

Transnational project meeting -TPM 4

hosted by Bizzcom s.r.o. company, in
Bucany, Slovakia

11th -12th September 2023

- **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



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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**

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1. Main aims and details of the EMERALD project

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

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

Coordinator



Selection Results – Cooperation projects



TU Cluj-Napoca (RO)

Total Budget:
198.810 EUR

Total Duration:
2 years

Starting date:
15.02.2022

Ending date:
30.09.2023

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

Partners from Higher Education institutions



University of Agder (NO)



University POLITEHNICA Bucharest (RO)



Poznan University of Technology (PL)



(SK)

Education, Scholarships, Apprenticeships and Youth Entrepreneurship Programme financed by the EEA Financial Mechanism (2014 – 2021)

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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.**

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



ARM NEUROPROSTHESIS EQUIPED WITH ARTIFICIAL SKIN AND SENSORIAL FEEDBACK - ARMIN

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

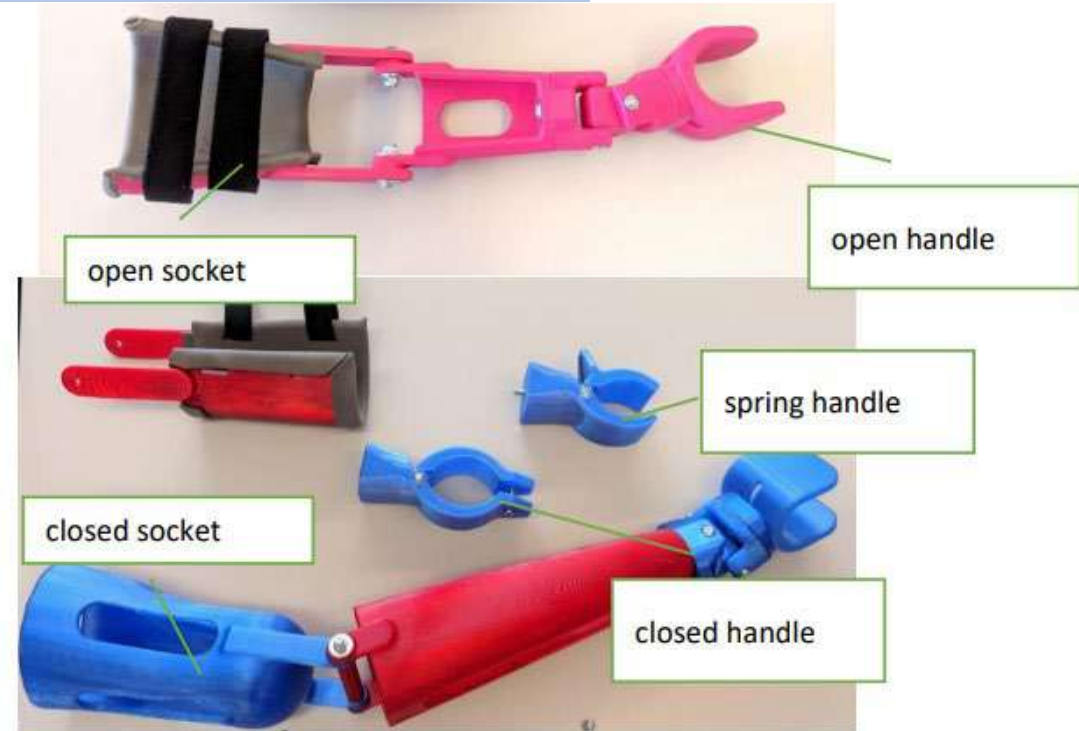
The main objective of the project was to design and fabricate the command and control system of a neuroprosthesis that integrates the motion algorithms with the command and sensory signals. The sensorial feedback system is re-establishing the sensorial function of amputated arms and is able to achieve 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 be 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.



Case studies proposed to be solved in the EMERALD project



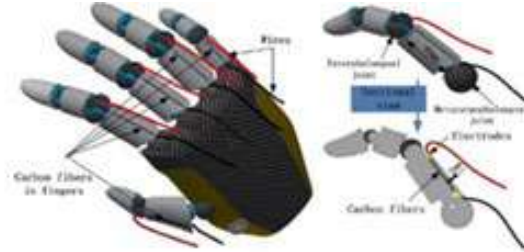
Bicycle prosthesis used by various patients [PUT project report]



Components of the bicycle prosthesis [PUT project report]

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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)

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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.

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



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

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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 - EMERALD

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**.

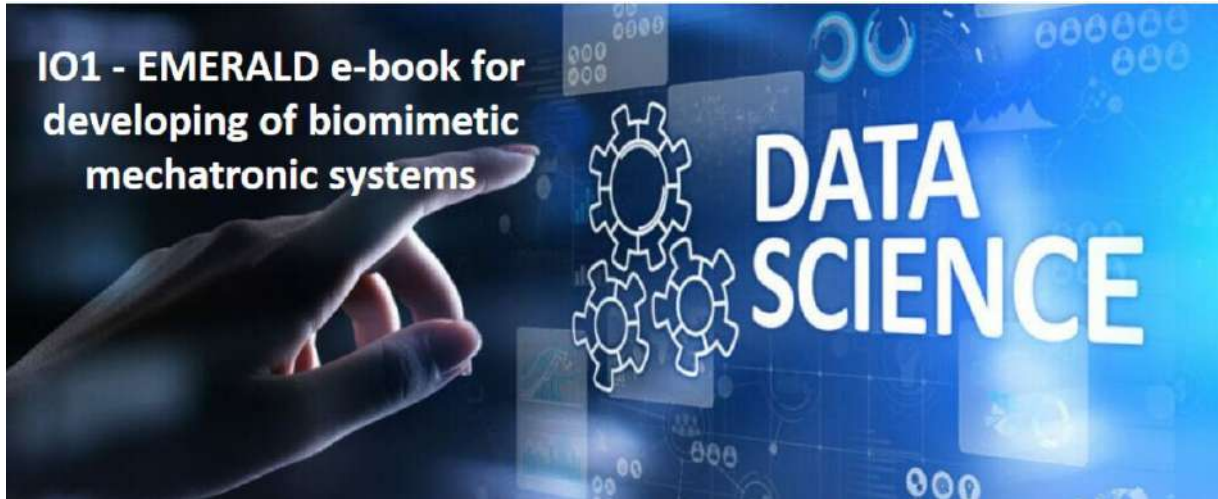
	MODULES	RESPONSIBLES	
Open access on the platform?	1. Computer Aided Design (CAD)	PUT	Starting: 15.02.2022
	2. Computer Aided Engineering (CAE)	TUCN	
	3. Computer Programming	UiA	
	4. Virtual Reality / Augmented Reality	PUT & BIZZCOM	
Content?	5. Sensors and Electronics	UPB	Deadline: 31.07.2022
	6. Bio-Mechatronics	UiA	
Template?	7. 3D printing and Rapid Tooling methods	TUCN	
	8. Intelligent (smart) materials	UPB	
Report?	<p>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.</p>		

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Intellectual Output – IO1

POSTED ON 2022-09-30 BY RĂZVAN PĂCURAR

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



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

EMERALD

The Education, Scholarships, Apprenticeships and Youth
Entrepreneurship
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

This project has been funded with support from the EU and Liechtenstein Norway grants. The publication is an external reflection of the views of the authors, and the Commission is not responsible for any use which may be made of the information contained therein.



Open-access book published on the EMERALD project website

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

Quick overview of the Intellectual outputs related to the EMERALD project

102 - 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 102 : > to provide e-toolkit for teaching purposes
 > to provide the basics knowledge about the realizing of biomimetic mechatronic systems by 3D printing.
 > to provide the other preliminary and post processing steps that are required to be followed in terms of CAD modeling
 > diploma project themes

		RESPONSIBLES
Open access on the platform?	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
Content?	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
Template?	Description of assembling and programming of the systems	UiA
Report?	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.

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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

Intellectual output – IO2

IO2 – E-toolkit for teaching purposes, basic knowledge about realizing biomimetic mechatronic systems



E-toolkit manual

The main aims of the IO2 are to provide an e-toolkit for teaching purposes, basic knowledge about realizing biomimetric 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.

EMERALD

The Education, Scholarships, Apprenticeships and Youth
Entrepreneurship
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 WIERZBIĆKA, Magdalena ZUKOWSKA, 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

		RESPONSIBLES
Open access on the platform?	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
Content?	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
Report?	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

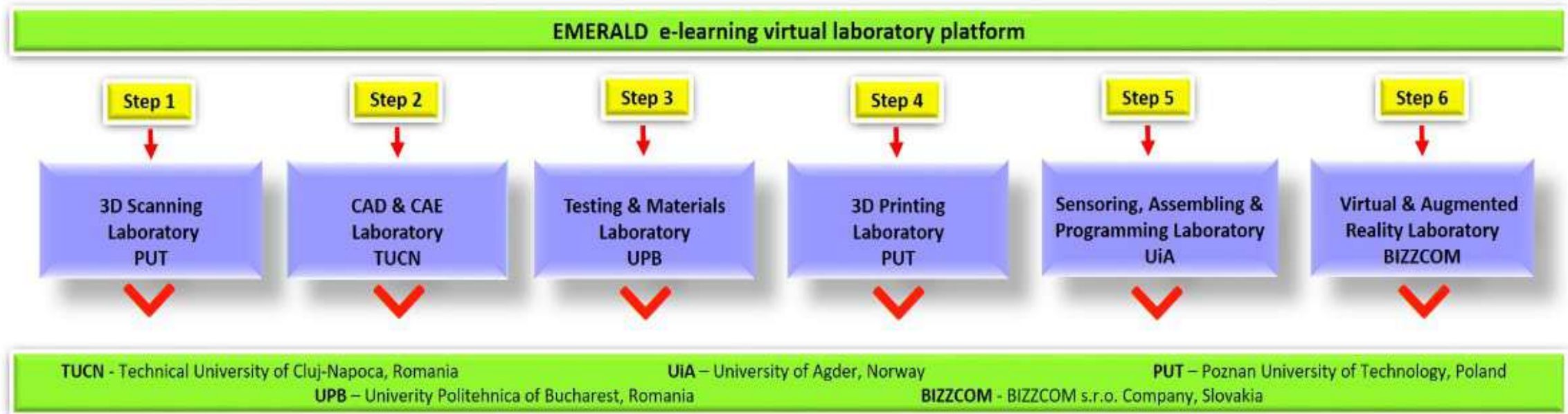


Please click on the tooltips on the diagram below to virtually visit our laboratories.

For a better understanding of the EMERALD e-learning virtual laboratory platform, which includes 3D scanning, CAD, CAE, testing and material characterization, 3D printing, sensorizing, assembly, programming, AR & VR, it is advisable to access the virtual laboratories by following the steps that are outlined in the diagram given below. By following the steps in the indicated order, this will lead to a more comprehensive understanding of the logical process involved in conceiving and developing of new biomimetic mechatronic systems to be realized utilizing 3D printing technologies.

