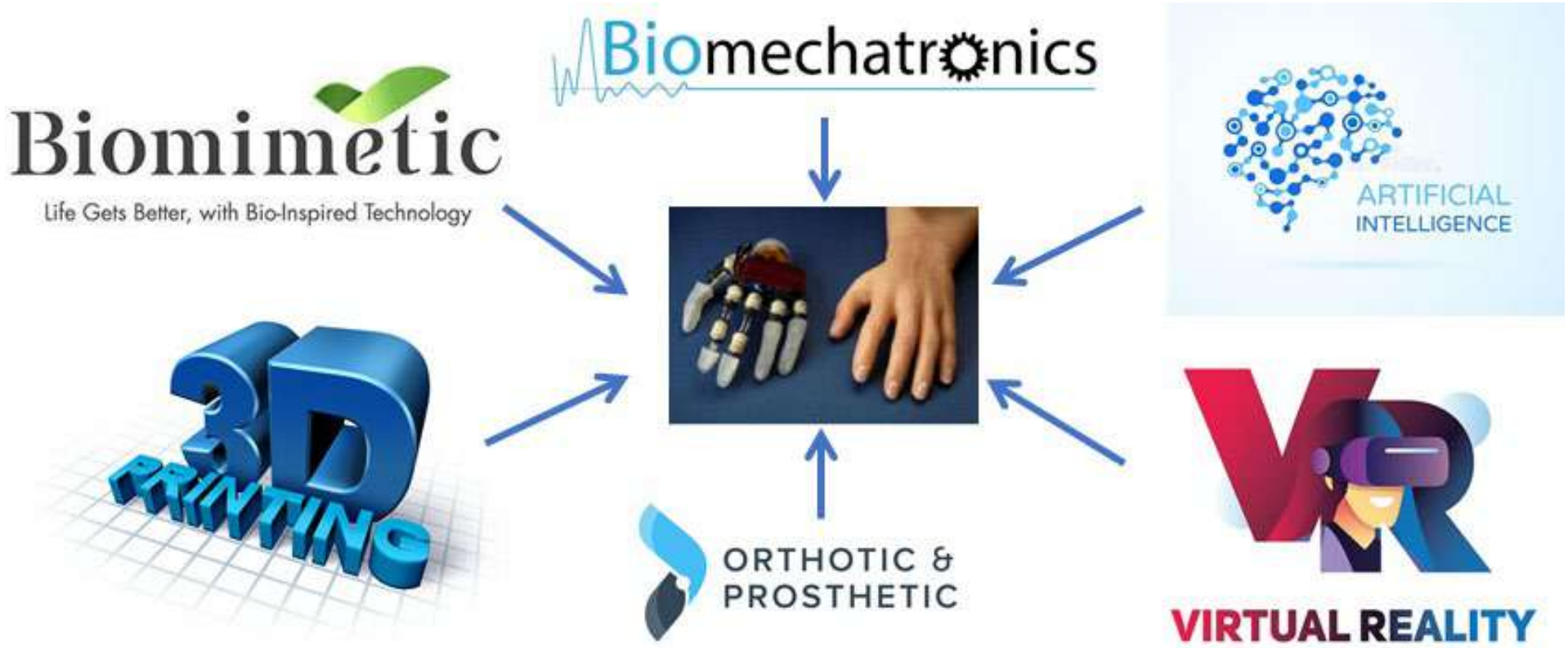




Biomimetic structures to be materialized by 3D printing methods

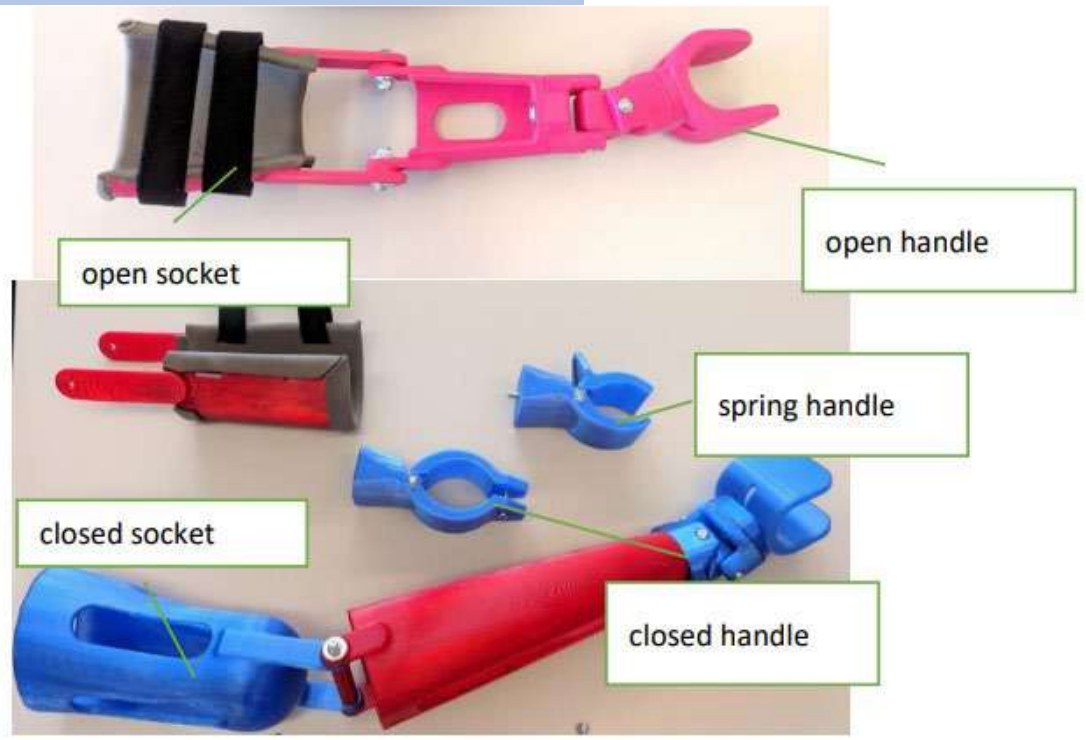
Definition: **Biomimetic (biomimicry)** refers to human-made processes, substances, devices, or systems that imitate nature.
The field is of top interest to researchers involved in 3D printing, nanotechnology, robotics, artificial intelligence, smart (intelligent) materials, medicine, industrial applications (aerospace industry, automotive, etc).

Defining of the of the project idea and main concept



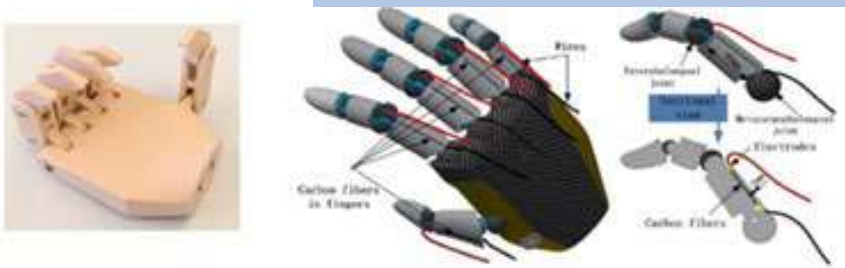
Case studies proposed to be solved in the EMERALD project

Bicycle prosthesis used by various patients [PUT project report]



Components of the bicycle prosthesis [PUT project report]

Case studies proposed to be realized in the EMERALD project



Universal prosthetic hand with mechanical fingers [PUT materials]

Corrective WHOs for patients with shoulder dystocia [PUT project report]

Orthyo sensors available at PUT [orthyo.com]

3D printed waterproof AFOs for patient with severe spina bifida

Therapy using VR applications (gamification)

Target audience (groups) / relevant stakeholders to be involved in the project)

The EMERALD project proposal is addressing to the professors and students that are interested in gaining knowledge and competences related to the developing, designing, producing of biomimetic mechatronic systems made by 3D printing methods and testing of developed systems that are aimed to support people with special needs (with amputated arms). They are the main target audience / to whom the project is being addressing to.

People with special needs are beneficiaries (end users) of developed solutions in the EMERALD project.

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European Network For 3D Printing Of Biomimetic Mechatronic Systems

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Target audience (groups) / relevant stakeholders to be involved in the project)

Conceiving of the European network for 3D printing of biomimetic mechatronic systems is one objective of the project. This will be done by finding the proper ways to involve the major stakeholders in the project (Public organizations, Health / Medical institutions, 3D printing companies, SMEs, clusters), etc through the activities organized in the project (multiplier events, summer school activities). Stakeholders are the key actors that might benefit of the project results.

Involving of local authorities

materialise
3D SYSTEMS
SLM SOLUTIONS
Stratasys
envisionTEC
symme3D
Nutechnologies
CADWORKS
SOLFINS
OMNI3D
SPEE3D
bizzcom
ADR NORD-VEST
TRANSILVANIA IT CLUSTER
MDPI
IntechOpen

Attracting of most important companies and organizations that are acting in 3D printing / bio-mechatronics sector – EMERALD aim is to build an EUROPEAN Network also

TUCN – strategic partner within the European University of Technology EuT+ (https://www.univ-tech.eu/) and ERASMUS + programs

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2. Main activities of the EMERALD project. General presentations of the Intellectual Outputs. Most important KPIs of the EMERALD project

European Network For 3D Printing Of Biomimetic Mechatronic Systems

Quick overview of the Intellectual outputs related to the EMERALD project

IO1	EMERALD e-book for developing of biomimetic mechatronic systems	TUCN
IO2	EMERALD e-toolkit manual for digital learning in producing biomimetic mechatronic systems	*University of Agder*
IO3	EMERALD e-learning VR / AR platform for programming and using biomimetic mechatronic systems	*Bizzcom*
IO4	EMERALD e-case studies for project based learning method used in developing, testing and manufacturing of new biomimetic mechatronic systems by 3D printing technologies	*Poznan University of Technology*

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European Network For 3D Printing Of Biomimetic Mechatronic Systems

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I01 - EMERALD e-book for developing of biomimetic mechatronic systems

Start Date : 15 Feb 2022 **End Date : 31 Jul 2022**

Responsible: Technical University of Cluj-Napoca

The main aim of the I01 is to provide the proposed **CURRICULUM** for increasing the application of research results in regenerative medicine, human-machine interfaces, advanced robotics, new paradigms in biomimetic mechatronic systems, etc. The curriculum comprise **8 MODULES.**

Open access on the platform?

Content?

Template?

Report?

MODULES	RESPONSIBLES
1. Computer Aided Design (CAD)	PUT
2. Computer Aided Engineering (CAE)	TUCN
3. Computer Programming	UiA
4. Virtual Reality / Augmented Reality	PUT & BIZZCOM
5. Sensors and Electronics	UPB
6. Bio-Mechatronics	UiA
7. 3D printing and Rapid Tooling methods	TUCN
8. Intelligent (smart) materials	UPB

Starting: **15.02.2022**

Deadline: **31.07.2022**

For each module according to the skills and competences of the EMERALD partners consortium, from the **Technical team there will be nominated 1-2 responsible persons** which will be in charge with one module and will need to provide course support for the particular module courses necessary for **producing biomechatronic / biomimetic systems**.

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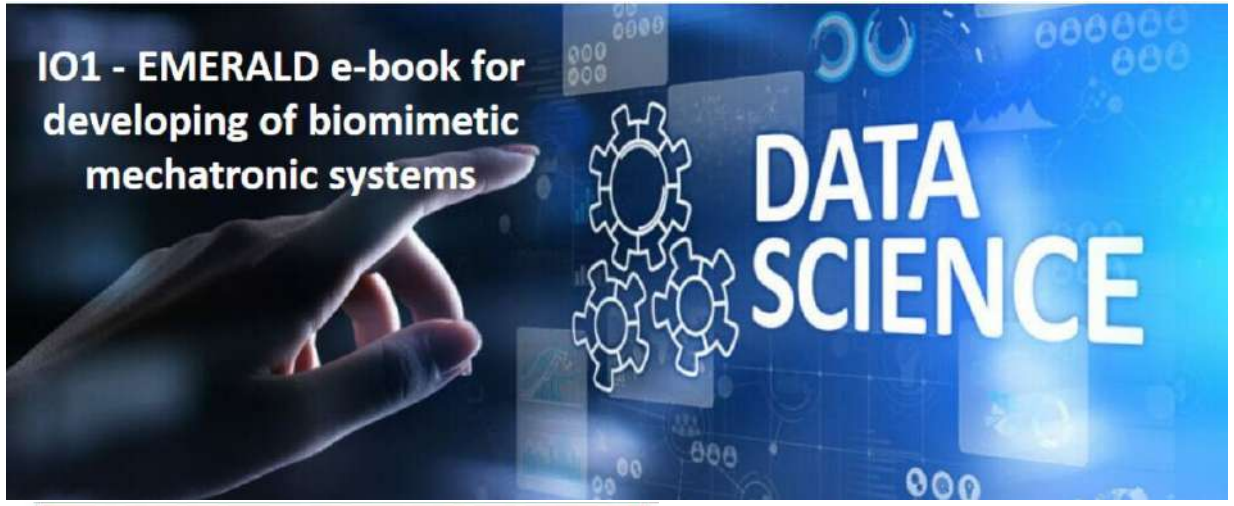
HOME PROJECT RESULTS

8 course modules relying on the curriculum conceived by the EMERALD consortium partners, each course module comprising 25-30 pages each were finalized by the EMERALD consortium partners and are available on the EMERALD project website

Intellectual Output – IO1

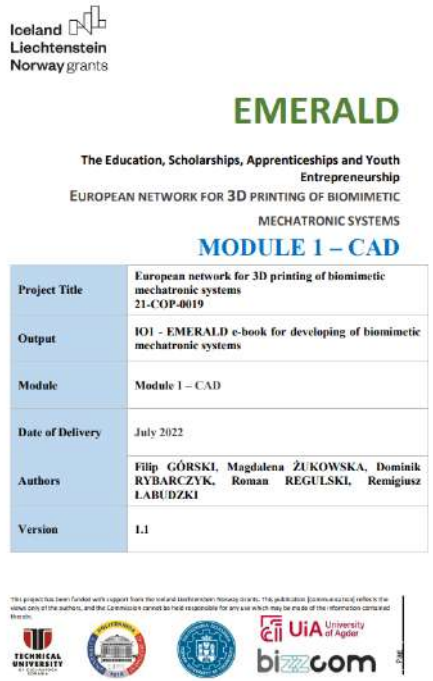
POSTED ON 2022-09-30 BY RĂZVAN PĂCURAR



www.project-emerald.eu

The curriculum comprises 8 modules:

- Module 1: Computer Aided Design (CAD)
- Module 2: Computer Aided Engineering (CAE)
- Module 3: Computer Programming
- Module 4: Virtual Reality / Augmented Reality
- Module 5: Sensors and Electronics
- Module 6: Bio-Mechatronics
- Module 7: 3D printing and Rapid Tooling methods
- Module 8: Intelligent (smart) materials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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS

MODULE 1 – CAD

Project Title	European network for 3D printing of biomimetic mechatronic systems 21-COP-0019
Output	IO1 - EMERALD e-book for developing of biomimetic mechatronic systems
Module	Module 1 – CAD
Date of Delivery	July 2022
Authors	Filip GÓRSKI, Magdalena ŻUKOWSKA, Dominik RYBARCZYK, Roman REGULSKI, Remigiusz LABUDZKI
Version	1.1

Open-access book published on the EMERALD project website

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Quick overview of the Intellectual outputs related to the EMERALD project

I02 - EMERALD e-toolkit manual for digital learning in producing biomimetic mechatronic systems

Start Date : 01 Aug 2022 End Date : 31 Jan 2023

Responsible: University of Agder

The aims of the I02 : ➢ to provide **e-toolkit for teaching purposes**
➢ to provide the **basics knowledge about the realizing of biomimetic mechatronic systems by 30 printing.**
➢ to provide **the other preliminary and post processing steps that are required to be followed in terms of CAD modeling**
➢ **diploma project themes**

Open access on the platform?

Content?

Template?

Report?

	RESPONSIBLES
Conceiving the concepts of biomimetic mechatronic systems / bio-mechatronic domain	UiA
Providing details related to the designing solutions used for conceiving the biomimetic mechatronic systems	PUT & TUCN
Validation of the biomimetic mechatronic systems (solutions designed by CAD systems based on CAE analyses)	TUCN
Solutions related to the materials to be used for the realizing of the new developed biomimetic mechatronic systems	UPB
3D printing and rapid tooling methods for the components to be realized for the new biomimetic mechatronic	TUCN & UPB & PUT
Desciption of assembling and programming of the systems	UiA
Aspects related to the set-up/functionality of the presented solutions/repeatability of the process /troubleshoot and control; inputs regarding the methods of testing of these new biomimetic mechatronic systems by AR / VR - solutions of conceiving, realizing and materializing of different scenarios in AR/VR where the biomimetic mechatronic systems will be connected and used for therapeutically purposes by the persons with special needs	BIZZCOM

Starting: **01.08.2022**

Deadline: **31.01.2023**

For each module according to the skills and competences of the EMERALD partners consortium, from the **Technical team there will be nominated 1-2 responsible persons** which will be in charge with the module and will need to provide the module for the e-toolkit manual.

European Network For 3D Printing Of Biomimetic Mechatronic Systems

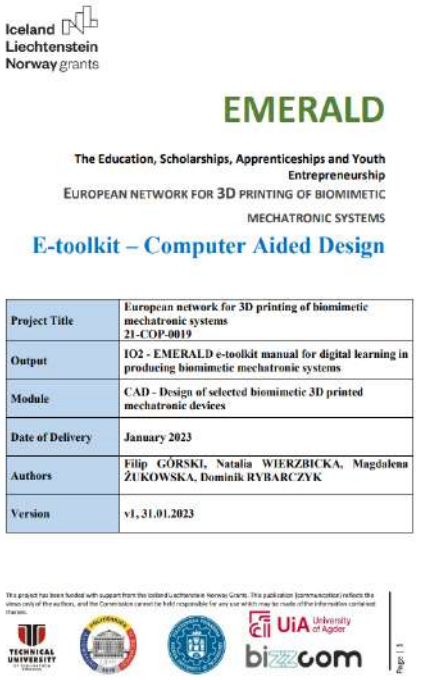
HOME PROJECT RESULTS

Intellectual output – IO2

1 e-toolkit manual comprising 5 modules on CAD, CAE, 3D printing, materials, AR / VR programming was finalized by the EMERALD consortium and is available on the EMERALD project website

E-toolkit manual

The main aims of the IO2 are to provide an e-toolkit for teaching purposes, basic knowledge about realizing biomimetic mechatronic systems by 3D printing, to provide the other preliminary and post processing steps that are required to be followed in the terms of CAD modeling as well as providing diploma project themes.



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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS

E-toolkit – Computer Aided Design

Project Title	European network for 3D printing of biomimetic mechatronic systems 21-COP-0019
Output	IO2 - EMERALD e-toolkit manual for digital learning in producing biomimetic mechatronic systems
Module	CAD - Design of selected biomimetic 3D printed mechatronic devices
Date of Delivery	January 2023
Authors	Filip GÓRSKI, Natalia WIERZBICKA, Magdalena ŻUKOWSKA, Dominik RYBARCZYK
Version	v1, 31.01.2023

www.project-emerald.eu

Open-access e-toolkit manual published on the EMERALD project website

Quick overview of the Intellectual outputs related to the EMERALD project

I03 - EMERALD e-learning VR / AR platform for programming and using biomimetic mechatronic systems

Start Date : 01 Feb 2023 **End Date : 31 ~~Jul~~ 2023** **31 Aug 2023**

Responsible: BIZZCOM company

The aims of the I03 : ➢ the realization of **a Virtual laboratory (e-learning) platform, that integrates VR / AR applications which can be accessed by professors and students**

➢ **Programming and realizing** of different scenarios in VR / AR / Mixed Reality, conceiving of different applications that can be connected with AR / VR (applications that can be downloaded at home)

➢ **Applications developed by professors and students will be uploaded on the EMERALD platform**

Open access on the platform?

Content?

Report?

	RESPONSIBLES
Designing of different scenarios, the programming of the biomimetic mechatronic systems	BIZZCOM Company
Preparing the e-library of the developed e-learning platform & aspects that are required to be followed by professors & students Hints & tips about regulations in modeling, selecting of the adequate materials, manufacturing solutions & assembling of such biomimetic mechatronic systems	TUCN & PUT & UPB
The project themes that are required for people with special needs & particularities of these types of topics	UiA / all partners
Logistics in terms of materials selecting, CAD, CAE, manufacturing & assembling of the new developed systems	TUCN & PUT & UPB
Potential stakeholders that are interested by the solutions developed by the EMERALD consortium	BIZZCOM
Feedbacks and recommendations	BIZZCOM/ all partners

Starting: **01.02.2023**

Deadline: ~~31.07.2023~~

Deadline: 31.08.2023

For each room according to the skills and competences of the EMERALD partners consortium, from the **Technical team there will be nominated 1-2 responsible persons** which will be in charge with the virtual room and will need to provide the informations for the virtual room of the virtual laboratory.

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Quick overview of the Intellectual outputs related to the EMERALD project

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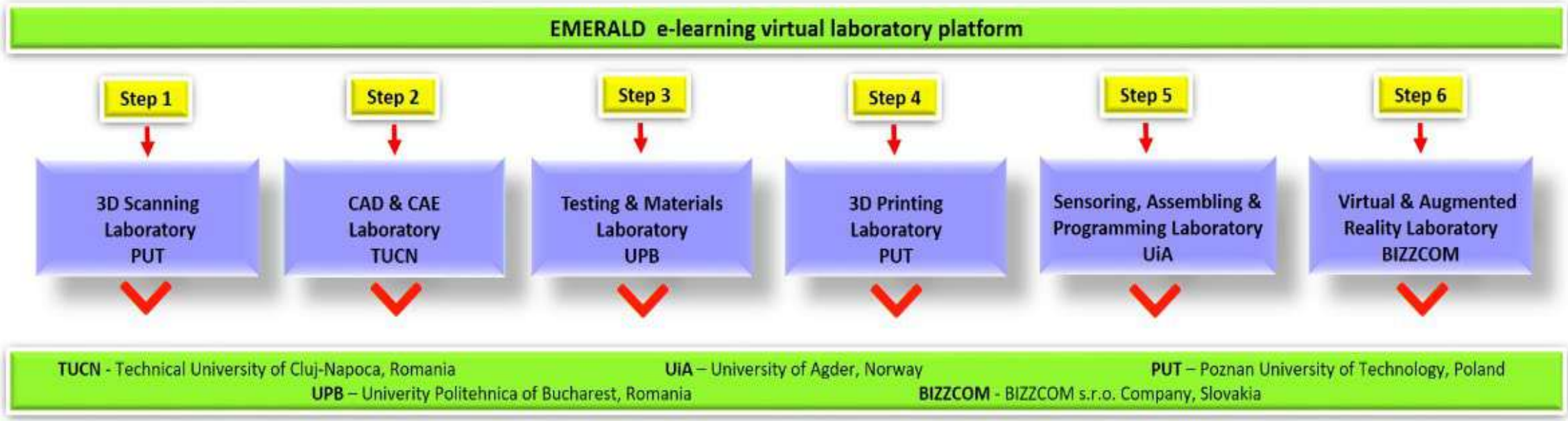

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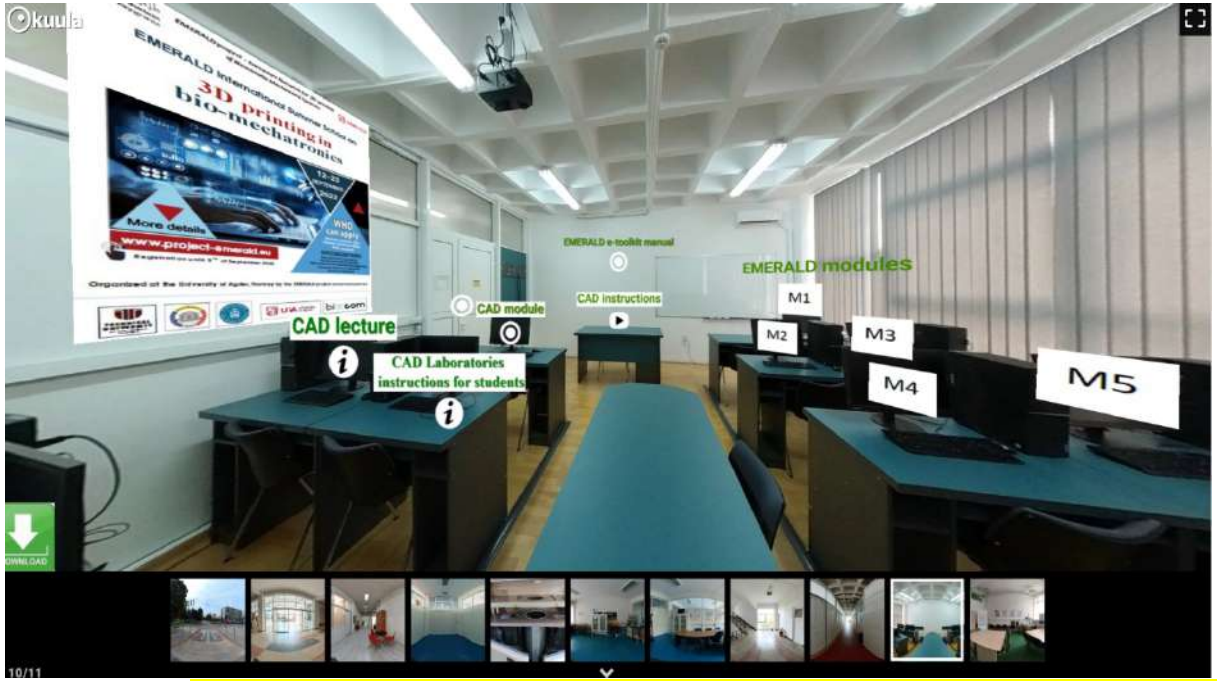
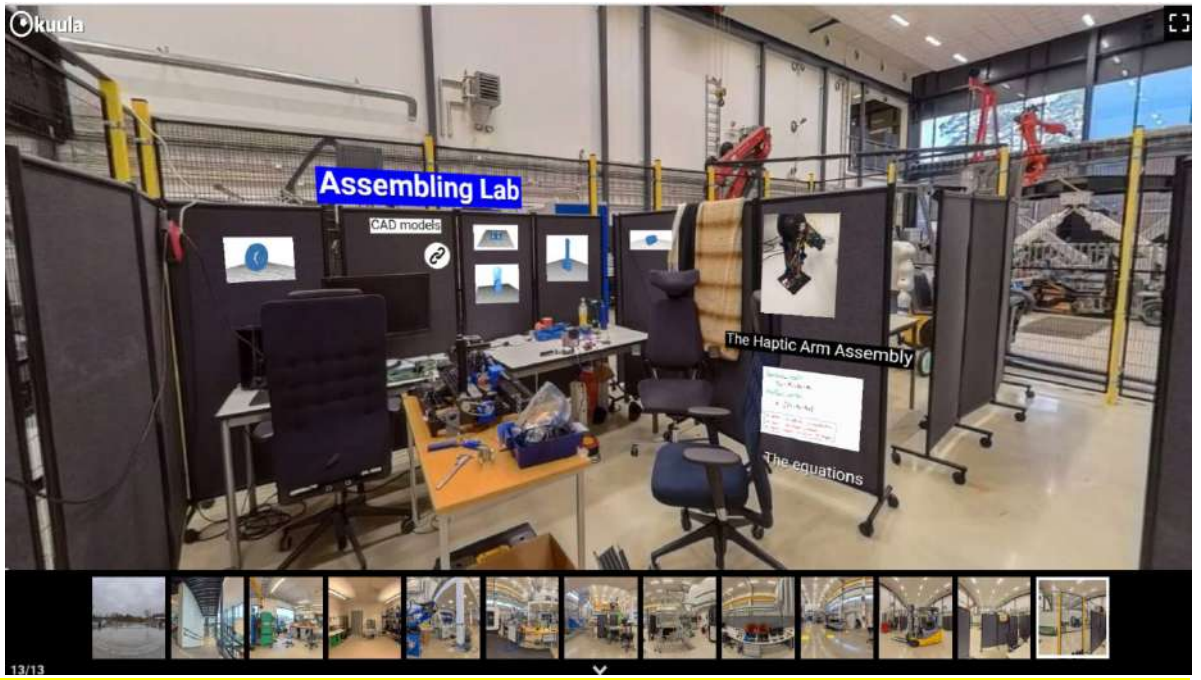
Quick overview of the Intellectual outputs related to the EMERALD project





Virtual platform laboratory (360 photos of the institutions involved in the EMERALD project) + e-learning teaching resources

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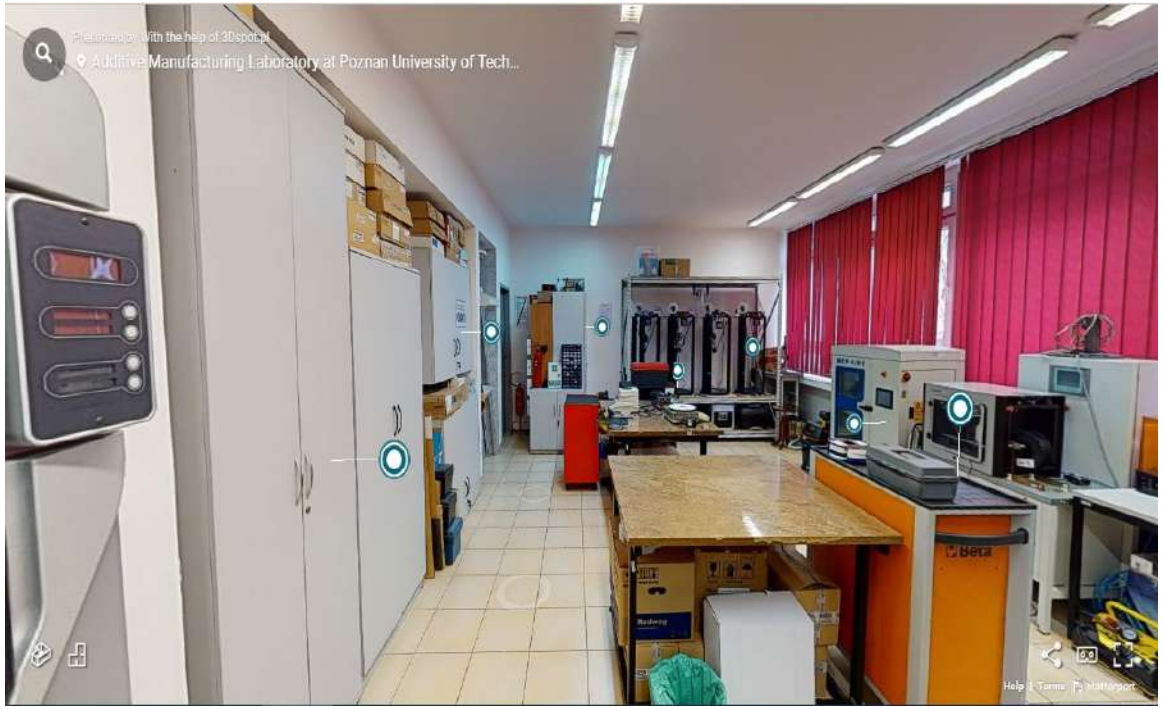
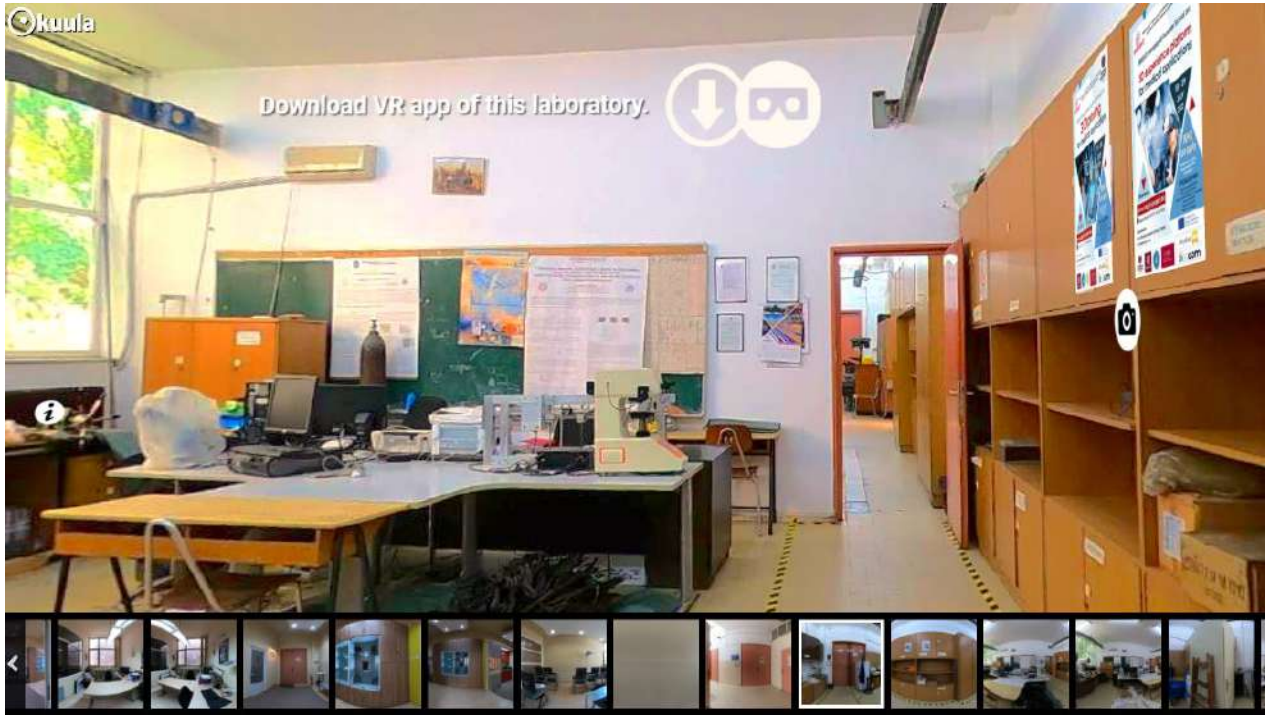
Quick overview of the Intellectual outputs related to the EMERALD project





Virtual platform laboratory (360 photos of the institutions involved in the EMERALD project) + e-learning teaching resources

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Quick overview of the Intellectual outputs related to the EMERALD project

Unity

blender

Matterport

kuula

Virtual platform laboratory (with elements of VR/AR integrated and considered also in the platform)

Quick overview of the Intellectual outputs related to the EMERALD project

IO4 - EMERALD e-case studies for project based learning method used in developing, testing and manufacturing of new biomimetic mechatronic systems by 3D printing technologies

Start Date : 15 Feb 2022 End Date : 29 Sep 2023

Responsible: Poznan University of Technology

The main aim of the IO4 : ➢ the implementation of the communication and dissemination strategy for increasing awareness, understanding and engagement with users and target groups

➢ **4 CASE STUDIES** of biomimetic mechatronic systems made by 30 printing for people with special needs.

Open access on the platform?

Content?

Template?

Report?

	RESPONSIBLES
Designating of one person from each technical team of the EMERALD consortium as MENTOR for the students which will work on these topics.	UiA & TUCN & UPB& PUT
Selection of the 4 case studies	PUT / all partners
3 different TEAMS comprising 5-7 students from different countries of the consortium will start to work on the topic, starting from the CAD & CAE methods	all partners
Validation of the solutions proposed by the students	all partners
Selection of the material and 3D printing process by the students	UPB & TUCN & PUT
Programming tests & procedures	UiA & BIZZCOM
Final feedback	UiA

Starting: **15.02.2022**

Deadline: **29.09.2023**

For each case study according to the skills and competences of the EMERALD partners consortium, from the **Technical team there will be nominated 1-2 responsible** persons. **3 different teams comprising 5-7 students** from different countries of the consortium will start to work on the topic. Validation of the solutions proposed by the students will be made with the help of their mentor (responsible professor of the EMERALD consortium) .

Main KPIs of the EMERALD project

I04 - EMERALD e-case studies for project based learning method used in developing, testing and manufacturing of new biomimetic mechatronic systems by 3D printing technologies

RESULTS (KPIs):

- ✓ 4 case study reports
- ✓ 1 open access book
- ✓ 1 open access toolkit manual
- ✓ 4 academic / scientific papers (ISI with Impact factor) are expected to be delivered at the end and shared via a-platform of EMERALD project as good practice use for dissemination
- ✓ e-learning platform conceived by the EMERALD consortium is intended to be used finally as one powerful tool for attracting the major stakeholders in he field of bio-mechatronics /30 printing domains) to scale up the solutions to build one active an representative network for 30 printing of biomimetic mechatronic systems in Europe (EMERALD network)

DISSEMINATION:

1. Chapters that might be used by students for BSc projects / reports that emphasize the case studies and use of EMERALD resources in developing, producing or testing new types of biomimetic mechatronic systems by 30 printing (reports will be shared via the e-learning platform of EMERALD project in open-access mode in order to emphasize how EMERALD resources were used in sorting out real issues in close correlation with the persons with special needs I adapted for these case studies);
2. Case studies developed, tested and made at this level will provide important feedbacks regarding the EMERALD resources and regarding the new biomimetic mechatronic systems developed for people with special needs.
3. Since topic of the EMERALD project and content is in the interest of SMEs and Medical Institutions, transfer of know-how from the universities engaged in the EMERALD consortium to stakeholders, as well as building strategic partnerships and applying for new EU projects is highly foreseen to be reached at dissemination level in the future as well.
4. patenting process of the solutions developed by the EMERALD consortium (patent submitting application)
5. Advertising is not for dissemination, but is needed for promoting of the consortium and events (logo of the project, advertising, web page, newspapers) etc.