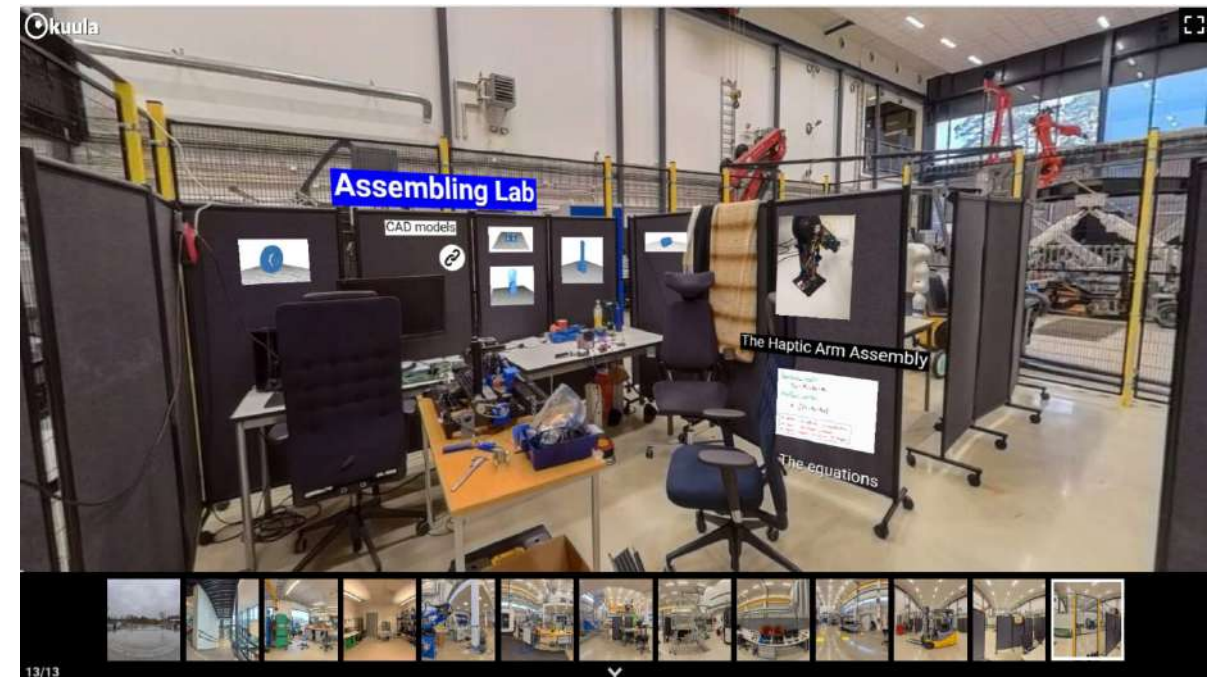
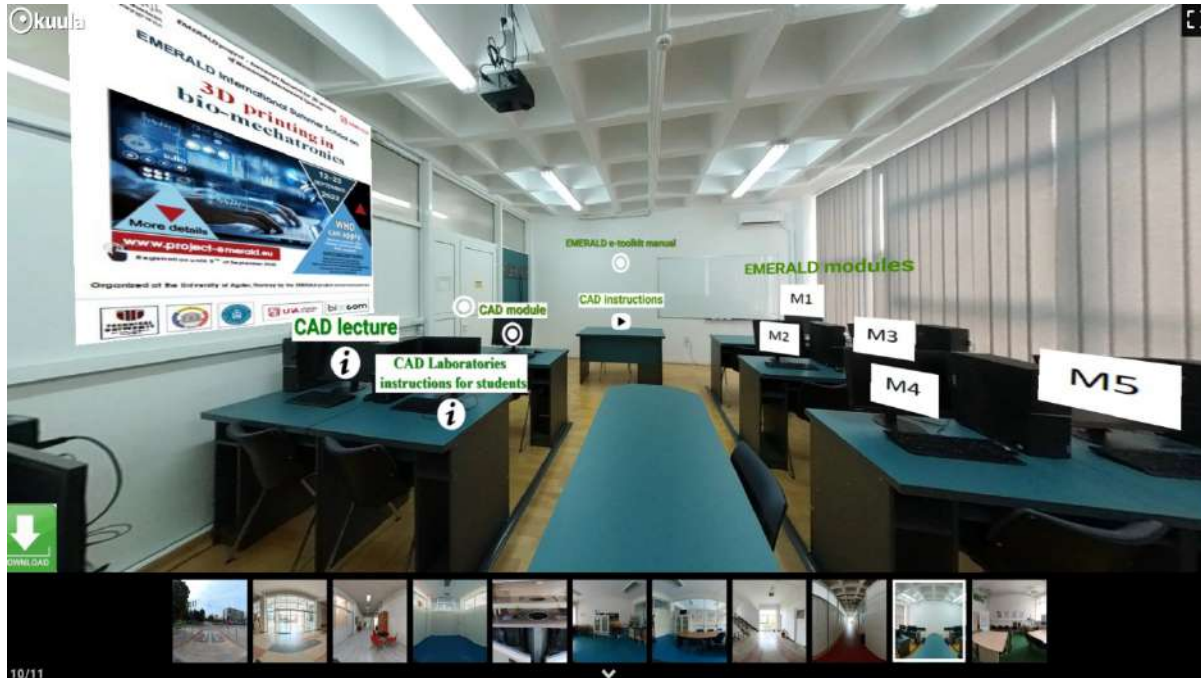
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Quick overview of the Intellectual outputs related to the EMERALD project



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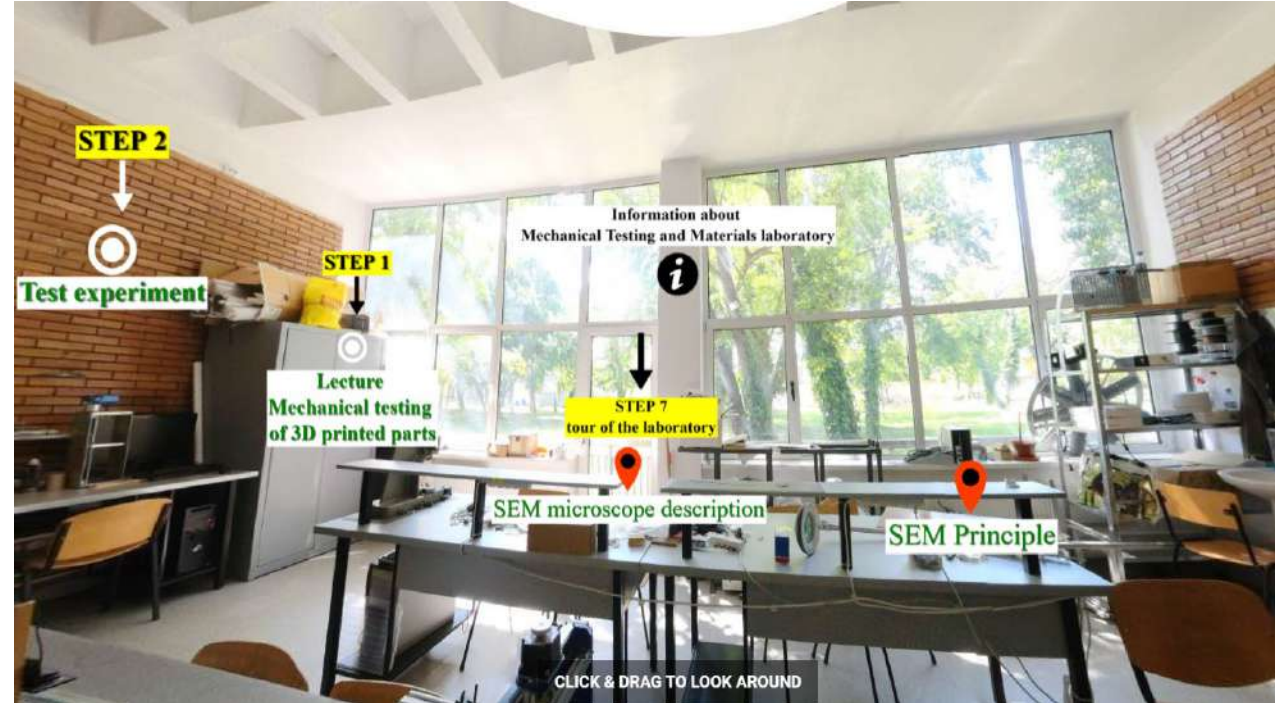
Quick overview of the Intellectual outputs related to the EMERALD project



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



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

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Quick overview of the Intellectual outputs related to 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
 Start Date : 15 Feb 2022 End Date : 29 Sep 2023
 Responsible: Poznan University of Technology

The main aim of the I04 : ➤ 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 3D 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

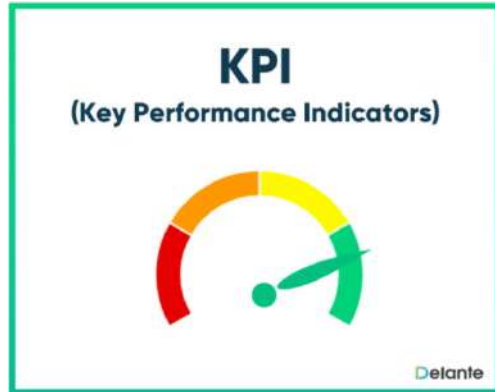
For each case study according to the skills and competences of the EMERALD partners consortium, from the Technical team there will be nominated 1-2 responsible persons. 3 different teams comprising 5-7 students from different countries of the consortium will start to work on the topic. Validation of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

**WORK IN
PROGRESS**

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PROGRESS**

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Main KPIs of the EMERALD project



104 - 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 the field of bio-mechatronics /3D printing domains) to scale up the solutions to build one active and representative network for 3D 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 3D 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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Disseminating plan /conceived for the EMERALD project

Main indicators

DISSEMINATION PLAN



EMERALD
The Education, Scholarship, Apprenticeship and Youth Entrepreneurship
EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS

MODULE *number*
Name of Module

Project Title	European network for 3D printing of biomimetic mechatronic systems
Project	EMERALD project for development of biomimetic mechatronic systems
Module	Module "number" "Name of Module"
Date of delivery	July 2023
Authors	
Contact	RENAL YARAYAN, "lead"



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

by Filip Górski^{1,*}, Remigiusz Labudzki¹, Magdalena Żukowska¹, Filippo Sanfilippo², Morten Ottestad², Martin Zelenay³, Diana-Irinel Băilă⁴ and Razvan Pacurar⁵

- 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., Šľachtitel'ská ulica 591/2, 919 28 Bučany, Slovakia
 - ⁴ Department of Manufacturing Engineering, Faculty of Industrial Engineering and Robotics, University Politehnica of Bucharest, Biv. 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, Biv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania
- * Author to whom correspondence should be addressed.