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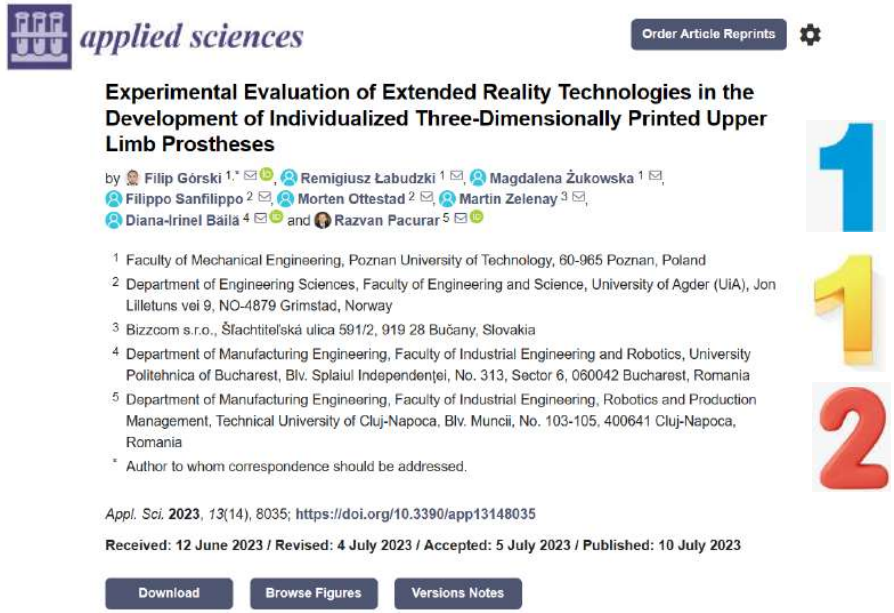
Publishing of open access book + e-toolkit manual realized “in common” by all partners of the EMERALD consortium

Main indicators



1 reached

1 in progress

2 still needed

- 1 patent + 4 ISI articles with IF published “in common” with all partners are expected to be reached at the end of the project

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Disseminating plan /conceived for the EMERALD project

DISSEMINATION PLAN

Results of the project

Special Issue "Smart Materials, Intelligent Structures and Innovative Applications of 3D Printing and Bio-Printing Methods"

- Special Issue Editors
- Special Issue Information
- Keywords
- Published Papers

A special issue of *Materials* (ISSN 1996-1944). This special issue belongs to the section "Manufacturing Processes and Systems".

materials MDPI

materials IMPACT FACTOR 3.748 Indexed in: PubMed MDPI

Special Issue Editors

Dr. Razvan Ioan Pacurar E-Mail Website SciProfiles
Guest Editor
Department of Manufacturing Engineering, Faculty of Industrial Engineering, Robotics and Production Management, Technical University of Cluj-Napoca, 400114 Cluj-Napoca, Romania
Interests: additive manufacturing; 3D printing; bio-printing; rapid tooling; hybrid manufacturing; topological optimization; computer aided design; computer aided engineering

Dr. Filip Górski E-Mail Website SciProfiles
Guest Editor
Faculty of Mechanical Engineering and Management, Poznan University of Technology, 60-965 Poznań, Poland
Interests: CAD/CAM/CAE systems; reverse engineering; 3D printing; virtual reality
Special Issues, Collections and Topics in MDPI journals

TUCN (Razvan Pacurar) / UPT (Filip Gorski) -Guest editors to MDPI Materials ISI journal – Q1 – ISI journal with IF 3.4

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Disseminating plan /conceived for the EMERALD project

Results of the project

Special Issue "Smart Materials, Intelligent Structures and Innovative Applications of 3D Printing and Bio-Printing Methods"

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Article

An Experimental Study on the Impact of Layer Height and Annealing Parameters on the Tensile Strength and Dimensional Accuracy of FDM 3D Printed Parts

Jelena R. Stojković [1,*], Rajko Turudija [1], Nikola Vitković [1], Filip Górski [2], Ancuța Păcurar [3], Alin Pleșa [4], Alexandru Ianoși-Andreeva-Dimitrova [4] and Răzvan Păcurar [3,*]

1 Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, 18000 Niš, Serbia; rajko.turudija@masfak.ni.ac.rs (R.T.); nikola.vitkovic@masfak.ni.ac.rs (N.V.)
2 Faculty of Mechanical Engineering, Poznan University of Technology, Piotrowo 3 STR, 61-138 Poznan, Poland; filip.gorski@put.poznan.pl
3 Department of Manufacturing Engineering, Faculty of Industrial Engineering, Robotics and Production Management, Technical University of Cluj-Napoca, Blv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; ancuta.costea@tcm.utcluj.ro
4 Department of Mechatronics and Machine Dynamics, Faculty of Automotive, Mechatronics and Mechanical Engineering, Technical University of Cluj-Napoca, Blv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; alin.plesa@mdm.utcluj.ro (A.P.); alexandru.ianosi@mdm.utcluj.ro (A.I.-A.-D.)
* Correspondence: jelena.stojkovic@masfak.ni.ac.rs (J.R.S.); razvan.pacurar@tcm.utcluj.ro (R.P.)

Abstract: This study investigates the impact of annealing time, temperature, and layer height on the tensile strength and dimensional change of three 3D printing materials (PLA, PETG, and carbon fiber-reinforced PETG). Samples with varying layer heights (0.1 mm, 0.2 mm, and 0.3 mm) were annealed at temperatures ranging from 60–100 °C for 30, 60, and 90 min. Tensile tests were conducted, and regression models were developed to analyze the effects of these parameters on tensile strength. The models exhibited high accuracy, with a maximum deviation of only 5% from measured validation values. The models showed that layer height has a significantly bigger influence on tensile strength than annealing time and temperature. Optimal combinations of parameters were identified for each material, with PLA performing best at 0.1 mm/60 min/90 °C and PETG and PETGCF achieving optimal tensile strength at 0.1 mm/90 min/60 °C. PETGCF demonstrated smallest dimensional

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Citation: Stojković, J.R.; Turudija, R.; Vitković, N.; Górski, F.; Păcurar, A.; Pleșa, A.; Ianoși-Andreeva-Dimitrova, A.;

TUCN (Razvan Pacurar) / UPT (Filip Gorski) –publishing of 2 articles in MDPI Materials journal jointly with authors from the EMERALD consortium and from outside the EMERALD consortium (Serbian authors) – Q2 – ISI journal with IF 3.4

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Results of the project

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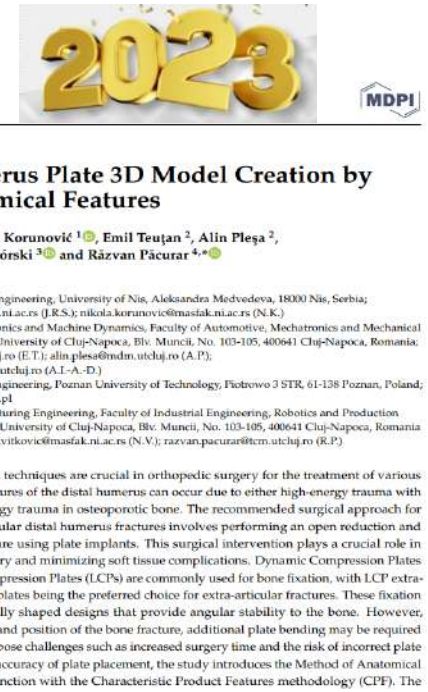
materials MDPI



materials 2023 MDPI

Article

Extra-Articular Distal Humerus Plate 3D Model Creation by Using the Method of Anatomical Features

Nikola Vitković [1,*], Jelena R. Stojković [1], Nikola Korunović [1], Emil Teuțan [2], Alin Pleșa [2], Alexandru Ianoși-Andreeva-Dimitrova [2], Filip Górski [3] and Răzvan Păcurar [4,*]

1 Faculty of Mechanical Engineering, University of Nis, Aleksandra Medvedeva, 18000 Nis, Serbia; jelena.stojkovic@masfak.ni.ac.rs (J.R.S.); nikola.korunovic@masfak.ni.ac.rs (N.K.)
2 Department of Mechatronics and Machine Dynamics, Faculty of Automotive, Mechatronics and Mechanical Engineering, Technical University of Cluj-Napoca, Blv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; emil.teutan@mdm.utcluj.ro (E.T.); alin.plesa@mdm.utcluj.ro (A.P.); alexandru.ianosi@mdm.utcluj.ro (A.I.-A.-D.)
3 Faculty of Mechanical Engineering, Poznan University of Technology, Piotrowo 3 STR, 61-138 Poznan, Poland; filip.gorski@put.poznan.pl
4 Department of Manufacturing Engineering, Faculty of Industrial Engineering, Robotics and Production Management, Technical University of Cluj-Napoca, Blv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania
* Correspondence: nikola.vitkovic@masfak.ni.ac.rs (N.V.); razvan.pacurar@tcm.utcluj.ro (R.P.)

Abstract: Proper fixation techniques are crucial in orthopedic surgery for the treatment of various medical conditions. Fractures of the distal humerus can occur due to either high-energy trauma with skin rupture or low-energy trauma in osteoporotic bone. The recommended surgical approach for treating these extra-articular distal humerus fractures involves performing an open reduction and internal fixation procedure using plate implants. This surgical intervention plays a crucial role in enhancing patient recovery and minimizing soft tissue complications. Dynamic Compression Plates (DCPs) and Locking Compression Plates (LCPs) are commonly used for bone fixation, with LCP extra-articular distal humerus plates being the preferred choice for extra-articular fractures. These fixation systems have anatomically shaped designs that provide angular stability to the bone. However, depending on the shape and position of the bone fracture, additional plate bending may be required during surgery. This can pose challenges such as increased surgery time and the risk of incorrect plate shaping. To enhance the accuracy of plate placement, the study introduces the Method of Anatomical Features (MAF) in conjunction with the Characteristic Product Features methodology (CPF). The

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Citation: Vitković, N.; Stojković, J.R.; Korunović, N.; Teuțan, E.; Pleșa, A.; Ianoși-Andreeva-Dimitrova, A.; Górski, F.; Păcurar, R. Extra-Articular

TUCN (Razvan Pacurar) / UPT (Filip Gorski) –publishing of 2 articles in MDPI Materials journal jointly with authors from the EMERALD consortium and from outside the EMERALD consortium (Serbian authors) – Q2 – ISI journal with IF 3.4

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Results of the project

materials — MDPI

Article

Mechanical and Wetting Properties of Ta_2O_5 and ZnO Coatings on Alloy Substrate of Cardiovascular Stents Manufactured by Casting and DMLS

Diana-Irinel Băilă [1,*], Răzvan Păcurar [2,*], Tom Savu [1], Cătălin Zaharia [3], Roxana Trușcă [4], Ovidiu Nemeș [5], Filip Górski [6], Ancuța Păcurar [7], Alin Pleșa [7] and Emilia Sabău [2]

Publishing of an article in MDPI Materials journal by UPB and TUCN (EMERALD only) authors – Q1 – ISI journal with IF 3.748

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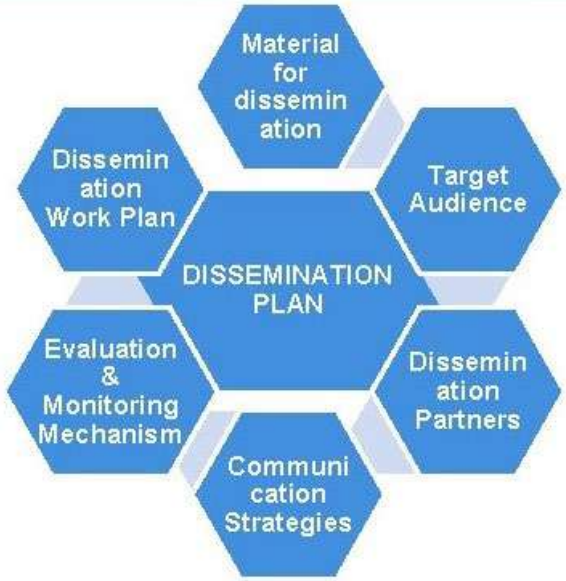
Disseminating plan /actions / involving stakeholders that are interested for the EMERALD project

DISSEMINATION PLAN



Results of the project

Manufacturing 2022 ISI conference

Springer Publishing House

Participating and publishing articles at important scientific conferences and other important events

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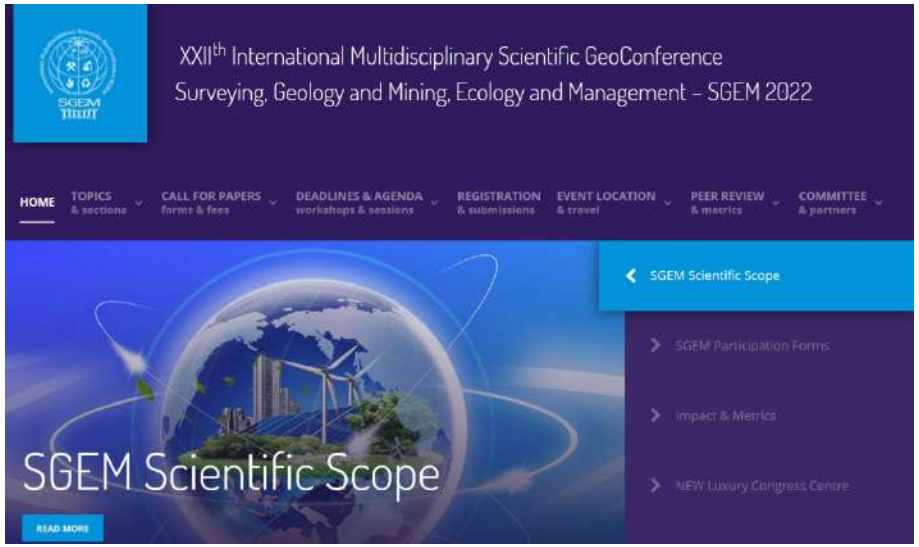
Results of the project



Papers presented and published at International Scientific Conferences – SGEM 2022 & EPSTEM 2022

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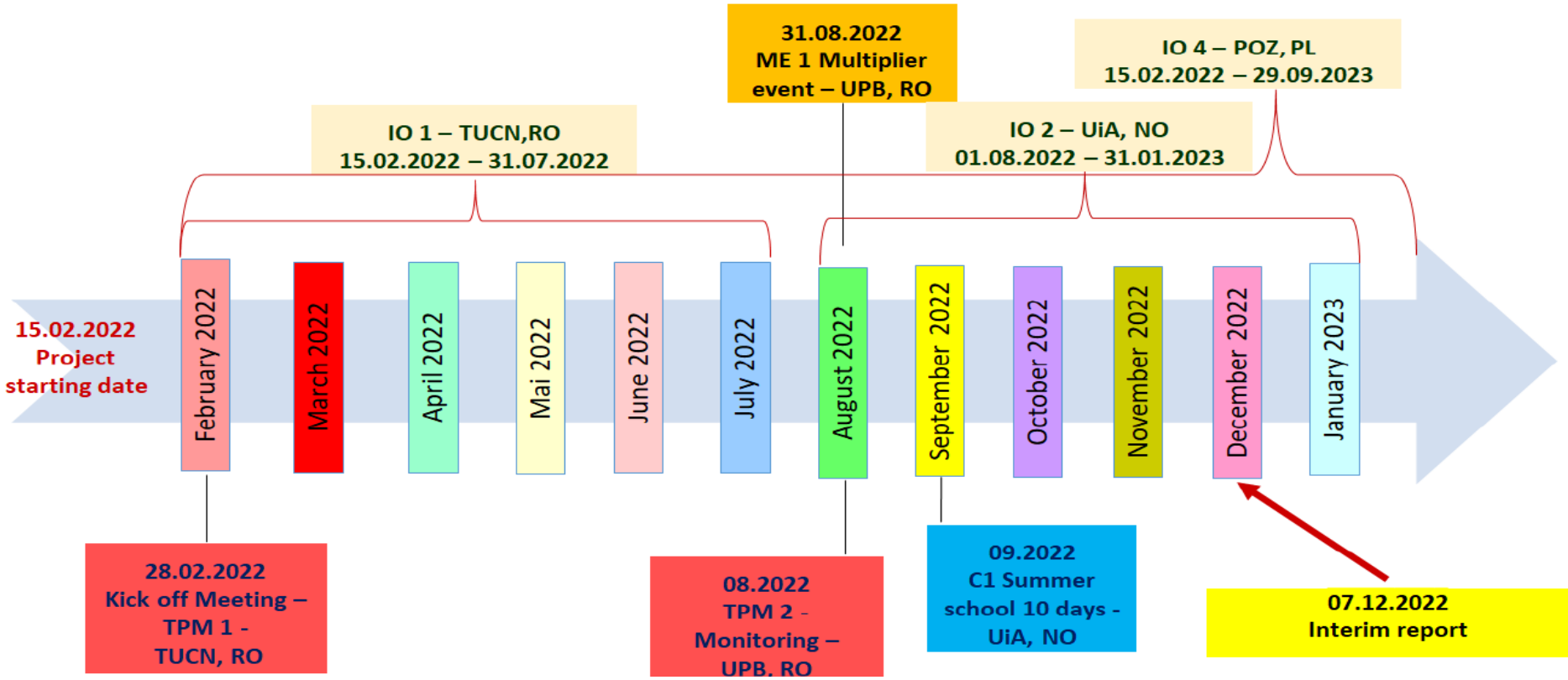
3. Main actions of the EMERALD project. Summarizing of the planned actions

Main actions of the EMERALD project

EMERALD - Calendar of the project / deadlines / milestones	
TPM	Transnational project meetings
ME	Multiplier Events
C	Intensive Programmes for higher education / Short-term joint staff training events

EMERALD - Calendar of the project / milestones – plan - February 2022 – January 2023



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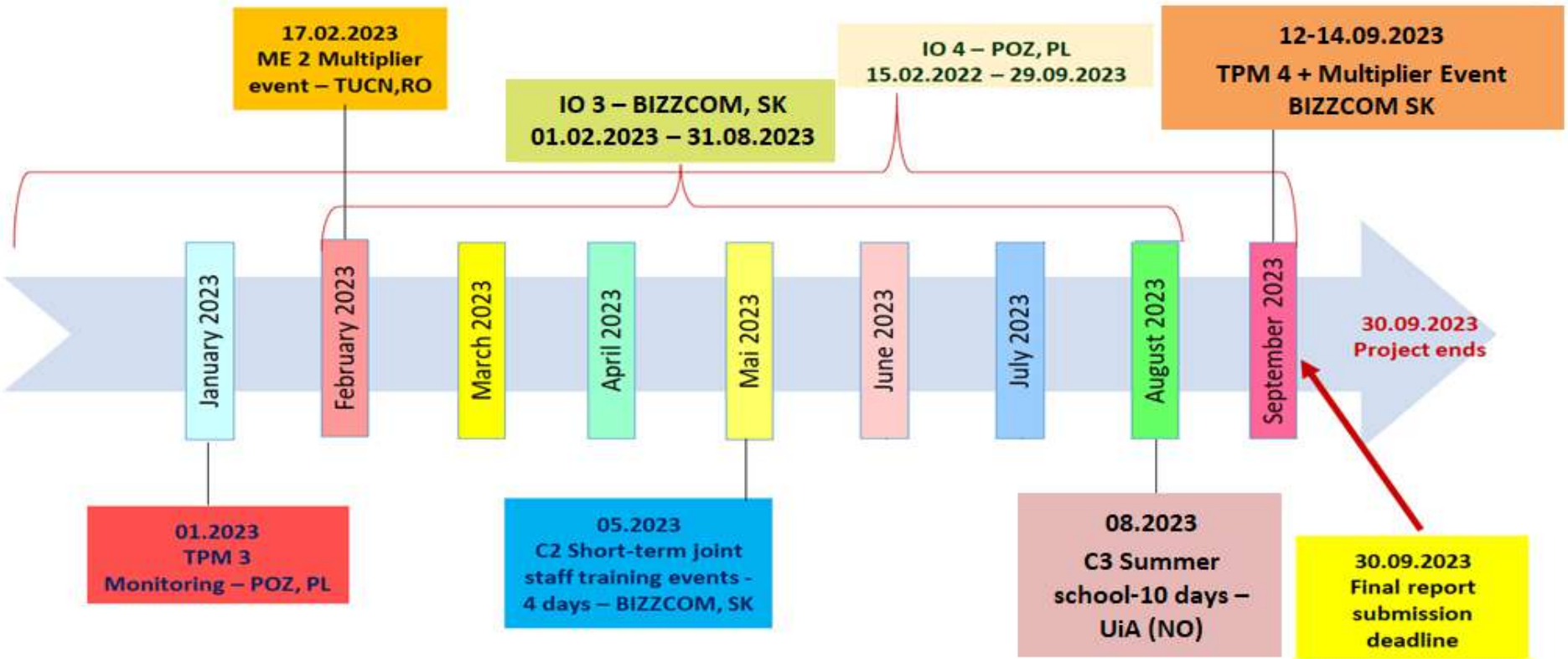
EMERALD - Calendar of the project / milestones – plan - February – September 2023



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Main actions of the EMERALD project

EMERALD - Calendar of the project / deadlines / milestones	
TPM	Transnational project meetings
ME	Multiplier Events
C	Intensive Programmes for higher education / Short-term joint staff training events

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EMERALD – Kick off meeting – 28.02.2022 – TUCN, RO

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EMERALD – Transnational Project Meeting – 30-31.08.2022 – University Politehnica Bucharest, RO

EMERALD – Transnational Project Meeting – 30-31.01.2023 – Poznan University of Technology, Poland

EMERALD – Monitoring Transnational Meeting - TPM 4 – 11-12 September 2023 - BIZZCOM company, SK

EMERALD – Monitoring Transnational Meeting - TPM 4 – 11-12 September 2023 - BIZZCOM company, SK

Main actions of the EMERALD project

EMERALD - Calendar of the project / deadlines / milestones	
TPM	Transnational project meetings
ME	Multiplier Events
C	Intensive Programmes for higher education / Short-term joint staff training events

Multiplier events organized within the EMERALD project in 2022-2023

	ORGANIZING INSTITUTION	DATE	LOCAL PARTICIPANTS	FOREIGN PARTICIPANTS
ME 1	University Politehnica Bucharest, Romania	2 SEPTEMBER 2022	40	-
ME 2	Technical University of Cluj-Napoca, Romania	17 FEBRUARY 2023	40	8
ME 3	BIZZCOM company ,Slovakia	11 SEPTEMBER 2023	40	-

European Network For 3D Printing Of Biomimetic Mechatronic Systems

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EMERALD: European network for 3D printing of biomimetic mechatronic systems
EEA & Norway Grant - Contract No. 21-COP-0019

MULTIPLIER EVENT ON RESEARCH BASE LEARNING METHOD FOR TEACHING IN BIO-MECHATRONICS

POLITEHNICA University of Bucharest, Romania

Program

Date: 02.09.2022, between 9.00-14.00, UPB Central Library, Hall 2.2

Hour	Activity
9:00	Participants registration
9:15	Event opening Prof. Nicolae Ionescu (Politehnica University of Bucharest) / Prof. Tom Savu (Politehnica University of Bucharest) – Dep TCM
9:30	EMERALD Project Presentation Assoc. Prof. Diana Băilă (Politehnica University of Bucharest)
9:45	ANPCDEFP – Radu Stoika – EEA Norway grants – aims, particularities and opportunities
10:00	EMERALD Project – Main Aims, Actions and Activities of the project Assoc.Prof. Răzvan Păcurar (Technical University of Cluj-Napoca, Romania)
10:15	University of Agder Norway – Presentation Prof. Filippo Sanfilippo
10:30	Poznan University of Technology – Presentation Prof. Filip Gorski
10:45	LEYCOM Company – Presentation (Additive manufacturing of prostheses: SLM, SLA, SLS, FRESH 3D Printing, etc)
11:00	Coffee Break
11:15	Intelligent (Smart) Materials Prof. Zaharia Cătălin (Politehnica University of Bucharest)
11:45	ADMASYS Company – Presentation NUTECHNOLOGIES Company – Presentation
12:15	BIZZCOM Company - Slovakia Director Eng. Branislav Rabara
12:30	« Ilie Murgulescu » Institute of Physical – Chemistry – Romanian Academy - Bucharest Oxide nanomaterials used for sensors CS3 Eng. Oana Cătălina Mocioiu
13:00	Round table discussions about future potential collaboration in the bio-mechatronics / 3D printing domain - Assoc. Prof. Diana Băilă (Politehnica University of Bucharest)
13:30	Final conclusions
14:00	Lunch time

Multiplier event – UPB – 02 September 2022

EMERALD project consortium partners:

Multiplier event – University Politehnica Bucharest – 02 September 2022

Multiplier event – University Politehnica of Bucharest, Romania – 2nd of September 2022

EMERALD Multiplier Event – UPB – plenary presentations

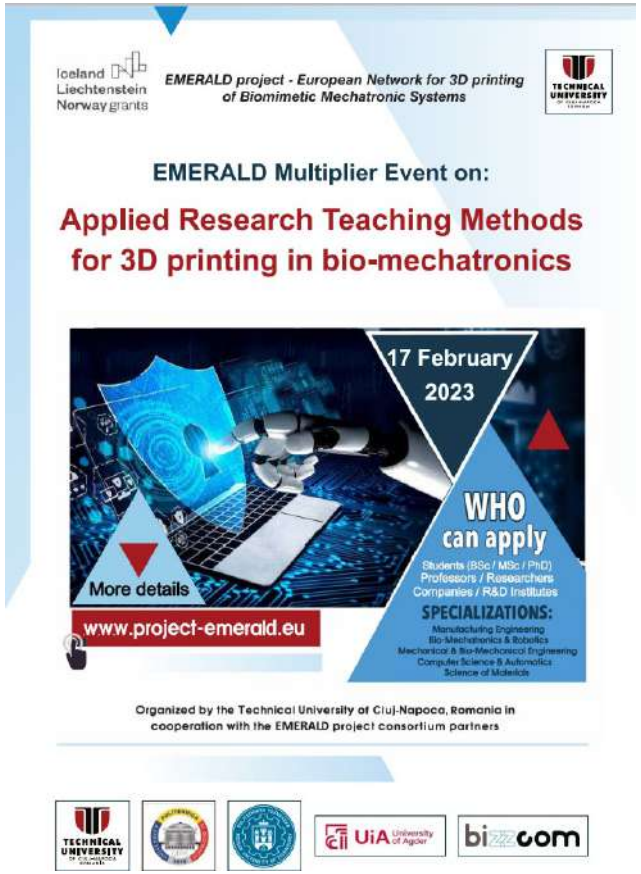
Multiplier event – University Politehnica Bucharest – 02 September 2022

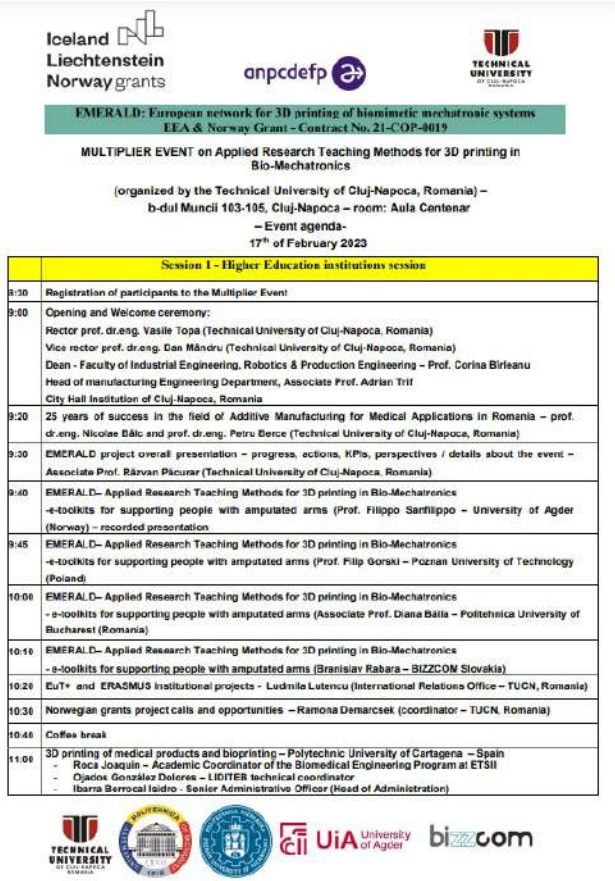
EMERALD Multiplier Event - visiting the Bio-technology laboratory - Department of Bioresources and Polymer Science of UPB

Multiplier event – University Politehnica Bucharest – 02 September 2022

EMERALD Multiplier Event – 3D printing live demonstrations made by the companies / 3D printed parts for the EMERALD consortium partners' realized by the companies

European Network For 3D Printing Of Biomimetic Mechatronic Systems



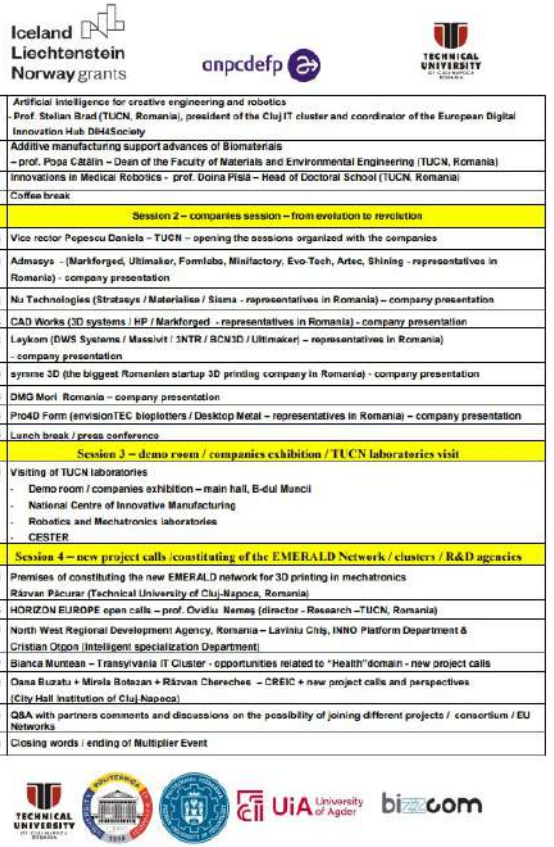


EMERALD: European network for 3D printing of biomimetic mechatronic systems
EEA & Norway Grant - Contract No. 21-COP-0019

MULTIPLIER EVENT on Applied Research Teaching Methods for 3D printing in Bio-Mechatronics

(organized by the Technical University of Cluj-Napoca, Romania) –
b-dul Muncii 103-105, Cluj-Napoca – room: Aula Centenar
– Event agenda-
17th of February 2023

	Session 1 - Higher Education institutions session
8:30	Registration of participants to the Multiplier Event
9:00	Opening and Welcome ceremony: Rector prof. dr.eng. Vasile Topa (Technical University of Cluj-Napoca, Romania) Vice rector prof. dr.eng. Dan Mândru (Technical University of Cluj-Napoca, Romania) Dean - Faculty of Industrial Engineering, Robotics & Production Engineering – Prof. Corina Birleanu Head of manufacturing Engineering Department, Associate Prof. Adrian Trif City Hall Institution of Cluj-Napoca, Romania
9:20	25 years of success in the field of Additive Manufacturing for Medical Applications in Romania – prof. dr.eng. Nicolae Bâlc and prof. dr.eng. Petru Berce (Technical University of Cluj-Napoca, Romania)
9:30	EMERALD project overall presentation – progress, actions, KPIs, perspectives / details about the event – Associate Prof. Răzvan Păcurar (Technical University of Cluj-Napoca, Romania)
9:40	EMERALD– Applied Research Teaching Methods for 3D printing in Bio-Mechatronics -e-toolkits for supporting people with amputated arms (Prof. Filippo Santfilippo – University of Agder (Norway) – recorded presentation
9:45	EMERALD– Applied Research Teaching Methods for 3D printing in Bio-Mechatronics -e-toolkits for supporting people with amputated arms (Prof. Filip Gorski – Poznan University of Technology (Poland)
10:00	EMERALD– Applied Research Teaching Methods for 3D printing in Bio-Mechatronics - e-toolkits for supporting people with amputated arms (Associate Prof. Diana Băila – Politehnica University of Bucharest (Romania)
10:10	EMERALD– Applied Research Teaching Methods for 3D printing in Bio-Mechatronics - e-toolkits for supporting people with amputated arms (Branislav Rabara – BIZZCON Slovakia)
10:20	EuT+ and ERASMUS institutional projects - Ludmila Lutencu (International Relations Office – TUCN, Romania)
10:30	Norwegian grants project calls and opportunities – Ramona Demarcsek (coordinator – TUCN, Romania)
10:40	Coffee break
11:00	3D printing of medical products and bioprinting – Polytechnic University of Cartagena – Spain - Roca Joaquin – Academic Coordinator of the Biomedical Engineering Program at ETSII - Ojados González Dolores – LIDITEB technical coordinator - Ibarra Berrocal Isidro - Senior Administrative Officer (Head of Administration)



11:20	Artificial intelligence for creative engineering and robotics - Prof. Stelian Brad (TUCN, Romania), president of the ClujIT cluster and coordinator of the European Digital Innovation Hub DIH4Society
11:35	Additive manufacturing support advances of Biomaterials – prof. Popa Cătălin – Dean of the Faculty of Materials and Environmental Engineering (TUCN, Romania)
11:45	Innovations in Medical Robotics - prof. Doina Pîslă – Head of Doctoral School (TUCN, Romania)
12:00	Coffee break
	Session 2 – companies session – from evolution to revolution
12:15	Vice rector Pepescu Daniela – TUCN – opening the sessions organized with the companies
12:25	Admaslys - (Markforged, Ultimaker, Formlabs, Minifactory, Evo-Tech, Artec, Shining - representatives in Romania) - company presentation
12:35	Nu Technologies (Stratasys / Materialise / Sisma - representatives in Romania) – company presentation
12:45	CAD Works (3D systems / HP / Markforged - representatives in Romania) - company presentation
12:55	Laykom (DWS Systems / Massivit / 3NTR / BCN3D / Ultimaker) – representatives in Romania) - company presentation
13:05	syrsme 3D (the biggest Romanian startup 3D printing company in Romania) - company presentation
13:15	DMG Mori Romania – company presentation
13:25	Pro4D Form (envisionTEC bioplotters / Desktop Metal – representatives in Romania) – company presentation
13:35	Lunch break / press conference
	Session 3 – demo room / companies exhibition / TUCN laboratories visit
14:30	Visiting of TUCN laboratories - Demo room / companies exhibition – main hall, B-dul Muncii - National Centre of Innovative Manufacturing - Robotics and Mechatronics laboratories - CESTER
	Session 4 – new project calls /constituting of the EMERALD Network / clusters / R&D agencies
15:30	Premises of constituting the new EMERALD network for 3D printing in mechatronics Răzvan Păcurar (Technical University of Cluj-Napoca, Romania)
15:35	HORIZON EUROPE open calls – prof. Ovidiu Nemeș (director - Research –TUCN, Romania)
15:50	North West Regional Development Agency, Romania – Lavinia Chiș, INNO Platform Department & Cristian Otpoa (Intelligent specialization Department)
16:10	Bianca Muntean – Transylvania IT Cluster - opportunities related to "Health"domain - new project calls
16:30	Oana Buzatu + Mirela Botezan + Răzvan Chereches – CREIC + new project calls and perspectives (City Hall institution of Cluj-Napoca)
16:40	Q&A with partners comments and discussions on the possibility of joining different projects / consortium / EU Networks
17:00	Closing words / ending of Multiplier Event

Multiplier event – TUCN – 17th of February 2023

Iceland Liechtenstein Norway grants

European Network For 3D Printing Of Biomimetic Mechatronic Systems

TECHNICAL UNIVERSITY OF CLUJ-NAPOCA ROMANIA

Multiplier event – TUCN – 17 February 2022

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – Applied Research Methods for 3D Printing in Bio-Mechatronics

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentation made by University of Agder (Norway) partner about results reached in the frame of IO2

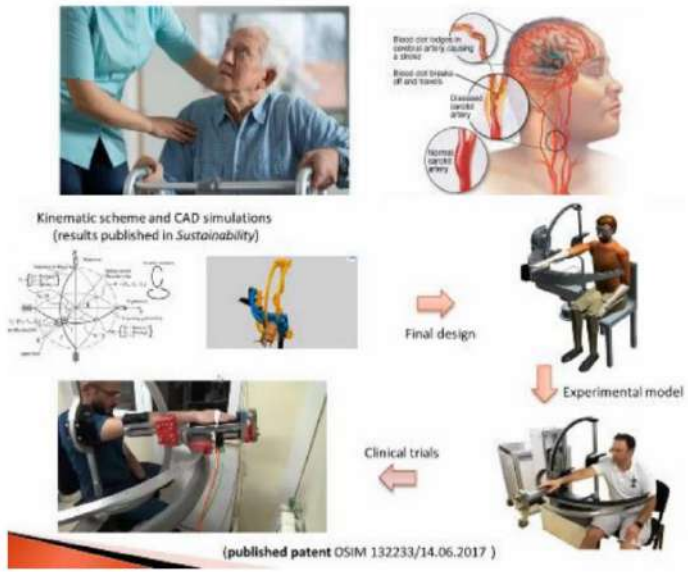
Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentation made by Poznan University of Technology (Poland) partner about results reached in the frame of IO2