Appl. Sci. 2023, 13(14), 8035; <https://doi.org/10.3390/app13148035>

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

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1 reached

1 in progress

2 still needed



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

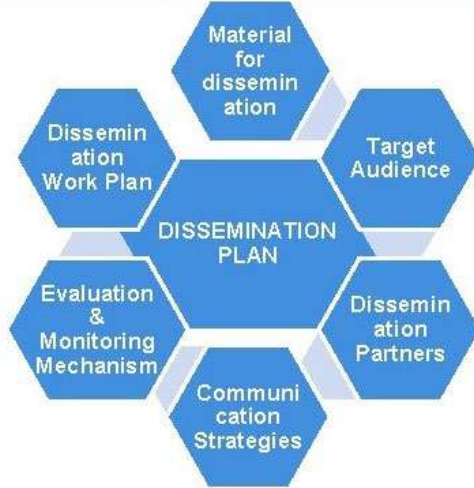
- 1 patent + 4 ISI articles with IF published "in common" with all partners are expected to be reached at the end of the project

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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".



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



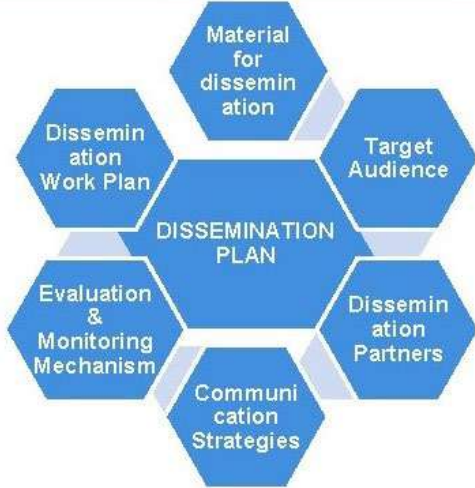
TUCN (Razvan Pacurar) / UPT (Filip Gorski) -Guest editors to MDPI Materials ISI journal – Q1 – ISI journal with IF 3.4

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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 Turudija¹, Nikola Vitković¹, Filip Górski², Ancuța Păcurar³, Alin Pleșa⁴, Alexandru Ianoși-Andreeva-Dimitrova⁴ 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, Biv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; ancua.coste@tcm.utcluj.ro
 - ⁴ Department of Mechatronics and Machine Dynamics, Faculty of Automotive, Mechatronics and Mechanical Engineering, Technical University of Cluj-Napoca, Biv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; alin.plesa@mdm.utcluj.ro (A.P.); alexandru.ianos@mdm.utcluj.ro (A.I.-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

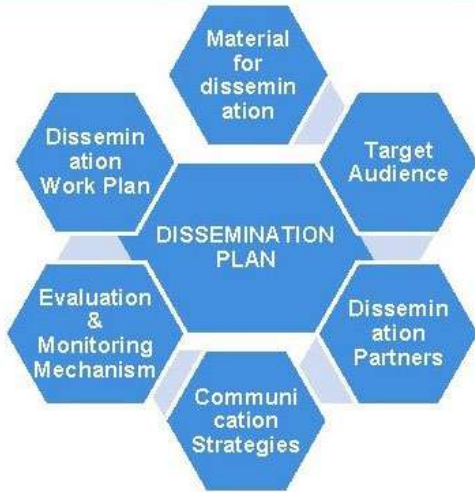
TUCN (Razvan Pacurar) / UPT (Filip Gorski) –publishing of 2 articles in MDPI Materials journal jointly with authors from the EMERALD consortium and from outside the EMERALD consortium (Serbian authors) – Q2 – ISI journal with IF 3.4

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Results of the project

DISSEMINATION PLAN



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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@mefak.ni.ac.rs (J.R.S.); nikola.korunovic@mefak.ni.ac.rs (N.K.)
 - ² Department of Mechatronics and Machine Dynamics, Faculty of Automotive, Mechatronics and Mechanical Engineering, Technical University of Cluj-Napoca, Bv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania; emil.teutan@mdm.utcluj.ro (E.T.); alin.plesa@mdm.utcluj.ro (A.P.); alexandru.ionosi@mmdm.utcluj.ro (A.I.-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, Bv. Muncii, No. 103-105, 400641 Cluj-Napoca, Romania
- * Correspondence: nikola.vitkovic@mefak.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. 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 surgical 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



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

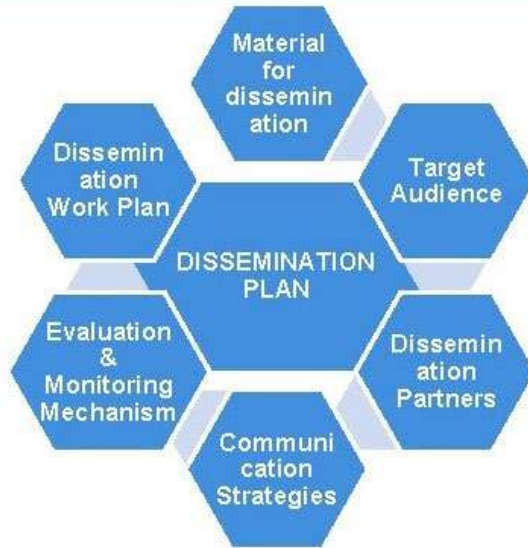
TUCN (Razvan Pacurar) / UPT (Filip Gorski) –publishing of 2 articles in MDPI Materials journal jointly with authors from the EMERALD consortium and from outside the EMERALD consortium (Serbian authors) – Q2 – ISI journal with IF 3.4

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Disseminating plan /conceived for the EMERALD project

Results of the project

DISSEMINATION PLAN



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



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

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Disseminating plan /conceived for the EMERALD project

Results of the project

The Eurasia Proceedings of
Science, Technology,
Engineering & Mathematics

EPSTEM

VOLUME 18 ICBASET CONFERENCE
ISSN: 2602-3199
ISBN: 978-605-73797-9-5

ISRES
Establishing

The Eurasia Proceedings of Science, Technology,
Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 2022
Volume 18, Pages 55-63

ICBASET 2022: International Conference on Basic Sciences, Engineering and Technology

Moisture Absorption Behavior of CP5 Composite
Materials Used in Industry

BIBA DIANA-IRINEL
University Politehnica of Bucharest

PĂCĂRĂR RĂZVAN
Technical University of Cluj-Napoca

PĂCĂRĂR ANCUȚA
Technical University of Cluj-Napoca

Abstract: In engineering practice, perhaps the most interesting aspect of woodworking deals with the relationship between wood and moisture. The plywood composite presents hygroscopicity characteristic, as the wood and reaction almost like a sponge, will gain or lose moisture from the air based upon the conditions of the surrounding environment. When the tree is in the green state, as first felled, it contains a very large amount of moisture existing in two different forms: as free water that is contained as liquid in the pores or vessels of the wood itself and as bound water, trapped within the cell walls. After that the wood is exposed to the air and immediately loose free water and the wood does not contract or otherwise change in dimension, it is in the state of drying and it is called the fiber saturation point. The moisture content in each piece of CP5 composite material is expressed as a percentage of the weight of the water and oven-dry weight of CP5 composite material. The moisture absorption depends on the wood type, density of wood and it is influenced by the environmental temperature, this is an aspect very important in the furniture industry. The moisture absorption test is generally used for quality control purposes and to measure the degradation of the quality for the wood and composite materials.

DISSEMINATION PLAN



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

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Main actions of the EMERALD project

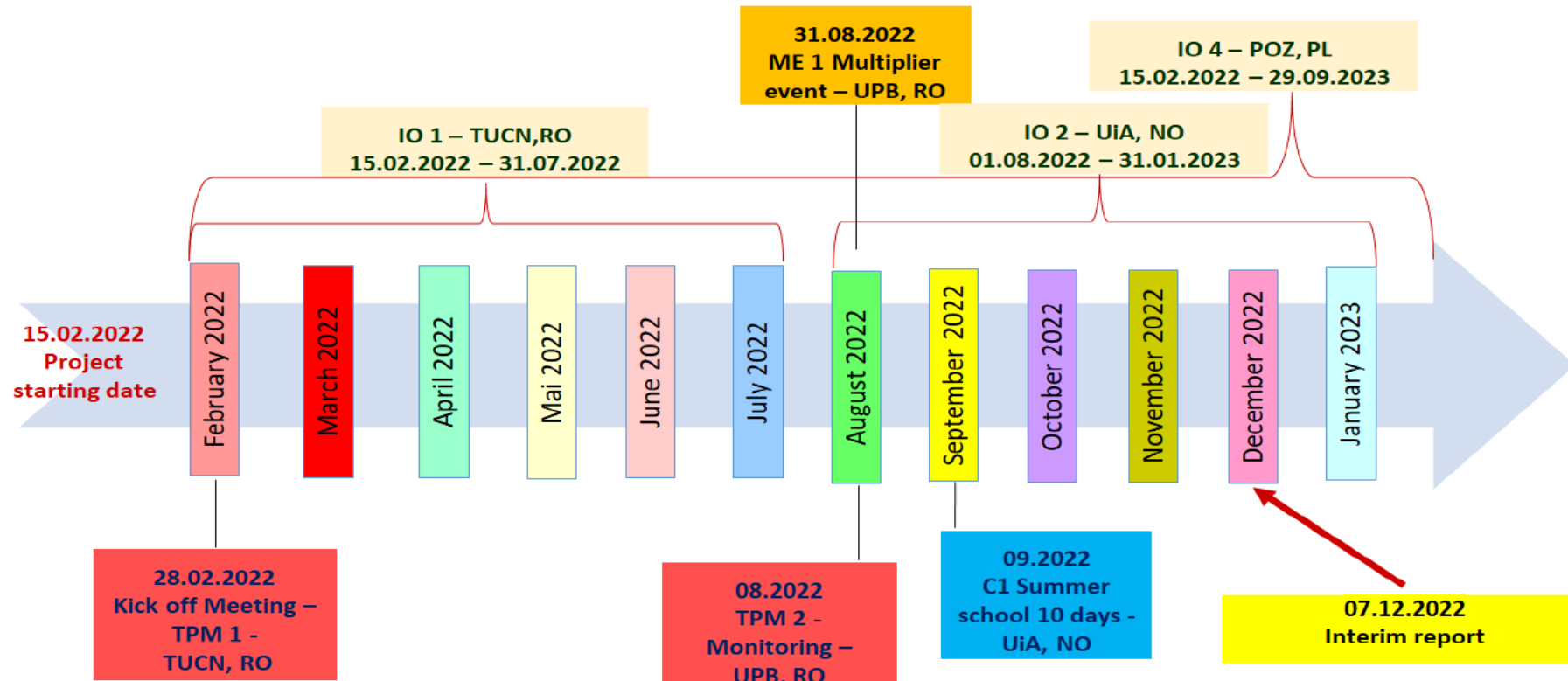
EMERALD - Calendar of the project / deadlines / milestones

TPM	Transnational project meetings
ME	Multiplier Events
C	Intensive Programmes for higher education / Short-term joint staff training events

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

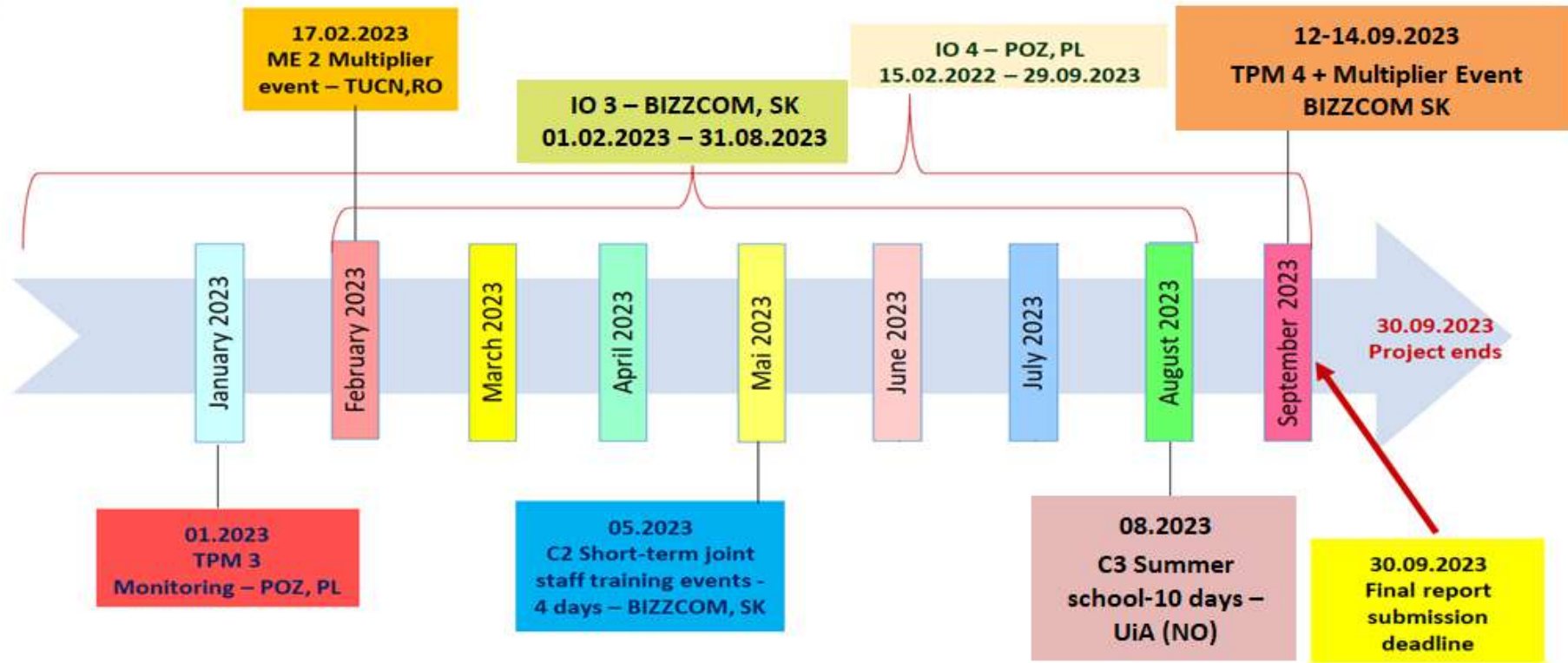
EMERALD - Calendar of the project / milestones – plan - February 2022 – January 2023



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

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

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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



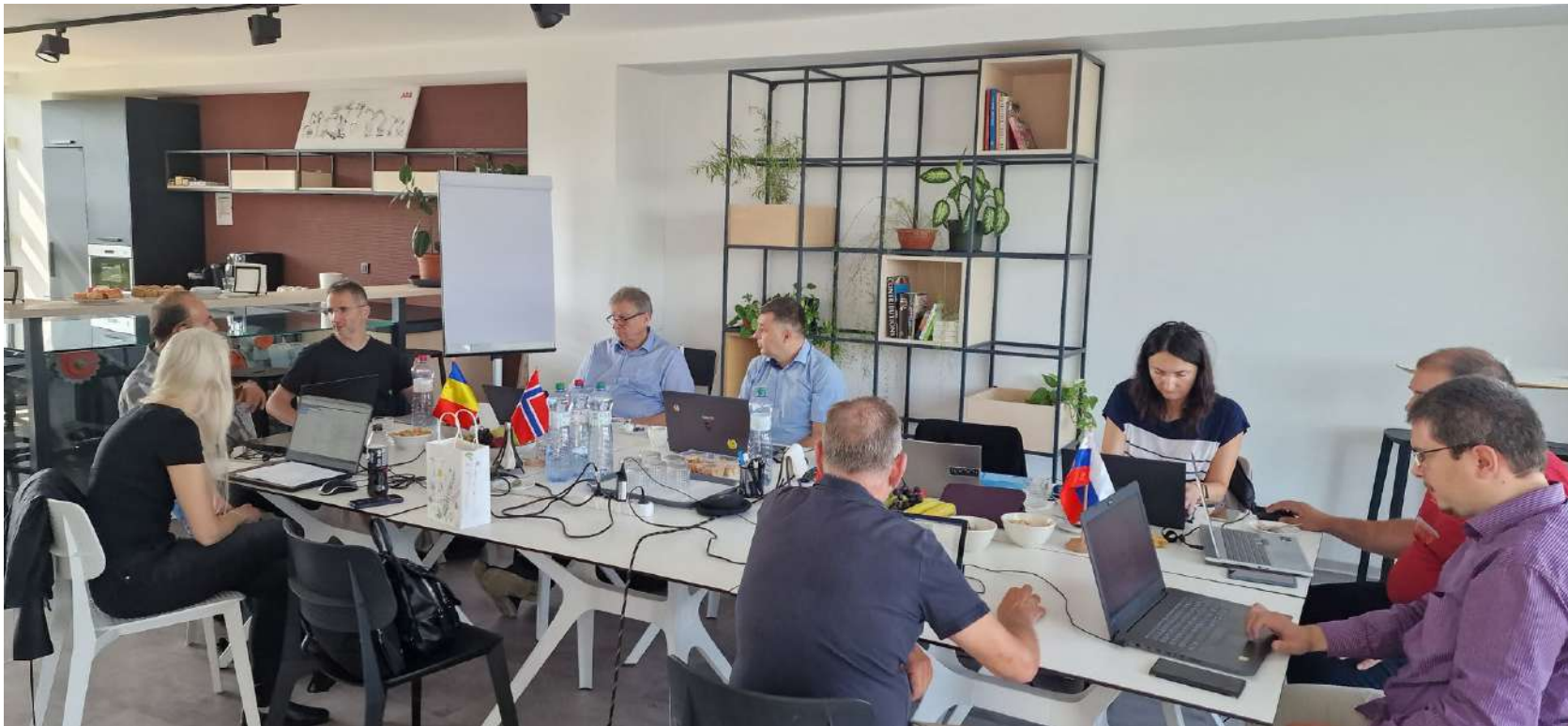
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EMERALD – Transnational Project Meeting – 30-31.01.2023 – Poznan University of Technology, Poland



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



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



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Main actions of the EMERALD project

EMERALD - Calendar of the project / deadlines / milestones

EMERALD - Calendar of the project / deadlines / milestones	
TPM	Transnational project meetings
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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	-

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EMERALD project - European Network for 3D printing of Biomimetic Mechatronic Systems

EMERALD Multiplier Event on:

Research base learning method for teaching in bio-mechatronics

2 SEPTEMBER 2022

WHO can apply
Students (BSc / MSc / PhD) / Professors / Researchers / Companies / R&D Institutes

SPECIALIZATIONS:
Manufacturing Engineering
Bio-Mechatronics & Robotics
Mechanical & Bio-Mechanical Engineering
Computer Science & Automation
Science of Materials

More details
www.project-emerald.eu
Registration until 30th of August 2022

Organized by the Politehnica University of Bucharest, Romania in cooperation with the EMERALD project consortium partners



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)

Multiplier event – UPB – 02 September 2022

11:00	Coffee Break
11:15	Intelligent (Smart) Materials Prof. Zaharia Cătălin (Politehnica University of Bucharest)
11:45	ADMASY'S 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

EMERALD project consortium partners:



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Multiplier event – University Politehnica Bucharest – 02 September 2022



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



EMERALD Multiplier Event – UPB – plenary presentations

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Multiplier event – University Politehnica Bucharest – 02 September 2022



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

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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

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

EMERALD project - European Network for 3D printing of Biomimetic Mechatronic Systems

EMERALD Multiplier Event on:
Applied Research Teaching Methods for 3D printing in bio-mechatronics

17 February 2023

WHO can apply
Students (BSc / MSc / PhD)
Professors / Researchers
Companies / R&D Institutes

SPECIALIZATIONS:
Manufacturing Engineering
Bio-Mechatronics & Robotics
Mechatronics & Bio-Mechanical Engineering
Computer Science & Automatics
Science of Materials

More details
www.project-emerald.eu

Organized by the Technical University of Cluj-Napoca, Romania in cooperation with the EMERALD project consortium partners

Iceland Liechtenstein Norway grants
anpcdefp
TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

EMERALD: European network for 3D printing of biomimetic mechatronic systems
EEA & Norway Grant - Contract No. 21-COP-4019

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 Măndru (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 Bălc 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 -4-tookits for supporting people with amputated arms (Prof. Filippo Santilippo - University of Agder (Norway) - recorded presentation)
9:45	EMERALD- Applied Research Teaching Methods for 3D printing in Bio-Mechatronics -4-tookits 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-tookits 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-tookits for supporting people with amputated arms (Branislav Rabara - BIZZCOM Slovakia)
10:20	Eu+ and ERASMUS institutional projects - Ludmila Letenscu (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 Joaquín - Academic Coordinator of the Biomedical Engineering Program at ETSII - Ojales González Deleros - LIDITER technical coordinator - Ibarra Berrocal Iaidro - Senior Administrative Officer (Head of Administration)

Iceland Liechtenstein Norway grants
anpcdefp
TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

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 D4H4Society
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 Pătraș - Head of Doctoral School (TUCN, Romania)
12:00	Coffee break
Session 2 - companies session - from evolution to revolution	
12:15	Vice rector Popescu Daniela - TUCN - opening the sessions organized with the companies
12:25	Admsys - (Markforged, Ultimaker, Formlabs, Minifactory, Evo-Tech, Artec, Shining - representatives in Romania) - company presentation
12:35	Nu Technologies (Stratsys / Materialise / Slama - representatives in Romania) - company presentation
12:45	CAD Works (3D systems / HP / Markforged - representatives in Romania) - company presentation
12:55	Laykon (DWS Systems / Masevit / INTR / BCN3D / Ultimaker) - representatives in Romania - company presentation
13:05	syntra 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 events / 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 Chis, INNO Platform Department & Cristian Ogoan (Intelligent specialization Department)
16:10	Bianca Muntean - Transylvania IT Cluster - opportunities related to "Health" domain - new project calls
16:30	Oana Burzoi + Mirola Botezoi + Răzvan Cherecheș - 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

UNIVERSITATEA
TEHNICĂ
DIN CLUJ-NAPOCA

MEMBRĂ A
EUT+
EUROPEAN UNIVERSITY
OF TECHNOLOGY

**Multiplier event –
TUCN – 17th of
February 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)



Multiplier event – TUCN – 17 February 2022



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



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

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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

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



POZNAŃ UNIVERSITY OF TECHNOLOGY

AUTOMATED DESIGN AND 3D PRINTING
OF PERSONALIZED LIMB PROSTHETICS
FILIP GÓRSKI, PH.D., D.SC, B.ENG, ASSOC. PROF.