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

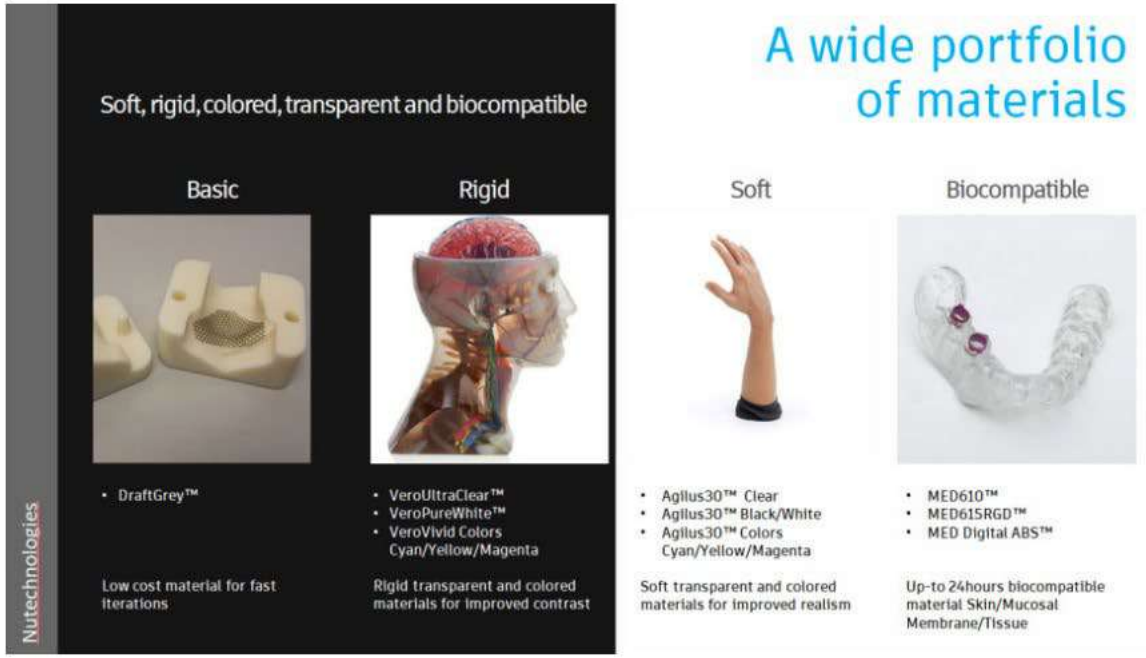
EMERALD Multiplier Event – presentation made by University Politehnica Bucharest (UPB) and Bizzcom (Slovakia) partners about results reached in the frame of IO2

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023



EMERALD Multiplier Event – presentations made by colleagues of TUCN in fields related to bio-mechatronics / robotics

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

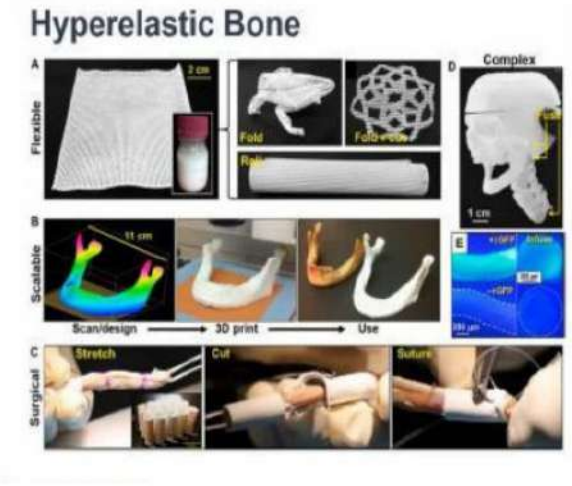


EMERALD Multiplier Event – presentations made by companies that are activating in the field of 3D printing

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentations made by companies that are activating in the field of 3D printing

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023



EMERALD Multiplier Event – presentations made by companies and colleagues that are activating in the field of bio-printing

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – exhibition realized by the companies showing real examples of 3D printing solutions for bio-mechatronics

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentation made by City hall representatives about possibilities of being involved and get financing for new collaborations and projects

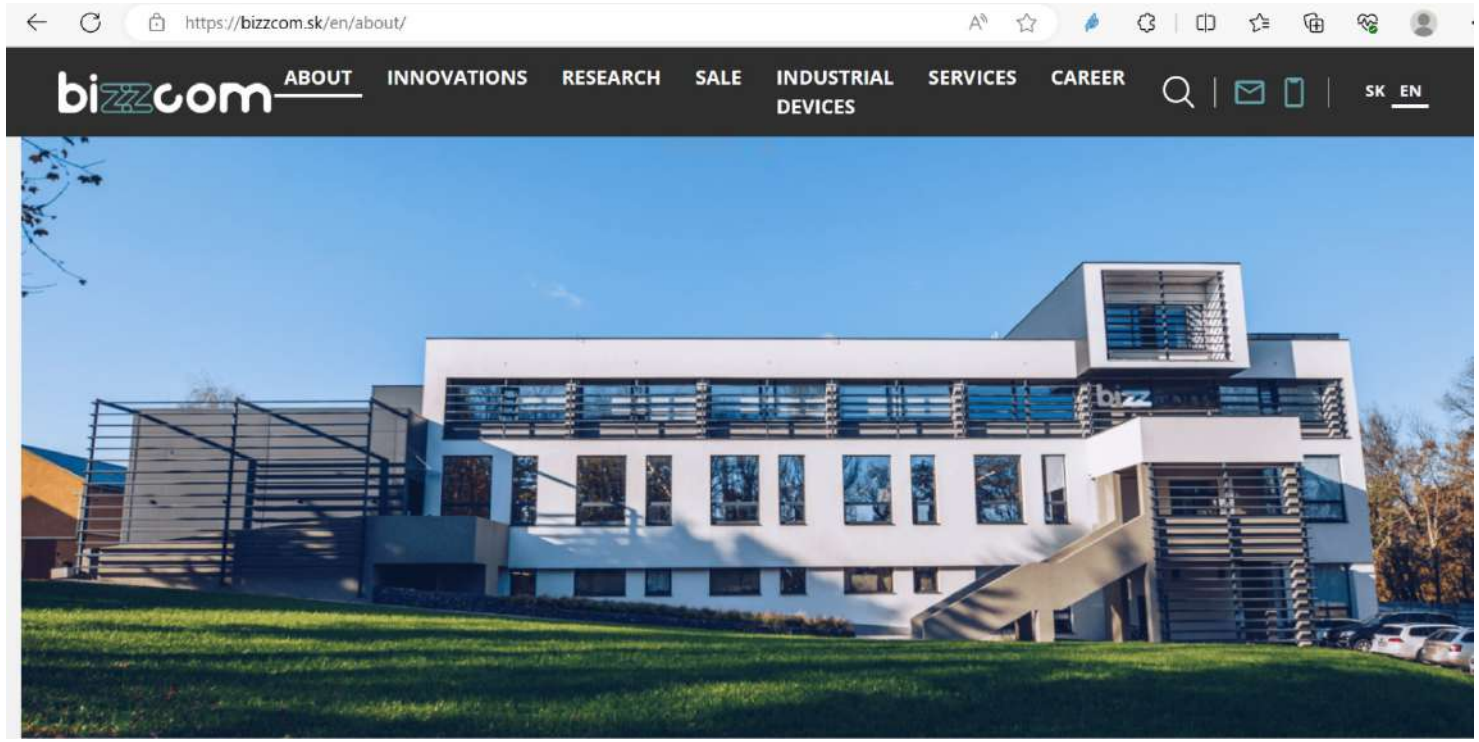
Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentation made by Transylvania IT CLUSTER and North-West Regional Development Agency about possibilities of being involved and get financing for new collaborations and projects

Multiplier event – Technical University of Cluj-Napoca – 17 February 2023

EMERALD Multiplier Event – presentation made by Research Department of Technical University of Cluj-Napoca about possibilities of being involved and get financing for new collaborations and projects (Horizon Europe in particular)

Multiplier event – BIZZCOM – Bucany, Slovakia – 13th of September 2023



Main actions of the EMERALD project

EMERALD - Calendar of the project / deadlines / milestones	
TPM	Transnational project meetings
ME	Multiplier Events
C	Intensive Programmes for higher education / Short-term joint staff training events

LTT activities

Intensive Programmes for higher education / Short-term joint staff training events

	ORGANIZING INSTITUTION	PERIOD / NUMBER OF DAYS	SENDING ORGANISATION	STUDENTS	PROFESSORS	INVITED STAFF	
C 1	University of Agder, NO	SEPTEMBER 2022 / 10 DAYS	Technical University of Cluj-Napoca	5	4	-	UiA – 5 extra participants TOTAL : 30 participants
			University Politehnica Bucharest	5	2	-	
			University of Agder	-	-	-	
			Bizzcom s.r.o.	-	-	2	
			Poznan University of Technology	5	2	-	
C 2	Bizzcom s.r.o., SK	MAY 2023 / 4 DAYS	Technical University of Cluj-Napoca	-	4	-	Bizzcom s.r.o. – 4 extra participants TOTAL:20 participants
			University Politehnica Bucharest	-	4	-	
			University of Agder	-	4	-	
			Bizzcom s.r.o.	-	-	-	
			Poznan University of Technology	-	4	-	
C 3	University of Agder, NO	SEPTEMBER 2023 / 10 DAYS	Technical University of Cluj-Napoca	5	4	-	UiA – 5 extra participants TOTAL : 30 participants
			University Politehnica Bucharest	5	2	-	
			University of Agder	-	-	-	
			Bizzcom s.r.o.	-	-	2	
			Poznan University of Technology	5	2	-	

LTT activities

C1 : Intensive Programmes for higher education students – 3D printing and bio-mechatronics

Duration : 10 day(s)

Country of Venue : Norway

Total number of Participants : 30

Date: September 2022

The 1st International summer school organized by the University of Agder

Participating Organizations : University Politehnica Bucharest, Technical University of Clui-Napoca, University of Agder, Bizzcom s.r.o., Poznan University of Technology

The target groups: **professors** (from EMERALD consortium and engaged in technical activities) & **students**
Organized free of charge ! the participants are required to **REGISTER** in the preamble.

Aims: Starting from the curriculum that has been defined by the EMERALD project consortium and taking into consideration that at the time of organizing this event, e-support courses are being delivered, EMERALD consortium professors will be able to exercise the usefulness of the information provided in the e-courses on the 1st edition of EMERALD International summer school, by being engaged in teaching activities and sharing the information prepared in the e-course modules (e-boock) IO1 with the attending professors & students.

Courses & practical activities related to the IO1 modules

Computer Aided Design,
Computer Aided Engineering,
Computer Programming,
Virtual Reality / Augmented Reality,
Sensors and Electronics,
BioMechatronics,
3D printing and Rapid Tooling methods,
Intelligent materials

Students will be organized in teams and competitions will be launched in order to finally produce the case studies that are being required to be made for the final test (case studies will be the ones stated to be realized in the 02, adapted for people with special needs).
At the end of the EMERALD International summer school, all participants will receive an invitation of joining the future activities of EMERALD consortium activities together with their professors (mentors) in the next upcoming year.

Content? Report? Certificates ?

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European Network For 3D Printing Of Biomimetic Mechatronic Systems

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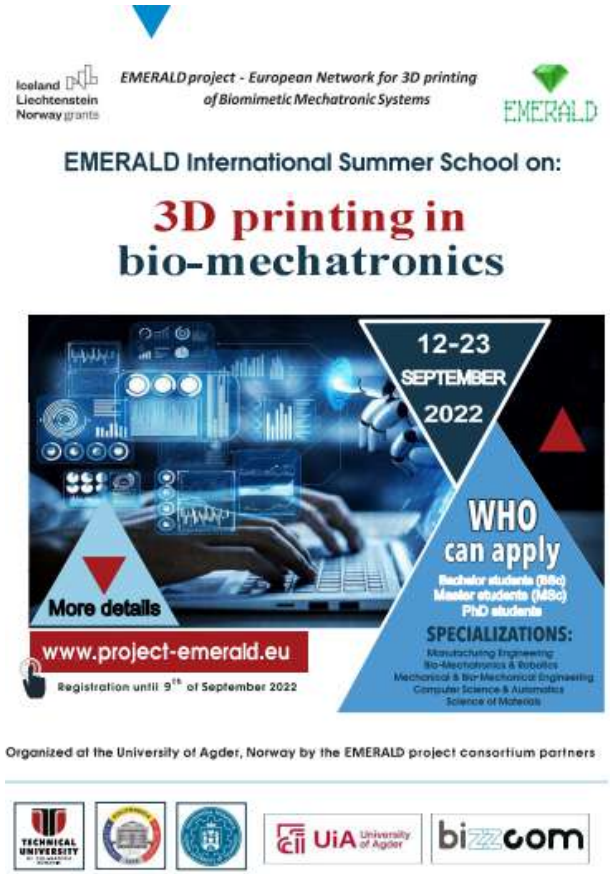

1st edition of the EMERALD International Summer School University of Agder (Grimstad, Norway)– 12-23 September 2022

EMERALD International Summer School on 3D Printing in Bio-Mechatronics – 12-23 September 2022

h	Monday 12.09.2022	Tuesday 13.09.2022	Wednesday 14.09.2022	Thursday 15.09.2022	Friday 16.09.2022	Monday 19.09.2022	Tuesday 20.09.2022	Wednesday 21.09.2022	Thursday 22.09.2022	Friday 23.09.2022	h
10	Opening ceremony and project presentation	CAD - Lecture	CAE - Lecture	Workshop 3D Printing and & Progress report, feedbacks regarding printing process, corrections to be made	Company visit, professional visit of SME company in Kristiansand / Stavanger + visiting of the fiords / socializing activity	General progress of W1 and objectives of W2	Intelligent (smart) materials	Computer Programming case studies	Finalizing progress report, preparing final presentation	Closing and awarding ceremony, future perspectives of the EMERALD project	10
11	Participants' presentation and program guidelines for summer school	Workshop 3D / Launching of case studies	Workshop 3D CAE & Progress report	Medical and mechanical tests, metrology of mechatronic systems		Students' presentation (interim report + scientific presentations)	Sensors and electronics	VR and AR programming applications presentation, case studies	Final test, final questionnaires and feedbacks	EMERALD final consortium meeting	11
12	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time		Feedback on behalf of the EMERALD experts and guidelines for W2	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time	12
13	Visiting of UiA laboratories and city tour of Kristiansand city	Workshop 3D CAD redesigned & Progress report	3D printing and Rapid Tooling for mechatronics	Laboratory on Mechanical test, metrology/ medical institute visit		Bio-mechatronics	Assembling and testing of mechatronic systems conceived and developed	Developing of VR /AR applications	Round table with local representatives of business sector (companies / research institutes) involved in mechatronics)	Free time, sightseeing	13
14			Workshop 3D Printing and & Progress report	Re-designing / re-analyzing / re-3D printing of the components		Laboratory on / bio-mechatronics			Final student presentations		14
15											15
	WEEK 1					WEEK 2					

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1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

EMERALD International summer school – unique of life experience

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Visiting of the MIL laboratory (University of Agder, Norway)

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European Network For 3D Printing Of Biomimetic Mechatronic Systems

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1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Launching of case studies by Prof. Filip Gorski, Poznan University of Technology, Poland

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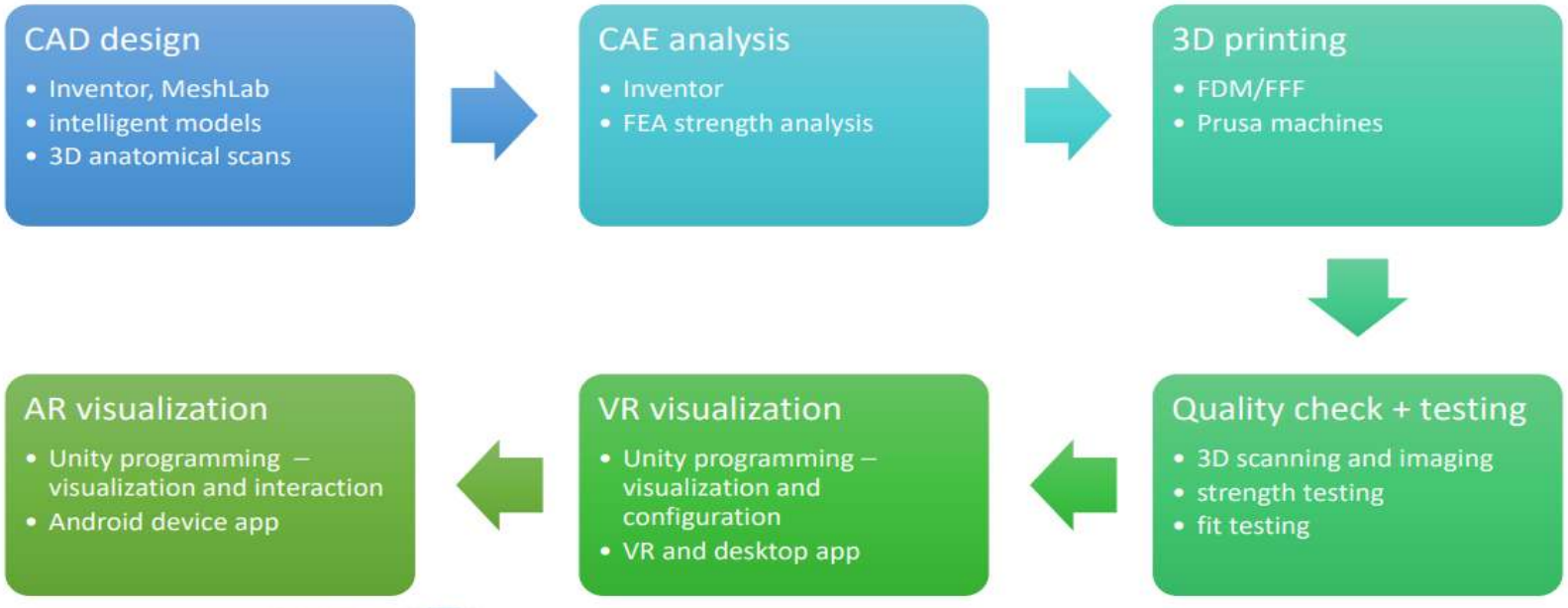
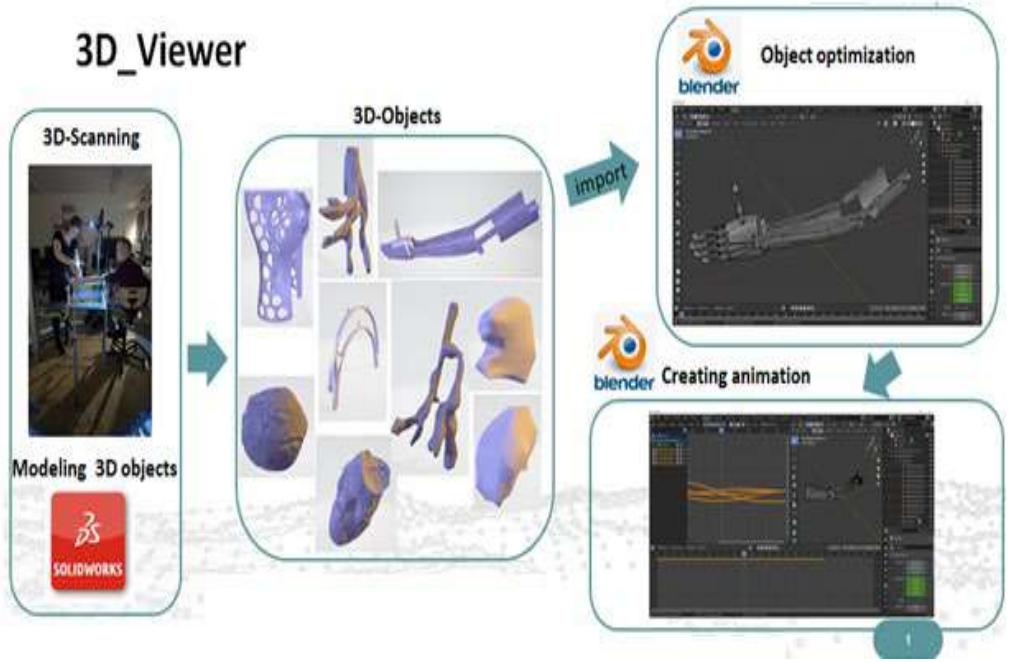
1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