WYDZIAŁ
INŻYNIERII
MECHANICZNEJ



- biologically disabled people constitute over 10% of the population (e.g. in Poland)
- the total number of disabled people is decreasing (2002 vs. 2011) BUT the number of biologically disabled people is increasing!
- causes: aging society, civilization diseases, accidents

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

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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

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



AI in Inventive Engineering
AI IN CREATIVE ENGINEERING AND ROBOTICS

- **AI in Generative Design:** This involves using algorithms to automatically generate design alternatives for complex engineering systems, based on a set of constraints and design goals. An example of AI for generative design in robotics is the use of optimization algorithms to create optimal structures for robot components such as frames and joints, which can improve their strength, durability, and weight.
- **AI in Design Optimization:** The use of machine learning to optimize engineering systems. Machine learning can also be used to predict the behavior of complex systems under different operating conditions, which can help engineers to optimize their designs. For example, researchers have used machine learning algorithms to optimize the design of aircraft wings, turbines, and other complex systems.
- **AI for Multi-Objective Optimization:** This involves optimizing engineering systems with respect to multiple conflicting objectives, such as cost, performance, and sustainability. Multi-objective optimization is a challenging problem, but recent advances in AI and optimization techniques have shown promise in this area. Technical University of Denmark used AI and optimization techniques to develop a new approach to wind turbine design. They created a machine learning model that could predict the performance of different wind turbine designs based on a range of input parameters. They then used multi-objective optimization algorithms to search for the optimal design that achieved the best balance between energy output, cost, and environmental impact.



Brain care helps in controlling gait, causing a stroke
Blood clot breaks off and travels
Excessive artery
Normal carotid artery

Kinematic scheme and CAD simulations
(results published in Sustainability)

Final design

Experimental model

Clinical trials

(published patent OSIM 132233/14.06.2017)

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

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



Soft, rigid, colored, transparent and biocompatible

Basic	Rigid
<ul style="list-style-type: none"> DraftGrey™ <p>Low cost material for fast iterations</p>	<ul style="list-style-type: none"> VeroUltraClear™ VeroPureWhite™ VeroVivid Colors Cyan/Yellow/Magenta <p>Rigid transparent and colored materials for improved contrast</p>

Nutechnologies

A wide portfolio of materials

Soft	Biocompatible
<ul style="list-style-type: none"> Agilus30™ Clear Agilus30™ Black/White Agilus30™ Colors Cyan/Yellow/Magenta <p>Soft transparent and colored materials for improved realism</p>	<ul style="list-style-type: none"> MED610™ MED61SRGD™ MED Digital ABS™ <p>Up-to 24hours biocompatible material Skin/Mucosal Membrane/Tissue</p>

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

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



#1. Case study

PROSTHESIS COVER



#2. Case study

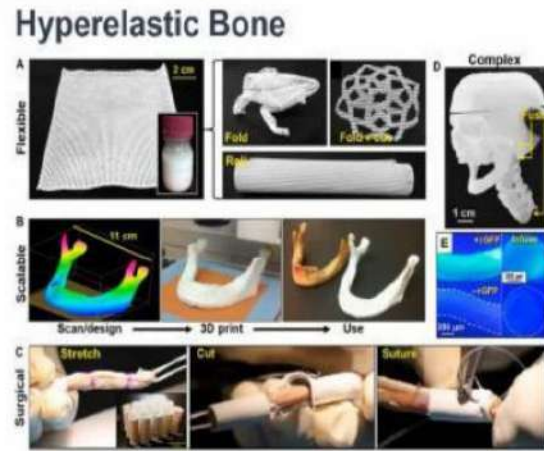
prosthetic limbs
with Ultimaker S5 3D printer



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

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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

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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

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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

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



GENERAL PRESENTATION

- 1 TRANSILVANIA IT CLUSTER
- 2 TRANSILVANIA DIGITAL INNOVATION HUB



Vision
For the Romanian Northwest Region to become the most innovative, entrepreneurial and attractive region in Eastern Europe

Mission
Support the continuous economical and social development of our region through business support services, tools and financial instruments

Obiectives

- Reducing disparities between localities and micro-regions
- Sustain social and economic development
- Support regional and international cooperation
- Attract foreign investments in the region
- Increasing the number of innovative start-ups
- Accelerating the exploitation of intellectual property

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

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



Horizon Europe – Cluster 1 ,Health'

Strategic Plan 2021-24 → 6 Expected Impacts

= 6 "Destinations" of :

Work Programme 2023-24

1. Staying healthy in a rapidly changing society
2. Living and working in a health-promoting environment
3. Tackling diseases & reducing disease burden
4. Ensuring access to innovative, sustainable & high-quality healthcare
5. Unlocking the full potential of new tools, technologies and digital solutions for a healthy society
6. Maintaining an innovative, sustainable & globally competitive health industry

→ Topics (Calls)

Focus on outcomes contributing to the impacts specified per Destination

Project proposals should
 ➤ make a **clear case** (*value proposition*)
 ➤ supported by a **convincing trajectory** (*pathway to impact*) for the project proposal to deliver the **output**, promote the **outcome** described in the topic, and contribute to the **impact** expected under that destination.



Strategic Plan: 2021-2024 – [link](#)

Work Programme 2023 – 2024 - [link](#)



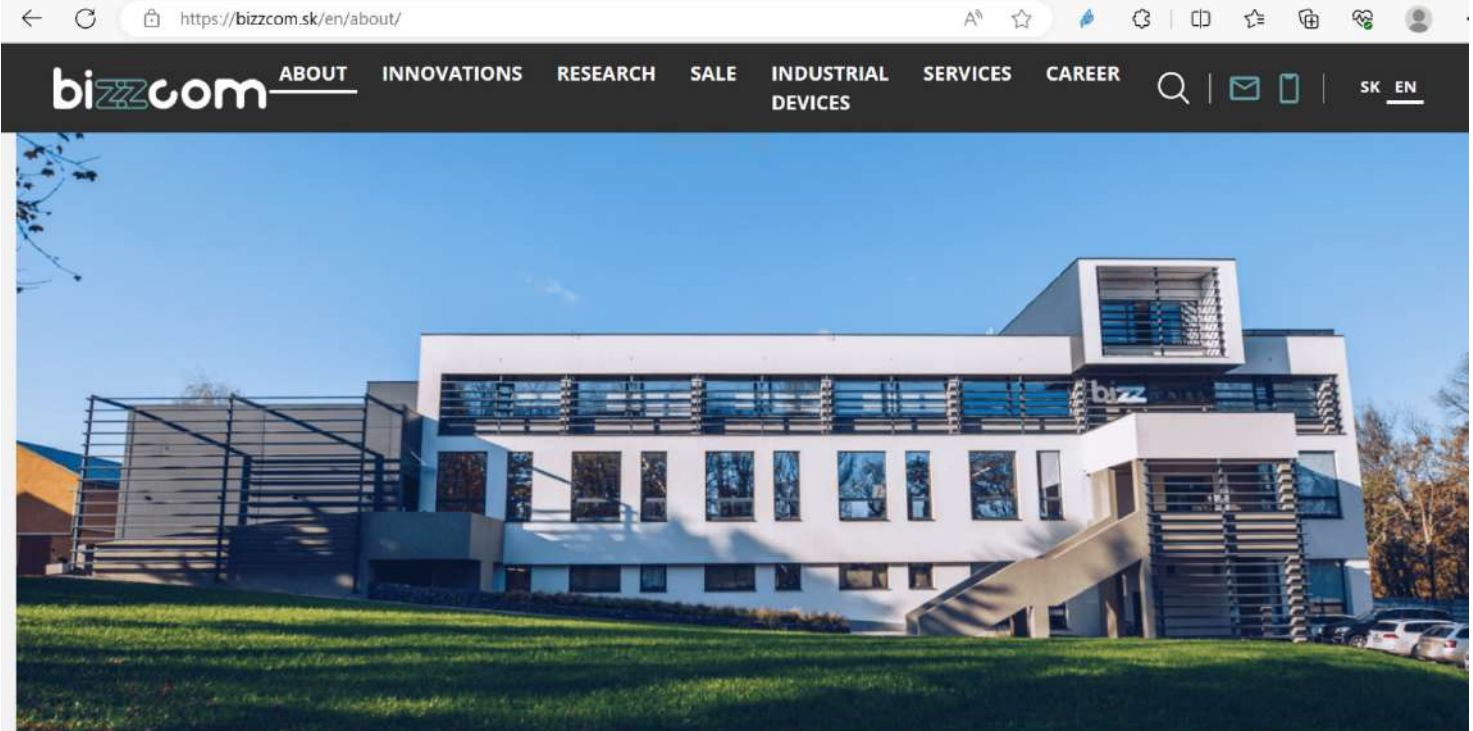
EMERALD Multiplier Event – presentation made by Research Department of Technical University of Cluj-Napoca about possibilities of being involved and get financing for new collaborations and projects (Horizon Europe in particular)

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



Multiplier event – BIZZCOM – Bucany, Slovakia – 13th of 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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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

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	-	

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

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 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: 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-book) 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 O2, 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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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



Organized at the University of Agder, Norway by the EMERALD project consortium partners



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 fjords / 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		Feedback on behalf of the EMERALD experts and guidelines for W2	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		Lunch & free time	Lunch & free time	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