COURSE OF WORK WITH THE CASES



Launching of case studies and requirements

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022



AR presentation held by Michal Gallia, programmer – BIZZCOM s.r.o, Slovakia

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Working on CAD / CAE / 3D printing topics for the case studies launched by Prof. Filip Gorski

constructive and nice interactions between students coming from different countries / universities

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Working on the mechatronic system developed by the students at the University of Agder, Norway

constructive and nice interactions between professors and professors coming from different countries / universities

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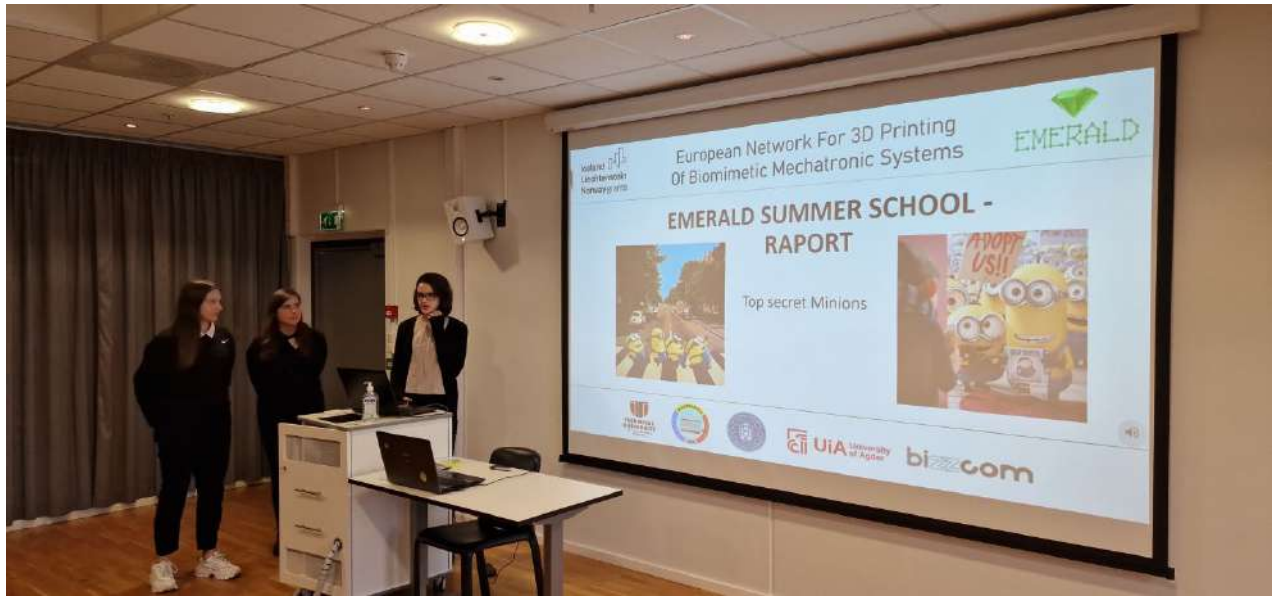
1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

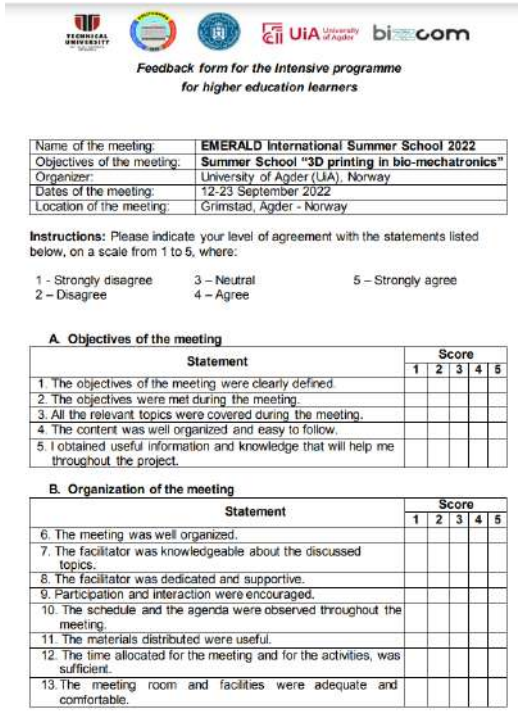
Final test defended by the EMERALD students

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022



Final presentations realized by the EMERALD students

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022



Feedback form for the intensive programme for higher education learners

Name of the meeting:	**EMERALD International Summer School 2022**
Objectives of the meeting:	**Summer School "3D printing in bio-mechatronics"**
Organizer:	University of Agder (UiA), Norway
Dates of the meeting:	12-23 September 2022
Location of the meeting:	Grimstad, Agder - Norway

Instructions: Please indicate your level of agreement with the statements listed below, on a scale from 1 to 5, where:

1 - Strongly disagree 3 – Neutral 5 – Strongly agree
2 – Disagree 4 – Agree

A. Objectives of the meeting

Statement	Score 1	2	3	4	5
1. The objectives of the meeting were clearly defined.					
2. The objectives were met during the meeting.					
3. All the relevant topics were covered during the meeting.					
4. The content was well organized and easy to follow.					
5. I obtained useful information and knowledge that will help me throughout the project.					

B. Organization of the meeting

Statement	Score 1	2	3	4	5
6. The meeting was well organized.					
7. The facilitator was knowledgeable about the discussed topics.					
8. The facilitator was dedicated and supportive.					
9. Participation and interaction were encouraged.					
10. The schedule and the agenda were observed throughout the meeting.					
11. The materials distributed were useful.					
12. The time allocated for the meeting and for the activities, was sufficient.					
13. The meeting room and facilities were adequate and comfortable.					

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CERTIFICATE OF ATTENDANCE

This is to certify that

Name and Surname

has attended the EMERALD International Summer School on:

3D Printing in Bio-Mechatronics

from 12.09.2022 to 23.09.2022

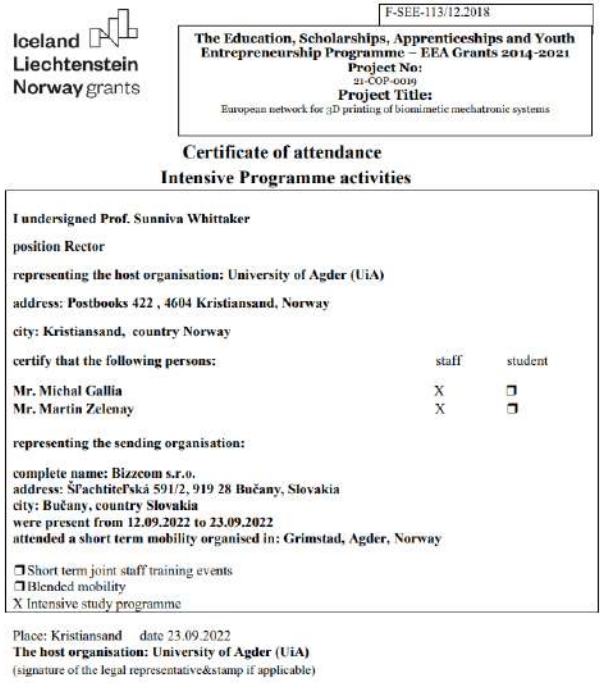
Organized at the University of Aeder, Norway by the EMERALD Project consortium partners

Prof.Dr.Ene. Filippo Sanfilippo,
Partner of EMERALD project

In cooperation with

bizzcom

EMERALD International Summer School on 3D Printing in Bio-Mechatronics is organized at the University of Agder, Norway by the EMERALD Project consortium partners



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F-SEE-113/12.2018

The Education, Scholarships, Apprenticeships and Youth Entrepreneurship Programme – EEA Grants 2014-2021
Project No: 21-COP-0019
Project Title: European network for 3D printing of biomimetic mechatronic systems

Certificate of attendance
Intensive Programme activities

I undersigned Prof. Sunniva Whittaker

position Rector

representing the host organisation: University of Agder (UiA)

address: Postbooks 422 , 4604 Kristiansand, Norway

city: Kristiansand, country Norway

certify that the following persons:	staff	student
Mr. Michal Gallia	X	❒
Mr. Martin Zelenay	X	❒

representing the sending organisation:

complete name: Bizzcom s.r.o.
address: Šľachtiteľská 591/2, 919 28 Bučany, Slovakia
city: Bučany, country Slovakia
were present from 12.09.2022 to 23.09.2022
attended a short term mobility organised in: Grimstad, Agder, Norway

❒ Short term joint staff training events
❒ Blended mobility
X Intensive study programme

Place: Kristiansand date 23.09.2022
The host organisation: University of Agder (UiA)
(signature of the legal representative&stamp if applicable)

Feedback forms and certificates provided to the EMERALD International summer school participants

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Blatchford ortopedi Norway company presentation - case studies revealed by Physiotherapist & Department leader of Blatchford Arendal - Bjarne Lindebø

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Blatchford ortopedi Norway company presentation - case studies revealed by Physiotherapist– Bjarne Lindebø

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Open discussions between Blatchford ortopedi Norway company representatives and professors / students of the EMERALD International summer school in Norway

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Ending up of a very intense , but consistent period of the EMERALD International summer school in Norway (2022 edition)

1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022

Ending of the first edition of the EMERALD International summer school

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European Network For 3D Printing Of Biomimetic Mechatronic Systems

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LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics

Duration : 4 day(s)

Country of Venue : Slovakia

Total number of Participants : 20

Bucany, Slovakia

Date: May 2023

The International summer school organized by the BIZZCOM company

Participating Organizations : University Politehnica Bucharest, Technical University of Cluj-Napoca, University of Agder, Bizzcom s.r.o., Poznan University of Technology

Staff for training event

Activity : ➢ is focused on **the use and testing the functionality of e-virtual laboratory** (e-learning) platform developed by the EMERALD consortium for teaching activities related to the manufacturing of biomimetic mechatronic systems by 3D printing

VR EMERALD platform

The target groups: ➢ **professors** ➢ **other people / institutions (stakeholders)** involved in research activities related to the developing, manufacturing and testing of new biomimetic mechatronic systems made by 3D printing, for people with special needs

1-6 May 2023

Testing the functionality of virtual laboratory platform developed within IO3 related to:
different scenarios in VR / AR / Mixed Reality applications for people with special needs

IMPORTANT FEEDBACKS

Content?

AR applications

Report?

Certificates ?

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UNIVERSITATEA POLITEHNICA DIN BUCUREȘTI 1818

POLITECHNIKA POZNAŃSKA POZNAN UNIVERSITY OF TECHNOLOGY

UiA University of Agder

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LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics

EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia

LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics

applied sciences

Order Article Reprints

Experimental Evaluation of Extended Reality Technologies in the Development of Individualized Three-Dimensionally Printed Upper Limb Prostheses

by Filip Górski [1,*], Remigiusz Łabudzki [1], Magdalena Żukowska [1], Filippo Sanfilippo [2], Morten Ottestad [2], Martin Zelenay [3], Diana-Irinel Băilă [4] and Razvan Pacurar [5]

[1] Faculty of Mechanical Engineering, Poznan University of Technology, 60-965 Poznan, Poland
[2] Department of Engineering Sciences, Faculty of Engineering and Science, University of Agder (UiA), Jon Lilletuns vei 9, NO-4879 Grimstad, Norway
[3] Bizzcom s.r.o., Šachtitelská ulica 591/2, 919 28 Bučany, Slovakia
[4] Department of Manufacturing Engineering, Faculty of Industrial Engineering and Robotics, University Politehnica of Bucharest, Blv. Splaiul Independenței, No. 313, Sector 6, 060042 Bucharest, Romania
[5] Department of Manufacturing Engineering, Faculty of Industrial Engineering, Robotics and Production Management, Technical University of Cluj-Napoca, Blv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania
* Author to whom correspondence should be addressed.

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Received: 12 June 2023 / Revised: 4 July 2023 / Accepted: 5 July 2023 / Published: 10 July 2023

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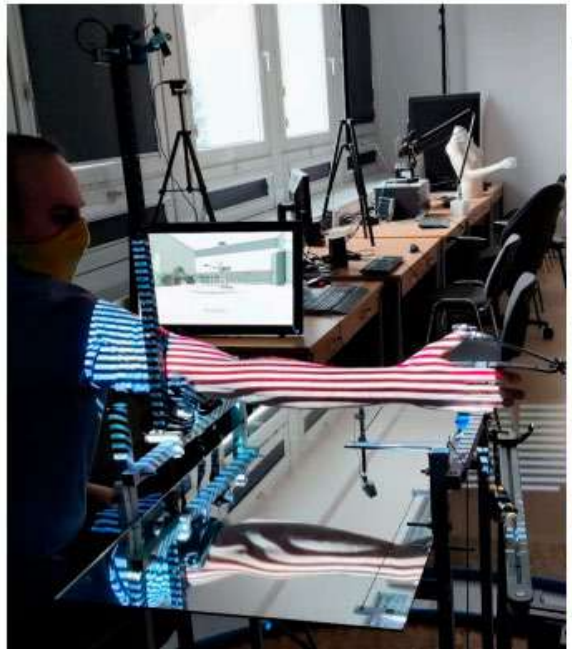
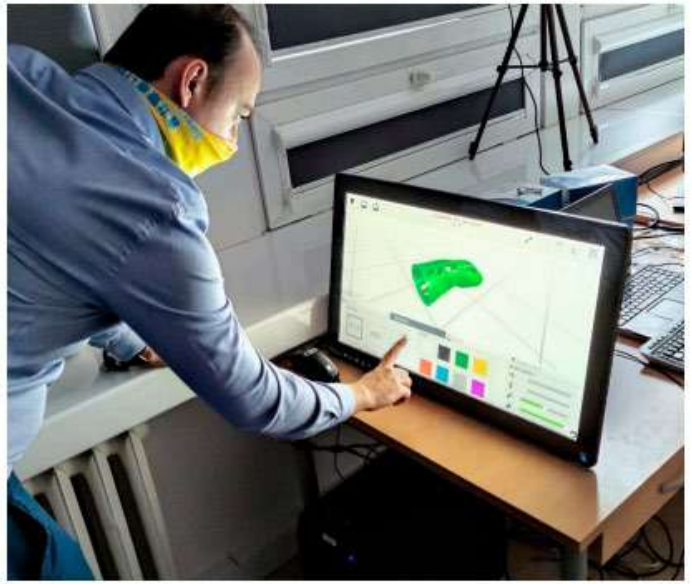
MDPI

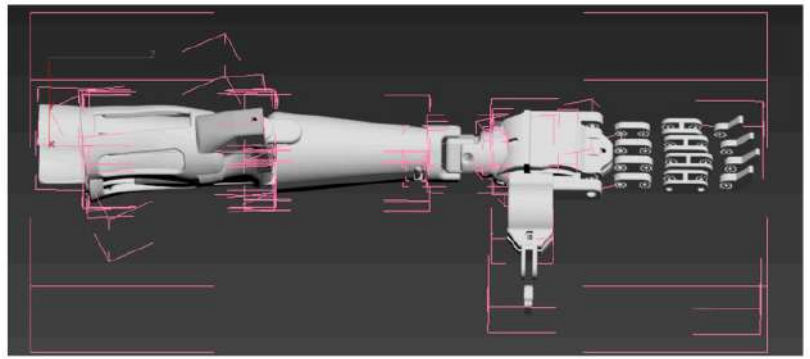


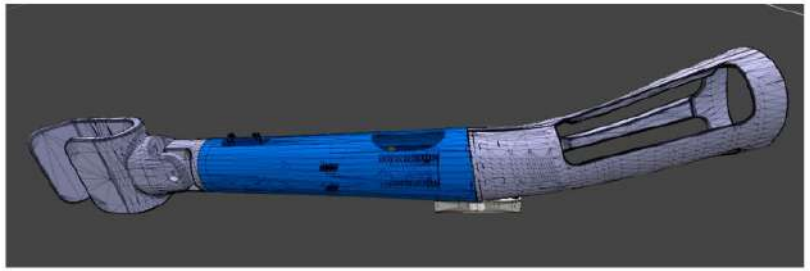


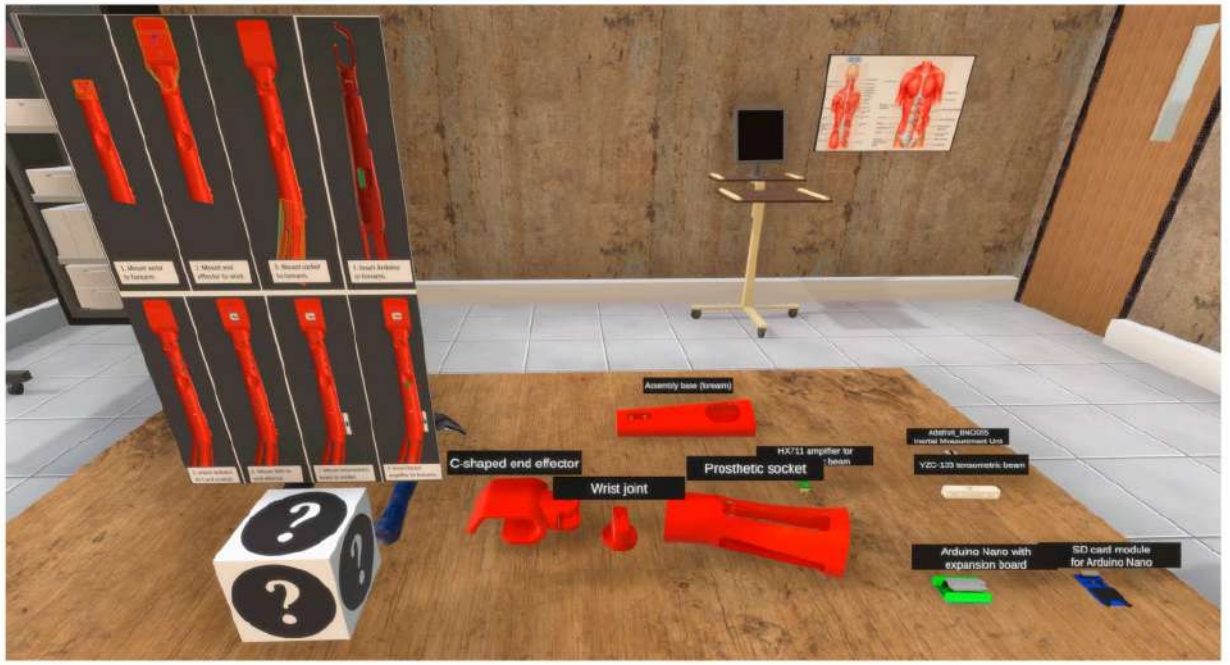
EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia

LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics



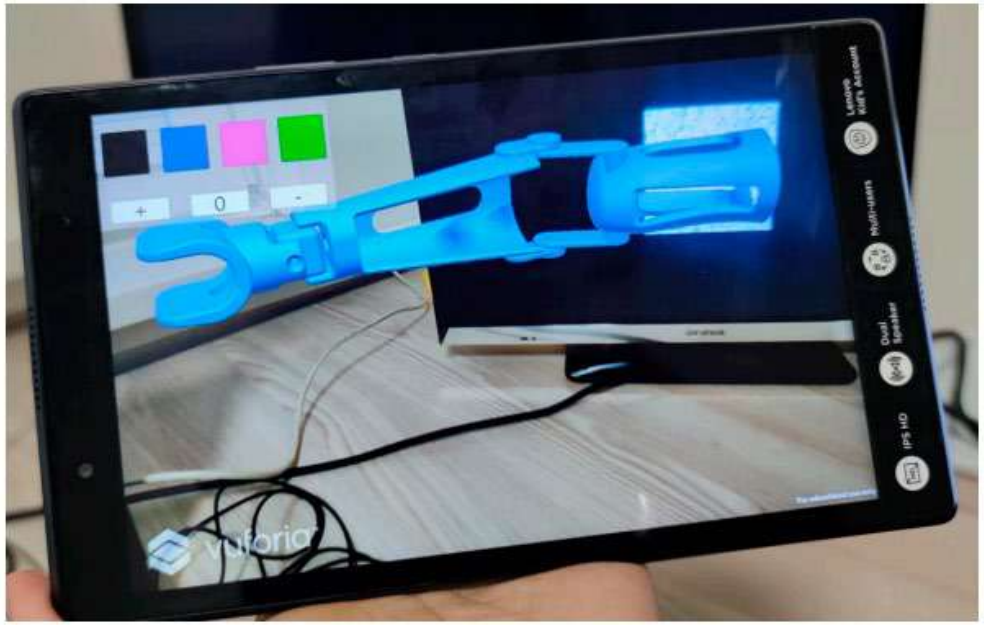


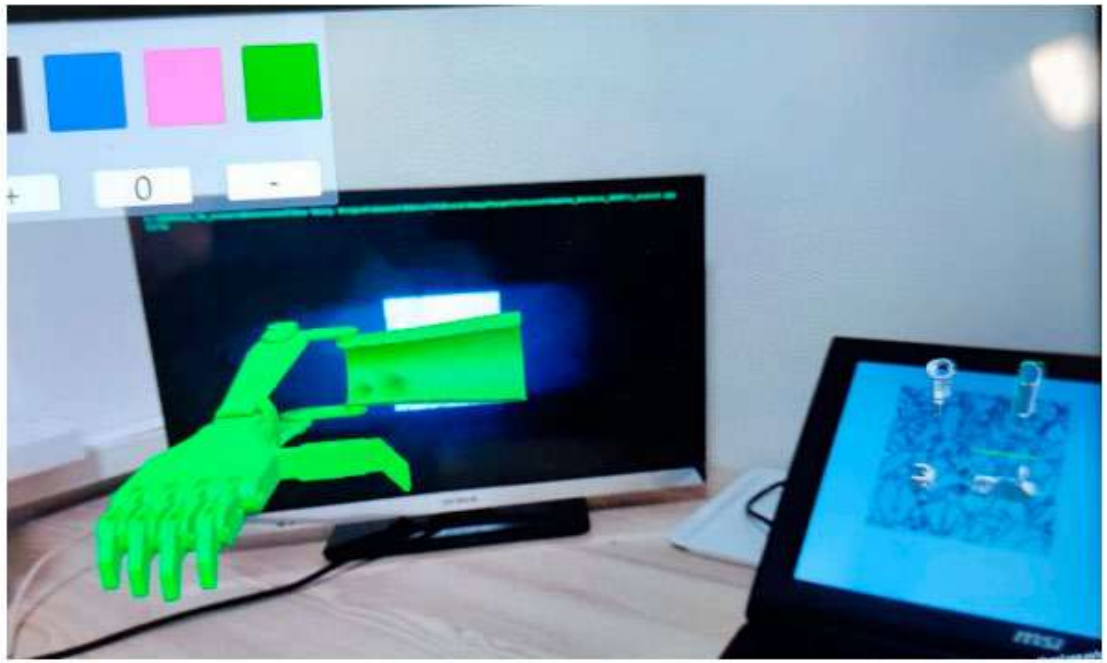


EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (VR)

LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics

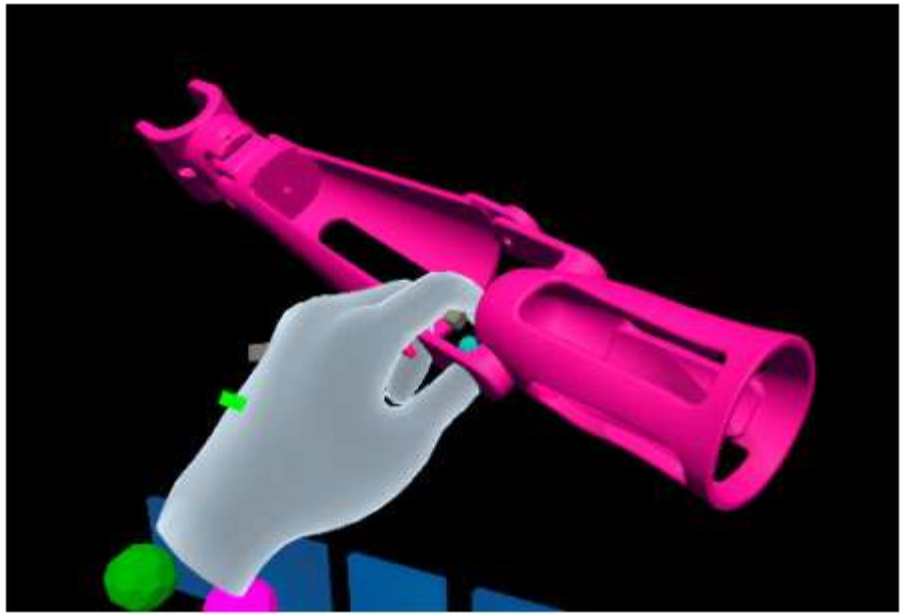




EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (AR)

LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics



EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (MR-mixed reality)

LTT activities

C2 : Short-term joint staff training events – 3D printing and bio-mechatronics

EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (programming and testing the made applications during the realized training in VR, AR and MR)

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LTT activities

C3 : Intensive Programmes for higher education students - 3D printing and bio-mechatronics

Duration : 10 day(s) | **Country of Venue : Norway** | **Total number of Participants : 30**

Date: July 2023

The 2nd International summer school organized by the University of Agder

Participating Organizations : University Politehnica Bucharest, Technical University of Cluj-Napoca, University of Agder, Bizzcom s.r.o., Poznan University of Technology

The target groups: ➢ **professors** (from EMERALD consortium and engaged in technical activities) & **students**
Organized free of charge ! the participants are required to **REGISTER** in the preamble.

Aims: to familiarize the attendees with the personalized and project based teaching methods used in Higher education and the efficiency of these methods in using the EMERALD project resources, especially e-virtual laboratory (e-learning platform) AR / VR / mixed reality applications **for getting knowledge and practical skills** in **developing of new biomimetic mechatronic systems by 3D** printing technologies and specific applications related to the **programming of biomimetic mechatronic** systems AR / VR applications.

Students will be able first to understand the **basic principles** that are related to CAD/CAE, manufacturing, programming and testing of biomimetic systems using e-virtual laboratory (e-learning) platform.
Professors will present on a course the basics of **different case study** that is being prepared, with the particularities involved in the case when biomimetic mechatronic systems are required to be materialized for people with special needs, emphasizing the facilities of the virtual laboratory (e-learning platform / AR / VR applications).
In this way the easiness in using the a-learning platform of the EMERALD consortium will be checked based on the feedbacks provided by students.

Testing and experiencing the virtual laboratory platform developed within IO3 related to:
different scenarios in VR / AR / Mixed Reality applications for people with special needs

IMPORTANT FEEDBACKS | Certificates ? | Report?

Main results reached during the EMERALD summer school organized at the University of Agder in July 2023 will be presented in September 2023 at the Multiplier event organized in Slovakia by BIZZCOM

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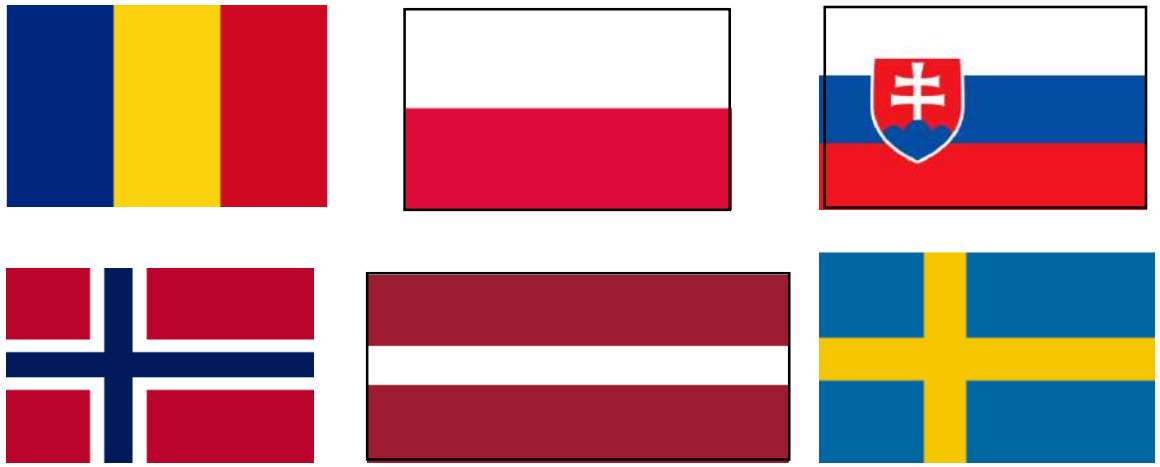
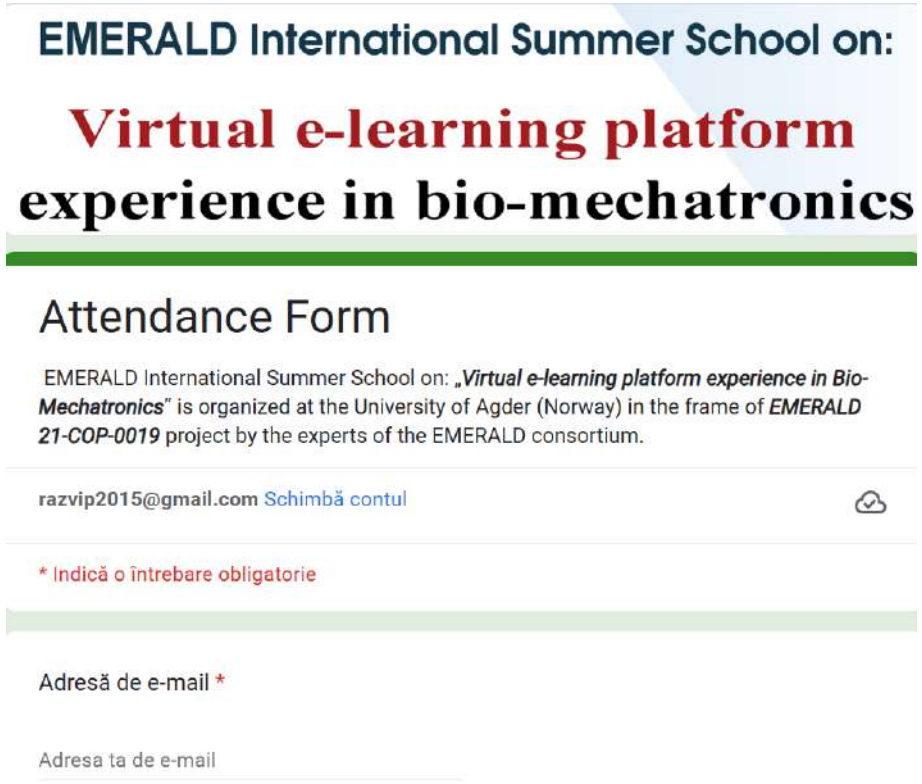
Registration until 18th of August 2023



Registered– 45 participants coming from Romania, Poland, Slovakia, Norway, Latvia and Sweden



Registering form – online – available on the EMERALD project webpage

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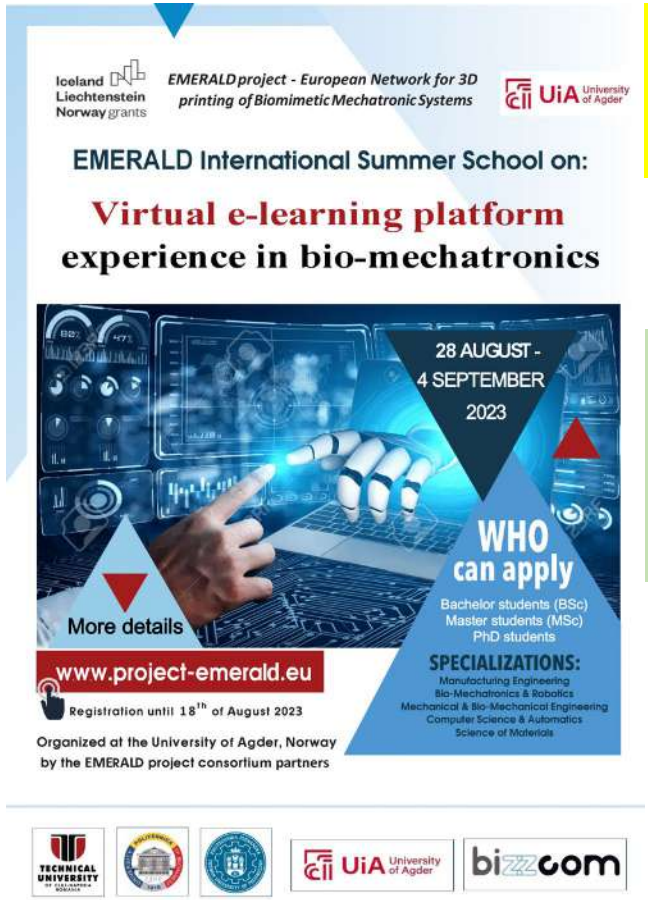

2nd edition of the EMERALD International Summer School University of Agder (Grimstad, Norway)– 28 August-4 September 2023

Free of charge

Main topic related to VR, AR, MR testing and programming

Pre-experience in VR / AR Programming is not required

h	Monday 28.08.2023	Tuesday 29.08.2023	Wednesday 30.08.2023	Thursday 31.08.2023	Friday 01.09.2023	Saturday 02.09.2023	Monday 04.09.2023	h
10	Opening ceremony and EMERALD project presentation	VR programming and applications in bio-mechatronics	AR applications in bio-mechatronics	Mixed Reality applications in bio-mechatronics	Digital manufacturing and Digital testing	VR, AR and mixed reality applications made by the students for the EMERALD e-learning virtual platform	Finalizing progress report and preparing final presentation - working on smaller groups)	10
11	Participants' presentation and program guidelines of the summer school	VR Unity applications – laboratory on realizing programming in VR – part 1	AR Unity applications – laboratory on realizing programming in AR – part 1	Mixed reality experience – laboratory on realizing programming in Mixed Reality	Smart and Intelligent materials		Final test, final questionnaires and feedbacks fulfilled by the participants concerning the organized summer school + test corrections	11
12	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time	Lunch & free time	12
13	Introduction to VR immersive technologies	VR Unity application – laboratory on realizing programming in VR – part 2	AR Unity application – laboratory on realizing programming in AR – part 2	EMERALD e-learning platform – concept presentation and Kuula presentation (basic concepts)	Digital factory - lecture Digital factory - seminar	Feedbacks provided regarding the content and functionality of the platform, sketching of potential scientific articles to be published by the EMERALD partners "in common"	Final student presentations, live demonstrations presenting and defining of common ideas of future diploma projects	13
14	Introduction to VR/AR and haptic technology integration in education	VR Unity application – laboratory on testing with VR googles	AR Blender application – laboratory of programming for realizing apps in AR	Kuula seminar – working on the EMERALD e-learning platform (virtual laboratories updating)	Presentation on behalf of companies, themes and feedbacks received from the companies	Finalizing progress report and preparing final presentation - working on smaller groups	Final conclusions, future perspectives of continuing the directions and using of resources conceived within the EMERALD project	14
15	Presentation of case studies and dividing into smaller groups	Conclusions, feedbacks and progress report	Conclusions, feedbacks and progress report	Conclusions, feedbacks and progress report	Conclusions, feedbacks and progress report	Conclusions, feedbacks and progress report	Closing and final awarding ceremony	15