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



Case 1: bicycle prosthesis



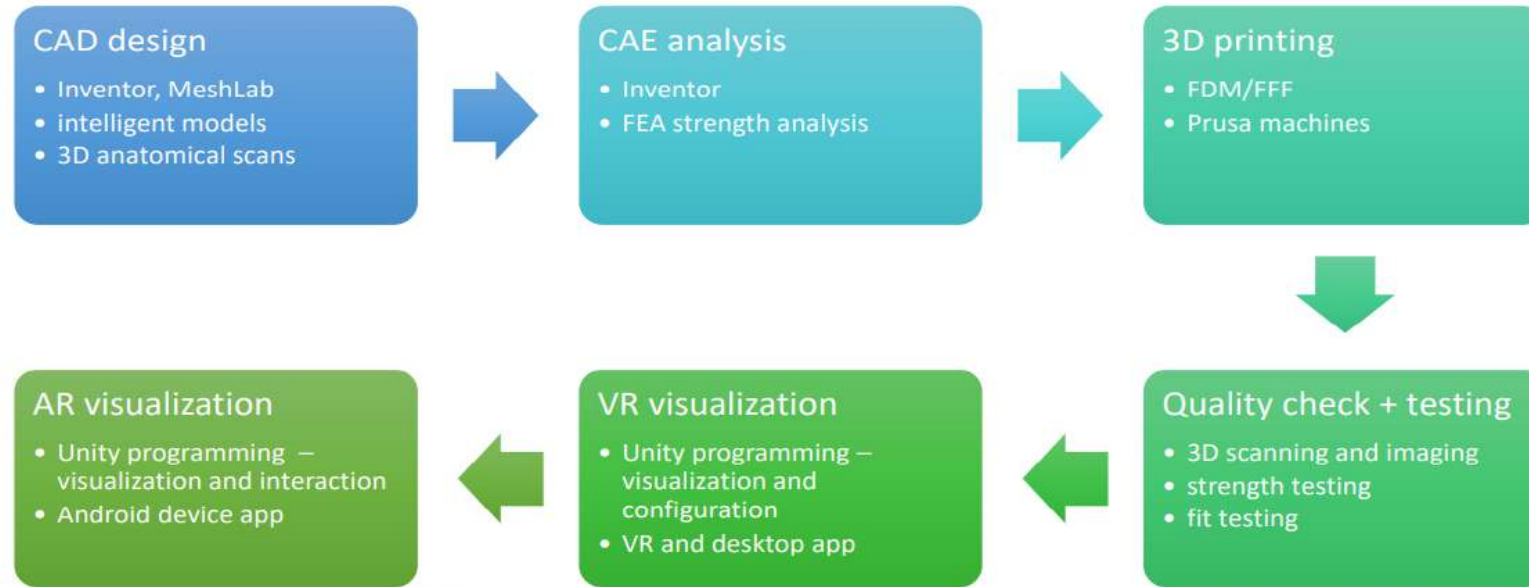
Case 2: hand orthosis

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

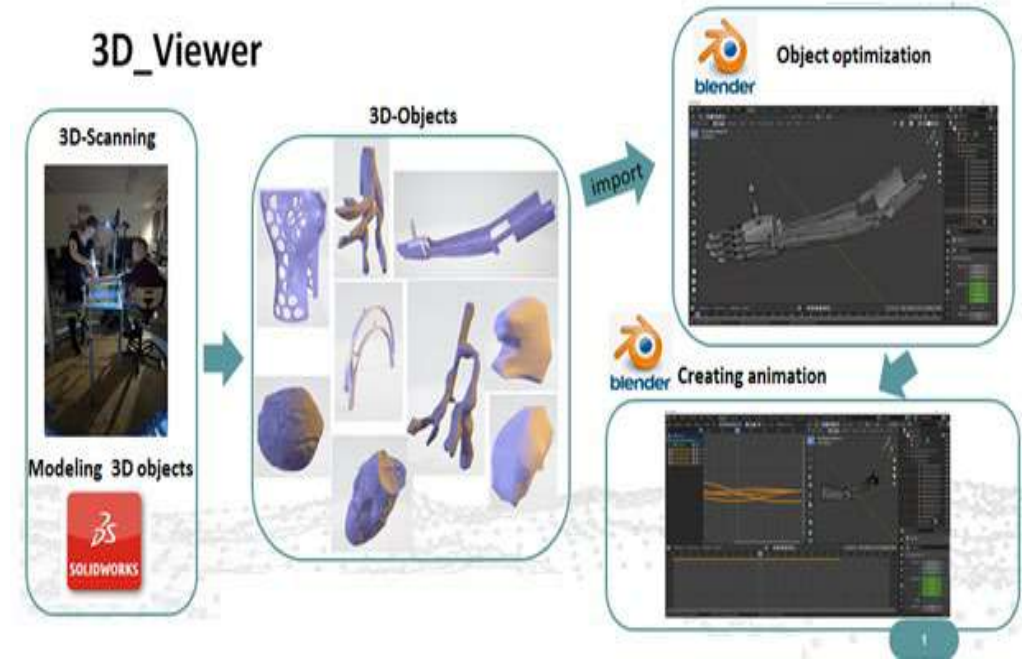
COURSE OF WORK WITH THE CASES



Launching of case studies and requirements

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



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

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



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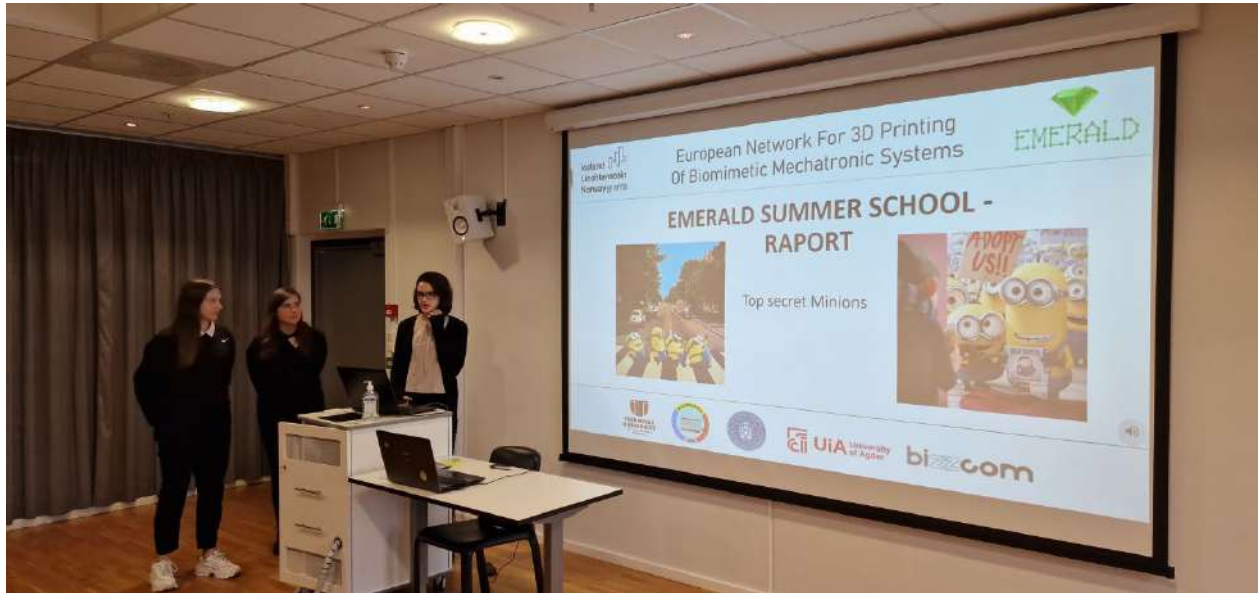
1st edition - EMERALD International Summer School - UiA (Norway)– 12-23 September 2022



Final test defended by the EMERALD students

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



Final presentations realized by the EMERALD students

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

Feedback form for the intensive programme for higher education learners

Logos: TECHNICAL UNIVERSITY OF CLUJ-NAPOCA, UCLM, UTA, UiA University of Agder, bizzcom

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.					

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 Aedre, Norway by the EMERALD Project consortium partners

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

In cooperation with

Logos: TECHNICAL UNIVERSITY OF CLUJ-NAPOCA, UCLM, UTA, bizzcom

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

F-SEE-113/12.2018

The Education, Scholarships, Apprenticeships and Youth Entrepreneurship Programme – EEA Grants 2014-2021
Project No: 21-4304-00019
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: Postboks 422 , 4604 Kristiansand, Norway
city: Kristiansand, country Norway

certify that the following persons:

	staff	student
Mr. Michal Gallia	X	<input type="checkbox"/>
Mr. Martin Zelenay	X	<input type="checkbox"/>

representing the sending organisation:

complete name: Bizzcom s.r.o.
address: Šľachitelská 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
 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

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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

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

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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

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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)

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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 - EMERALD

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

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

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

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

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?

Report?

Certificates ?

Bucany,
Slovakia

Staff for
training
event

1-6 May 2023

VR EMERALD
platform

AR applications

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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

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LTT activities

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



Order Article Reprints ⚙️

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

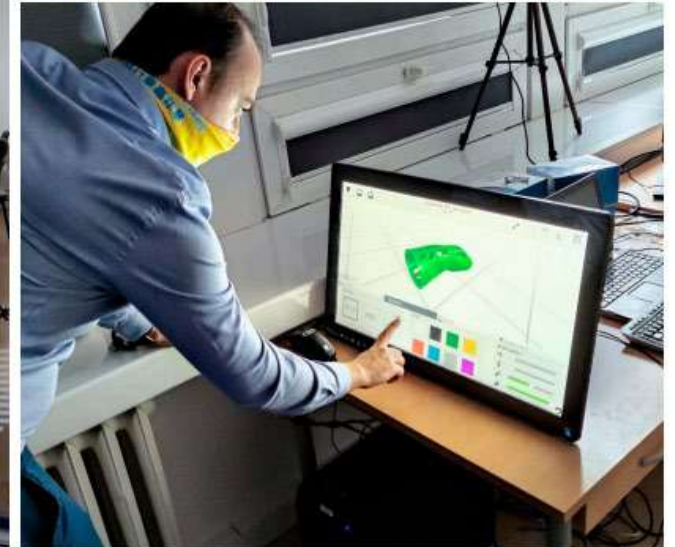
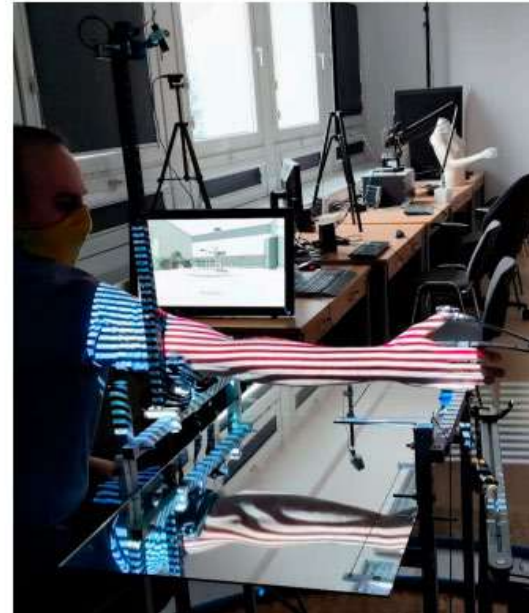
by Filip Górski^{1,*}, Remigiusz Łabudzki¹, Magdalena Żukowska¹,
Filippo Sanfilippo², Morten Ottestad², Martin Zelenay³,
Diana-Irinel Băilă⁴ and Razvan Pacurar⁵

- 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 Bizzoom s.r.o., Štachtiteľská 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.

Appl. Sci. 2023, 13(14), 8035; <https://doi.org/10.3390/app13148035>

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

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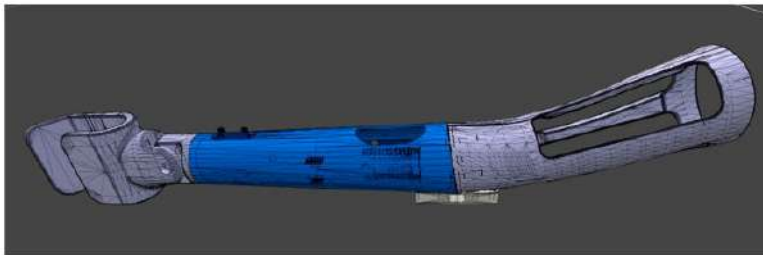
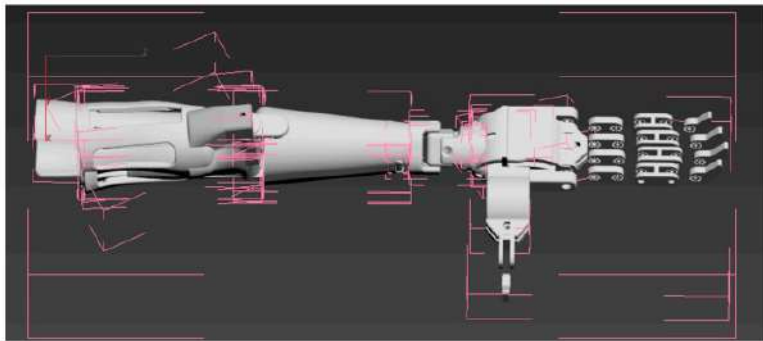


EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia

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LTT activities

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

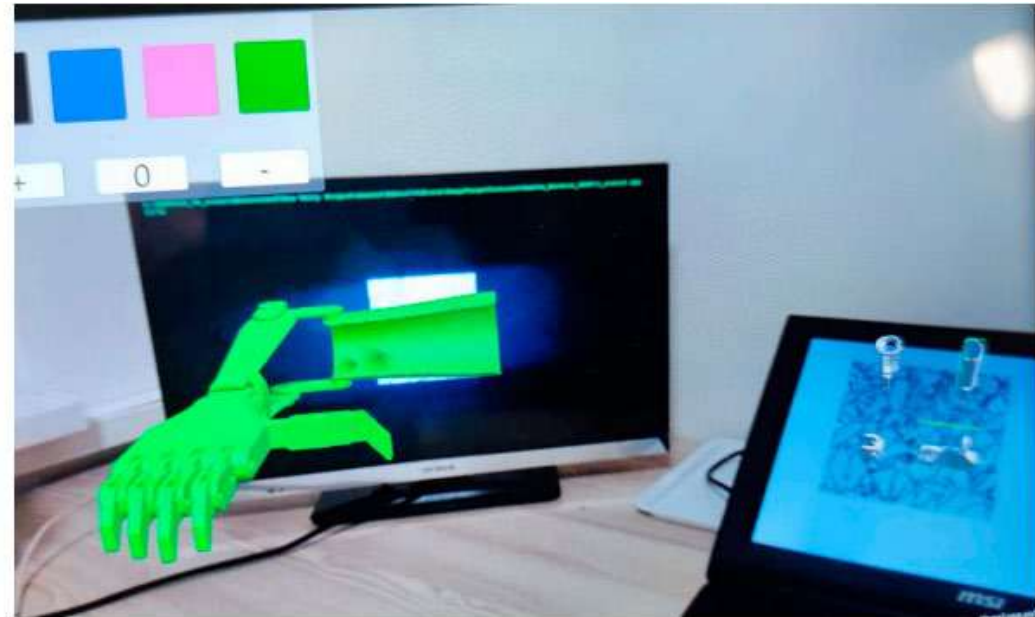
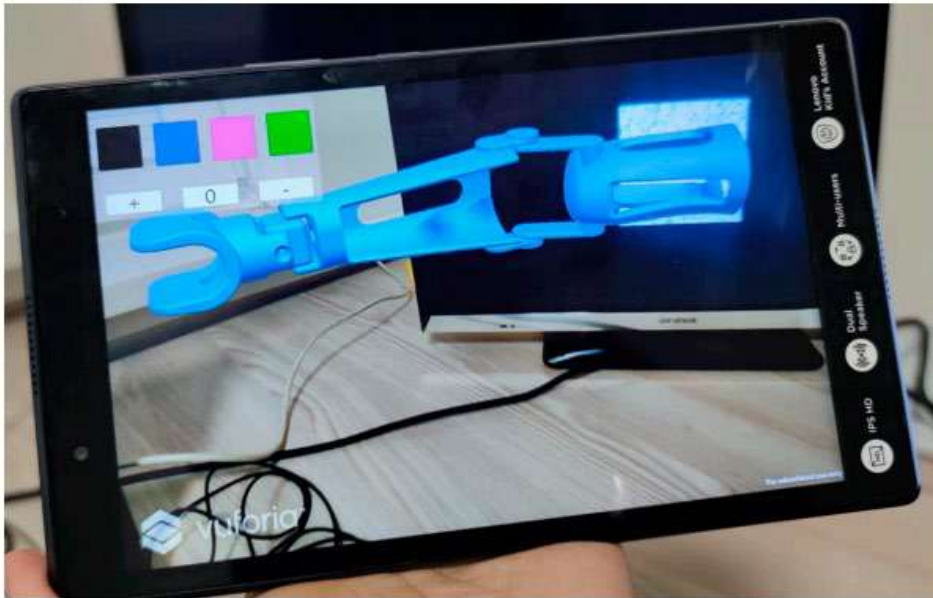


EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (VR)

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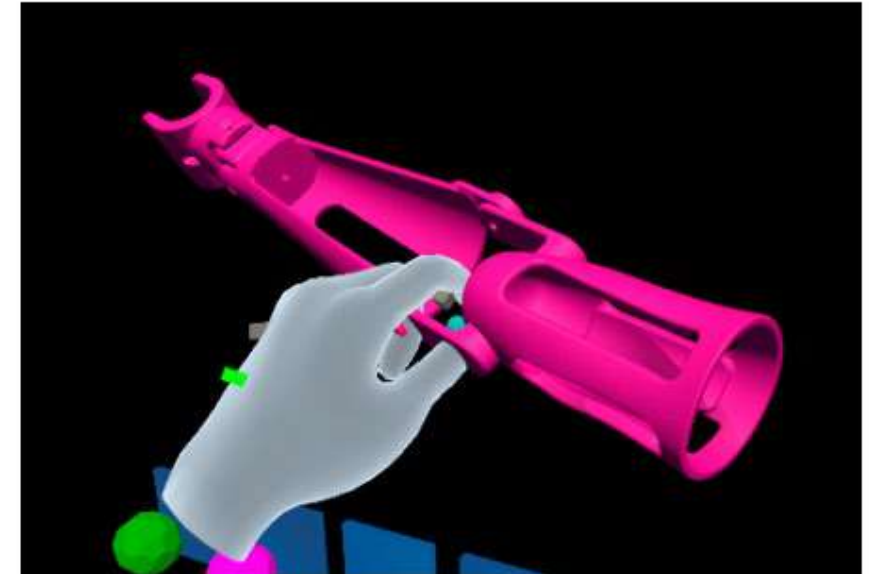


EMERALD Short-term joint staff training participants at BIZZCOM Company, Bucany, Slovakia (AR)

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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 (MR-mixed reality)

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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 (programming and testing the made applications during the realized training in VR, AR and MR)

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

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

EMERALD International Summer School on: **Virtual e-learning platform experience in bio-mechatronics**

Attendance Form

EMERALD International Summer School on: „*Virtual e-learning platform experience in Bio-Mechatronics*” is organized at the University of Agder (Norway) in the frame of *EMERALD 21-COP-0019* project by the experts of the EMERALD consortium.

razvip2015@gmail.com [Schimbă contul](#)

* Indică o întrebare obligatorie

Adresă de e-mail *

Adresa ta de e-mail

**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

Iceland Liechtenstein Norway grants EMERALD project - European Network for 3D printing of Biomimetic Mechatronic Systems Uia University of Agder

EMERALD International Summer School on:

**Virtual e-learning platform
experience in bio-mechatronics**



28 AUGUST - 4 SEPTEMBER 2023

WHO can apply
Bachelor students (BSc)
Master students (MSc)
PhD students

SPECIALIZATIONS:
Manufacturing Engineering
Bio-Mechatronics & Robotics
Mechanical & Bio-Mechanical Engineering
Computer Science & Automatics
Science of Materials

More details
www.project-emerald.eu
Registration until 18th of August 2023

Organized at the University of Agder, Norway
by the EMERALD project consortium partners



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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University of Agder (Grimstad, Norway) – 28 August - 4 September 2023



European Network For 3D Printing
Of Biomimetic Mechatronic Systems
Working together for a **green**, **competitive** and **inclusive** Europe

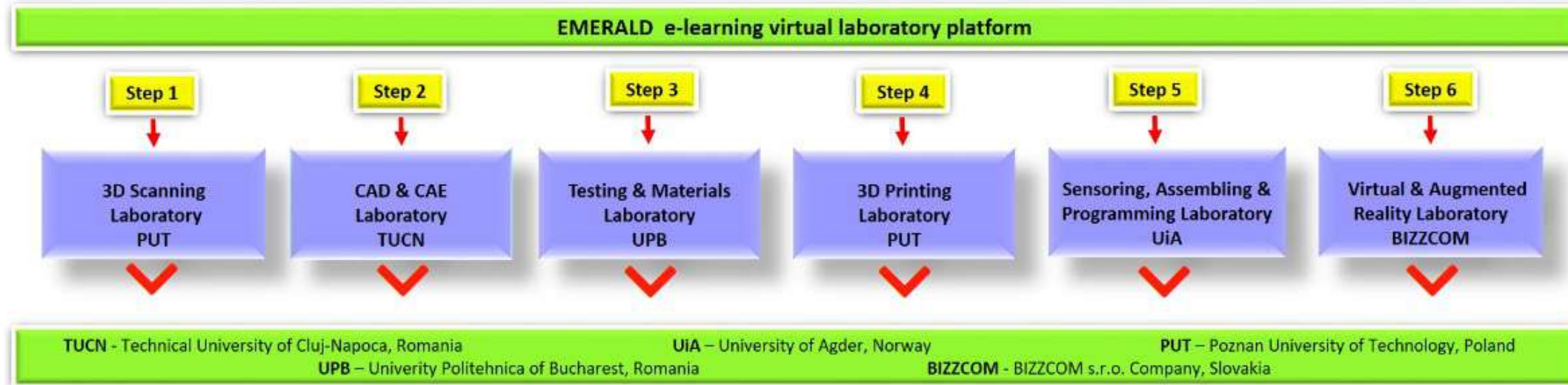
HOME PROJECT REPORTS DISSEMINATION INTELLECTUAL OUTPUTS EVENTS PARTNERS **VIRTUAL LABS** CONTACT 