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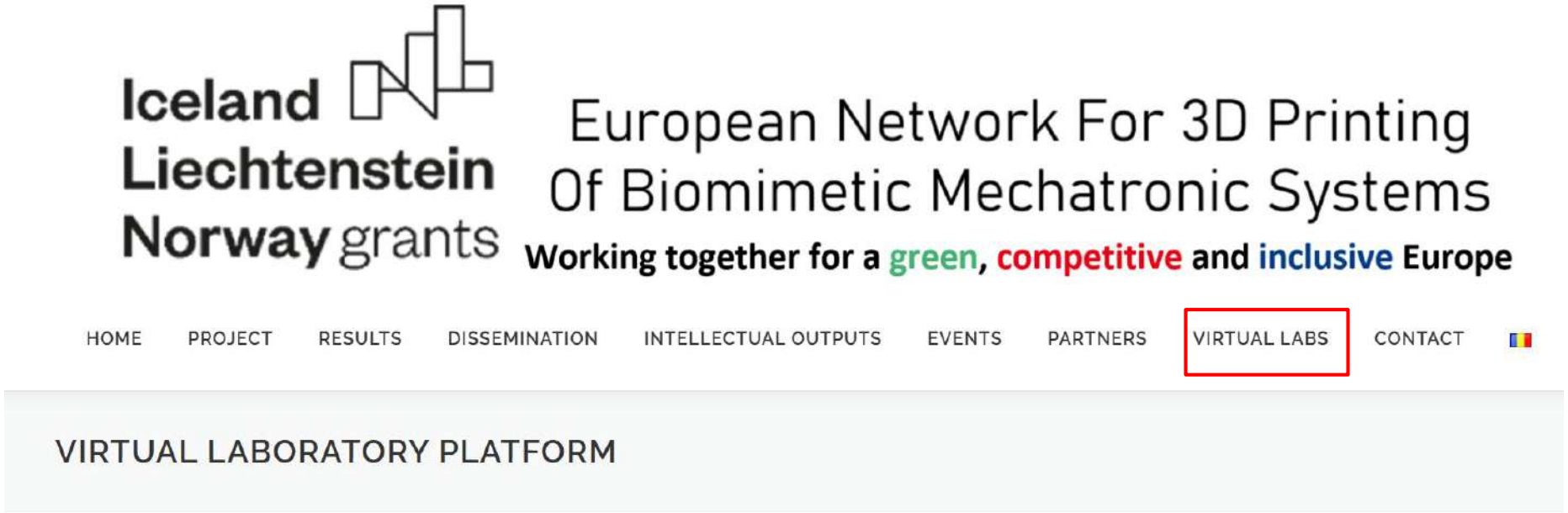

Experiencing of the Virtual platform laboratory conceived by the EMERALD consortium in bio-mechatronics / 3D printing (with AR /VR facilities)

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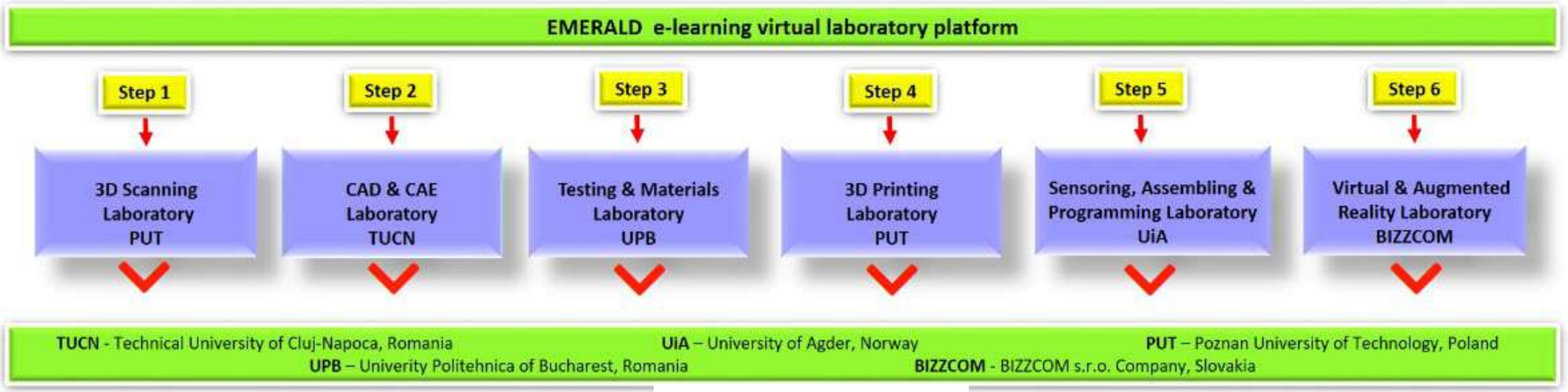

Click to visit virtual laboratory

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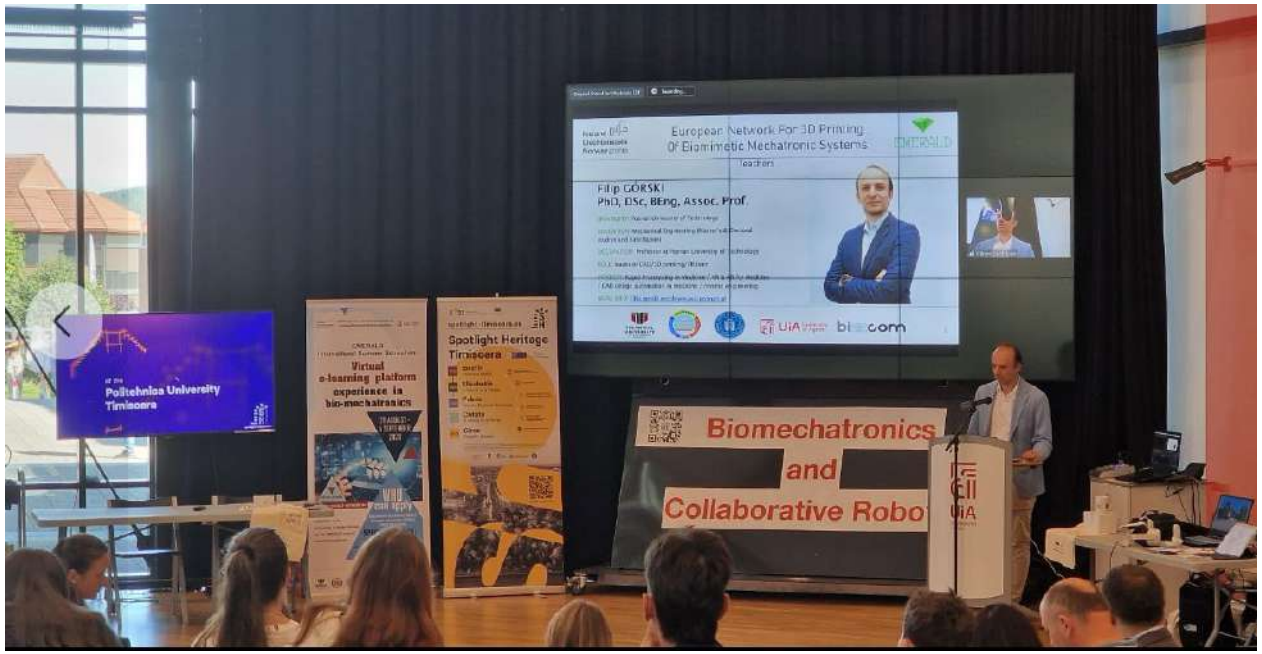

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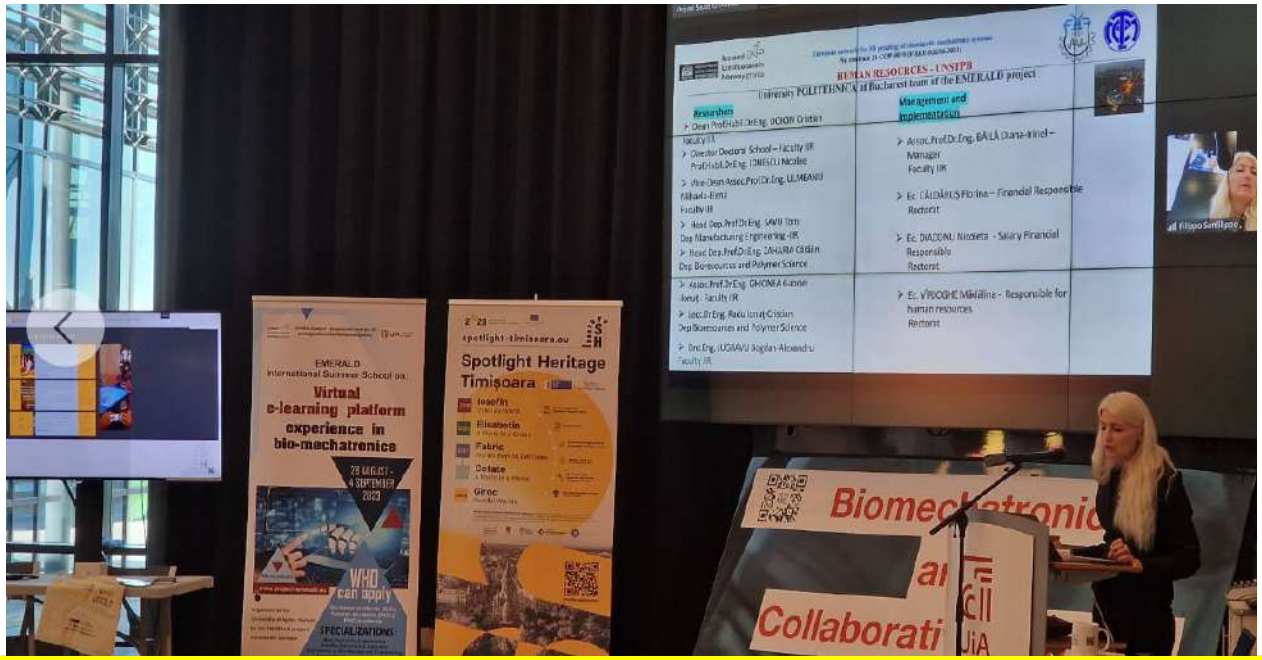

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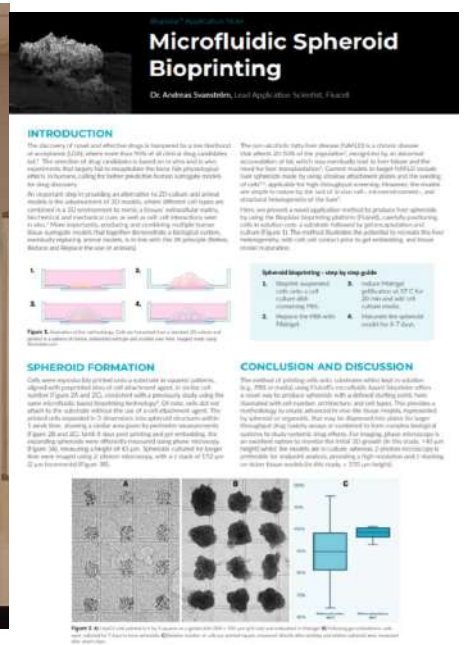

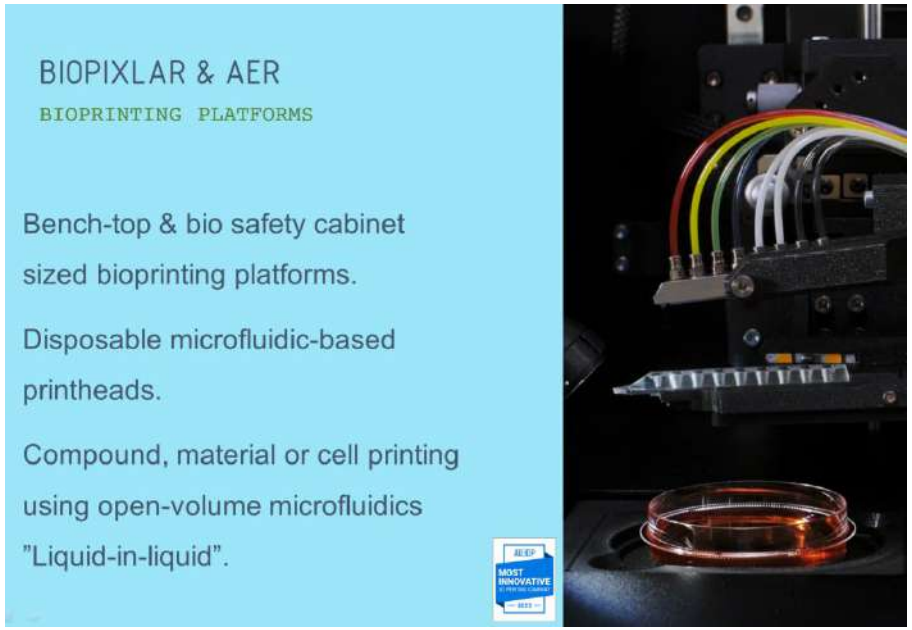

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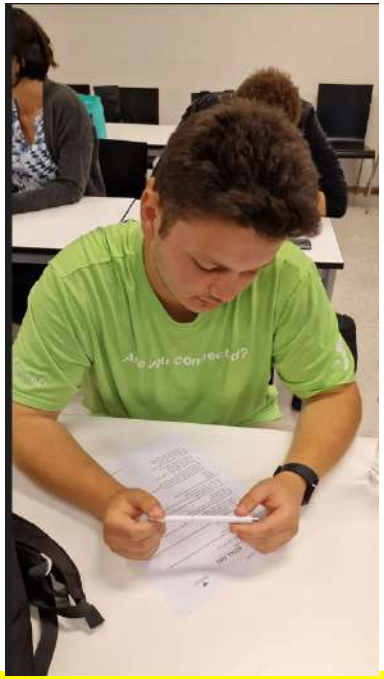

Feedback form for the evaluating of the EMERALD e-learning virtual laboratory platform

Name of the event:	EMERALD International Summer School 2023
Objectives of the questionnaire:	Virtual e-Learning (virtual laboratory) platform Feedback Questionnaire
Organizer:	University of Agder (UiA), Norway
Dates of the meeting:	31 August 2023
Location of the meeting:	Grimstad, Norway

Please take a few moments to answer the following questions regarding your experience with the EMERALD e-Learning (virtual laboratory) platform. Your feedback is invaluable and will help us improve the user experience. **Please mark with an "x" your answer below as it fits:**

1. **Structure & Logic of Steps:**
   - How would you rate the clarity and logic of the steps presented within the EMERALD e-Learning (virtual laboratory) platform?

Very Clear	Clear	Neutral	Unclear	Very Unclear

2. **Range and diversity of Applications:**
   - How satisfied are you with the range of applications (VR, AR, CAD models, etc.) presented within the EMERALD e-Learning (virtual laboratory) platform?

Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied

3. **Innovative Learning Methods:**
   - How novel, innovative and practical do you find the learning methods presented within the EMERALD e-Learning (virtual laboratory) platform?

Very Modern	Moderately Modern	Neutral	Unsatisfied	Very Unsatisfied

6. **User Interface (EMERALD e-Learning (virtual laboratory) platform which is being accessed through the provided scheme on the EMERALD website):**
   - How would you rate the user-friendliness of the platform interface?

Very User-Friendly	User-Friendly	Neutral	Difficult to Use	Very Difficult to Use

7. **Videos & Presentations:**
   - How would you evaluate the quality and relevance of the videos and presentations provided within the EMERALD e-Learning (virtual laboratory) platform?

Excellent	Good	Neutral	Poor	Very Poor

8. **Lectures & Laboratories:**
   - Were the lectures and laboratories found within the EMERALD e-Learning (virtual laboratory) platform informative and beneficial to your learning experience?

Very Beneficial	Beneficial	Neutral	Slightly Beneficial	Not Beneficial

9. **Suggestions & Improvements:**
   - Are there any features or aspects of the EMERALD e-Learning (virtual laboratory) platform you believe could be improved or added? Please specify below.

Experiencing of the Virtual platform laboratory conceived by the EMERALD consortium in bio-mechatronics / 3D printing (with AR /VR facilities)

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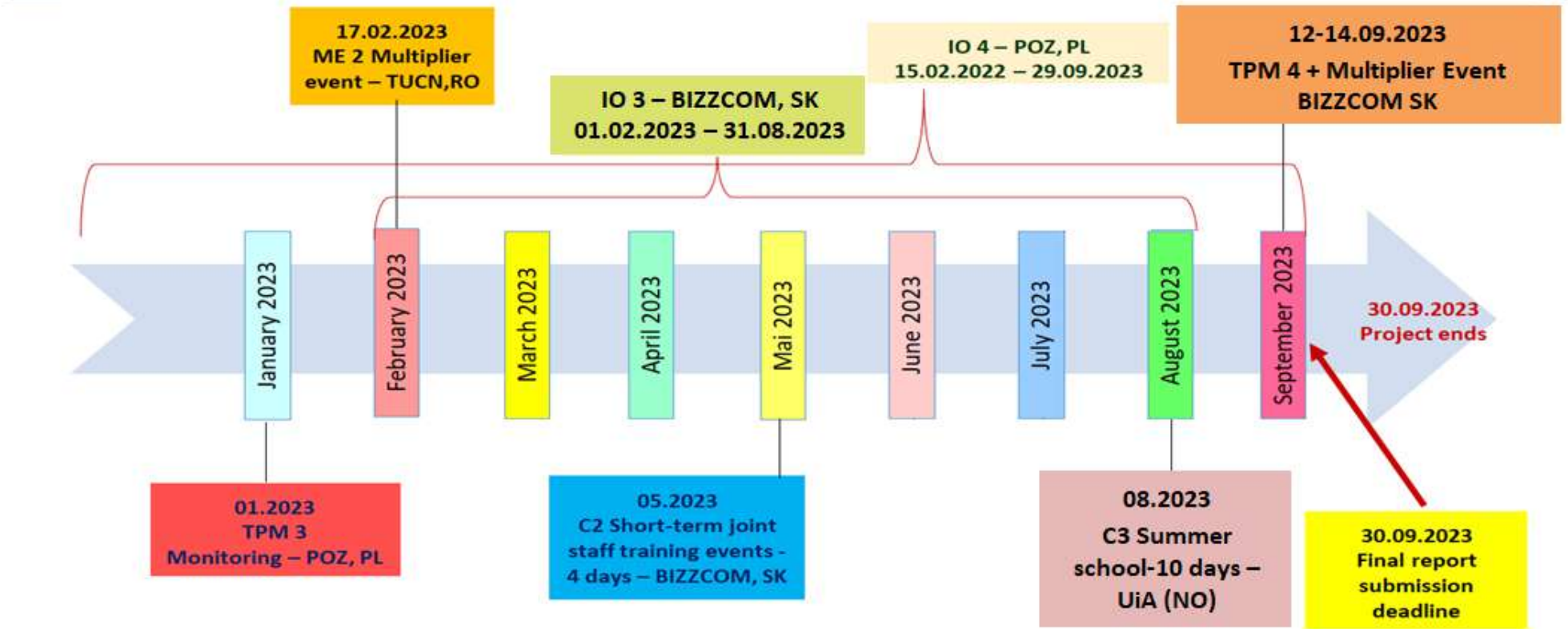
EMERALD - Calendar of the project / milestones – plan - February – September 2023



EMERALD ending conclusions

EMERALD is a matter of new and different perspectives

EMERALD experience….foreseen…to be continued

EMERALD strong network built and still growing

EMERALD is above / beyond numbers or indicators

EMERALD is strong, shiny and valuable as are the diamonds

EMERALD

EMERALD is a matter of teamwork / team building / building valuable memories, strong / durable relationships and unique experiences jointly / both for professors and students

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EMERALD is a matter of cultural exchange, collaboration, friendship and learning one from each other

EMERALD is a matter of exchanging knowledge and sharing values, experiences and expertise

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EMERALD project - contact details

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CONTACT US

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Assoc. Prof.dr.eng. Razvan Pacurar – razvan.pacurar@tcm.utcluj.ro

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