EMERALD E-LEARNING VIRTUAL LABORATORY PLATFORM

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

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



Click to visit virtual
laboratory

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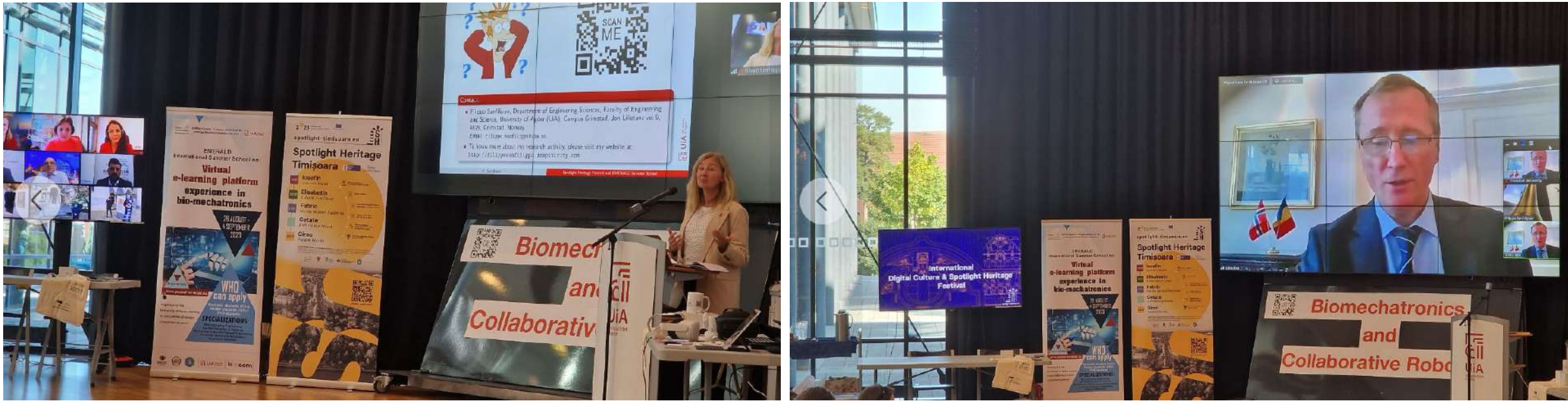
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University of Agder (Grimstad, Norway) – 28 August - 4 September 2023**



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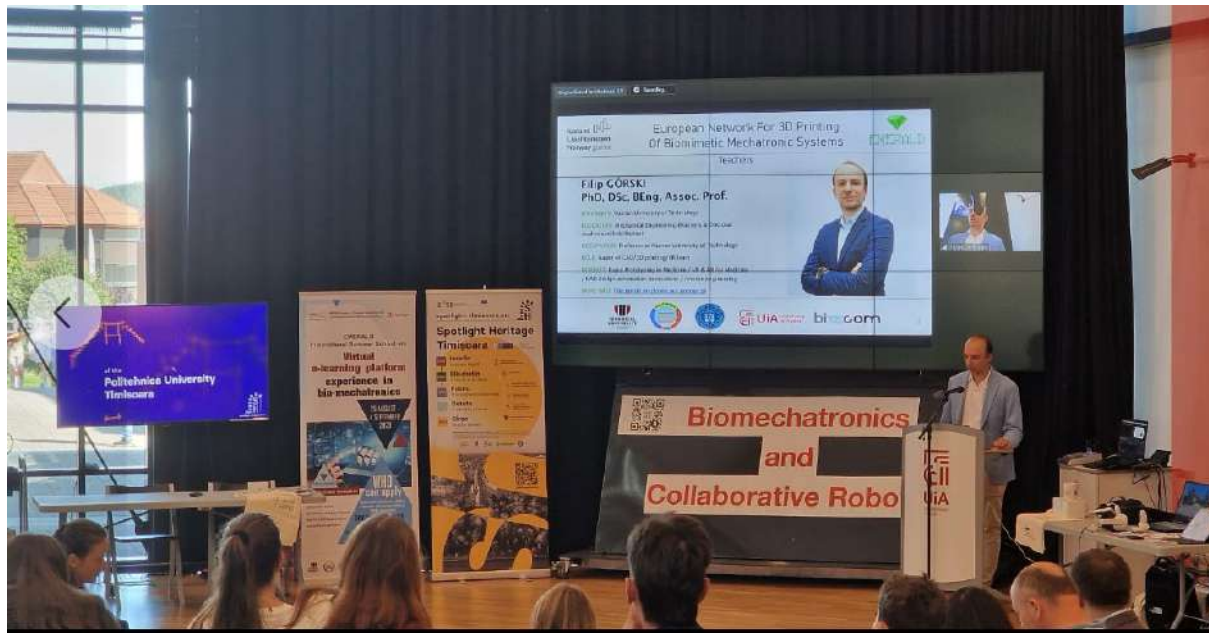
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University of Agder (Grimstad, Norway) – 28 August - 4 September 2023**



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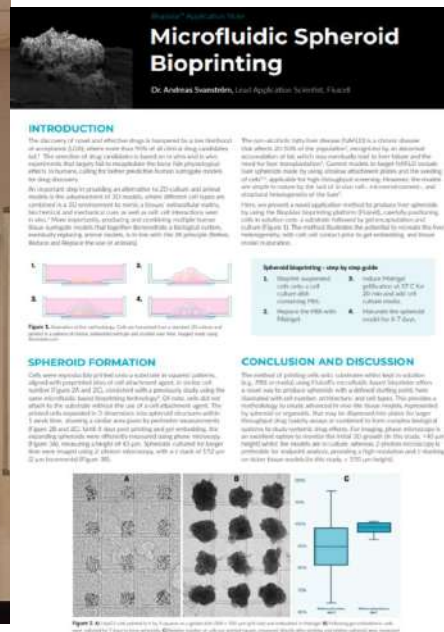
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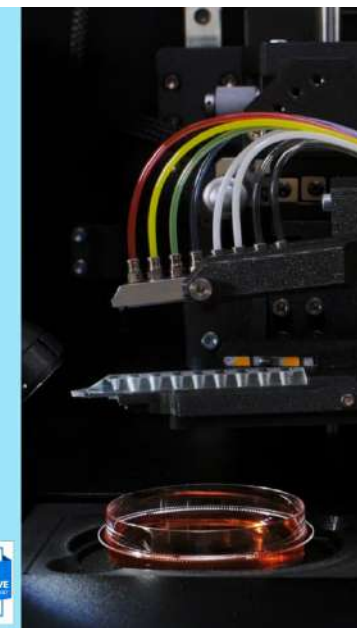


BIOPIXLAR & AER
BIOPRINTING PLATFORMS

Bench-top & bio safety cabinet sized bioprinting platforms.

Disposable microfluidic-based printheads.

Compound, material or cell printing using open-volume microfluidics "Liquid-in-liquid".



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



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?

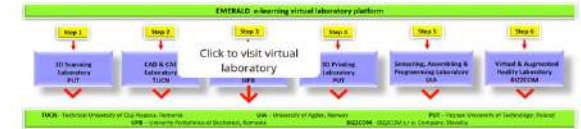
Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied
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3. Innovative Learning Methods:

- 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
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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
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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.

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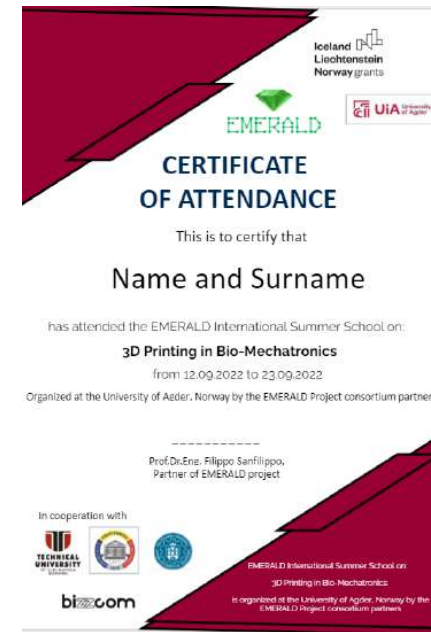
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2nd edition of the EMERALD International Summer School University of Agder (Grimstad, Norway) – 28 August - 4 September 2023

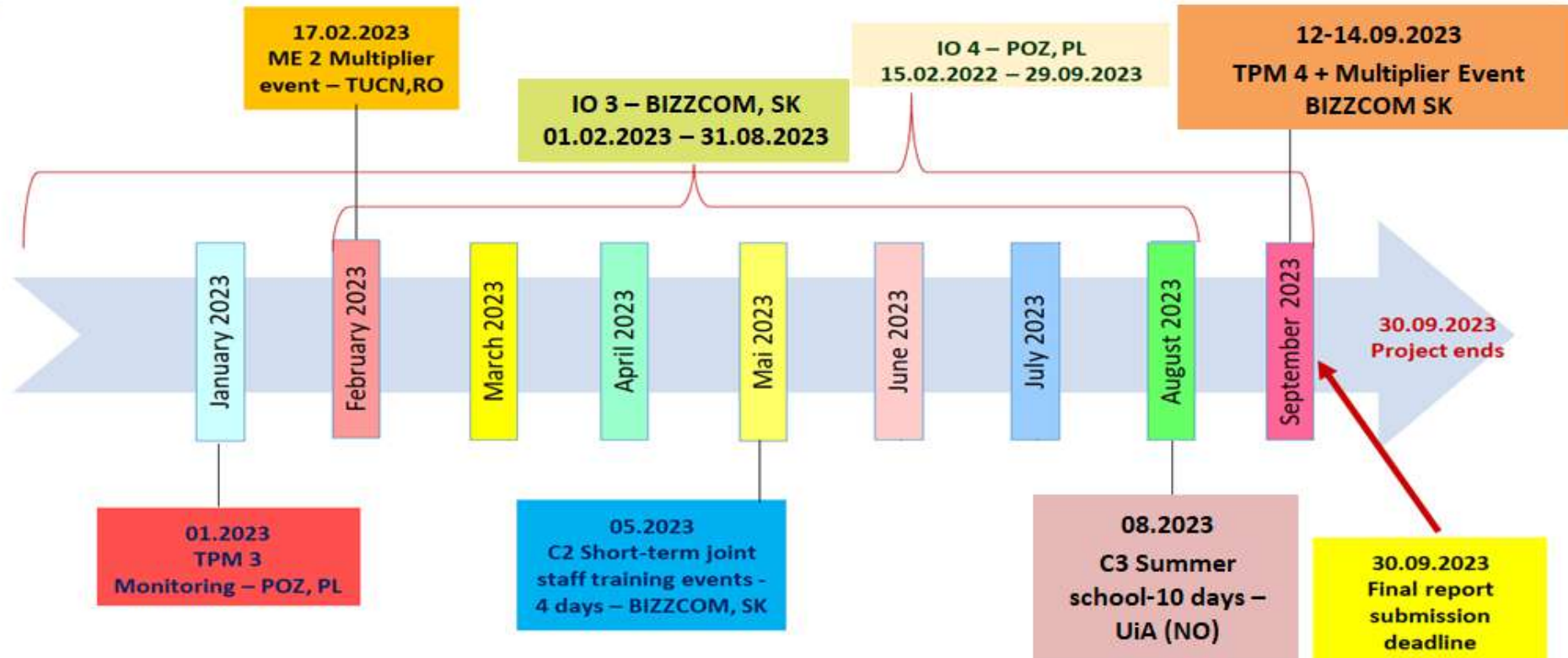


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EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC MECHATRONIC SYSTEMS - EMERALD

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



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EMERALD project



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EMERALD project - contact details



email addresses:

EMERALD project: emerald.project2022@gmail.com

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

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