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

Intellectual Output_O2: EMERALD e-toolkit manual for digital learning in producing biomimetic mechatronic systems Toolkit 3 3D Printing

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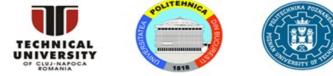
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MECHATRONIC SYSTEMS

E-toolkit – 3D Printing

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 manufacturing method
Module	3D Printing
Date of Delivery	January 2023
Authors	Diana BĂILĂ
Version	FINAL VARIANT, *24.01.2023*

		https://project-emerald.eu	
Pro	duct 1: Personalized Ort	hosis	
1.1	CAD Modeling		3.
1.2	STL file		5.
1.3	3D Printing software's		6.
Pro	duct 2: Robotic Arm		
2.1	CAD Modeling		16.
2.2	STL file		
2.3	3D Printing software's	5	19.
Pro	duct 3: 3D Fresh Printing	g of organ phantom for surgical applications	
3.1	CAD Modeling		27.
3.2	STL file		28.
3.3	3D Printing software's	5	29.
Con	clusions		38.
Ref	erences		39.









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1. 3D Printing toolkit for medical applications

Product 1: Personalized Orthosis – SLDPRT. file Poznan University of Technology Partner

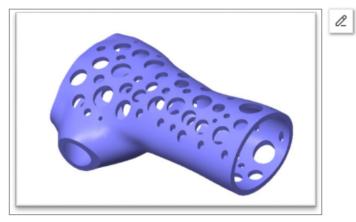


Fig.1. Personalised orthosis





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1.1. CAD Modeling

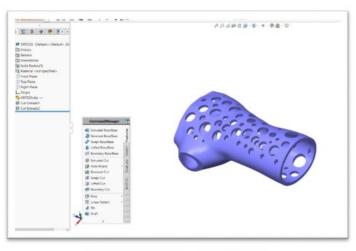


Fig.2. SolidWorks - SLDPRT. file

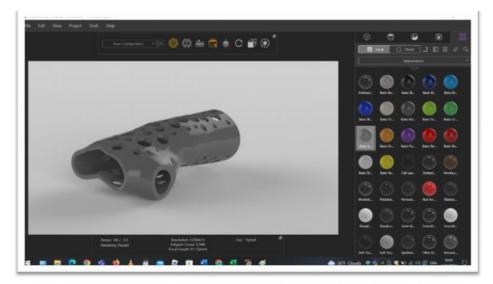


Fig.3. SolidWorks Visualize 2019 - orthosis with different texture mapping





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1.2. STL File

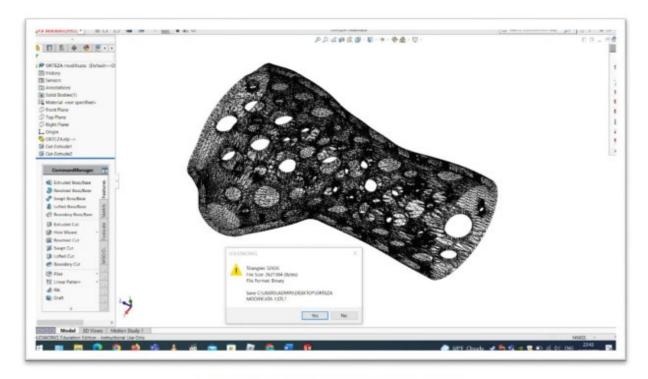


Fig.4.Orthosis meshing - STL. file





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1.3. 3D Printing software's

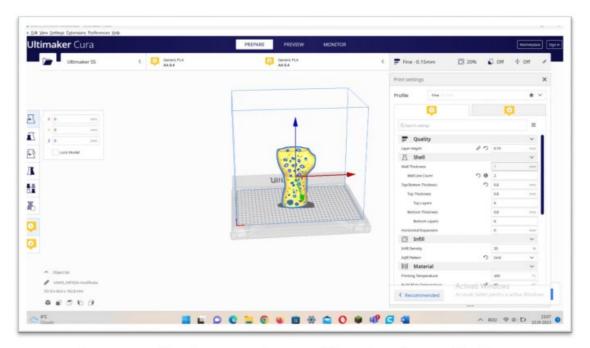


Fig.5. Open Ultimaker Cura software and introduce the STL. file of part

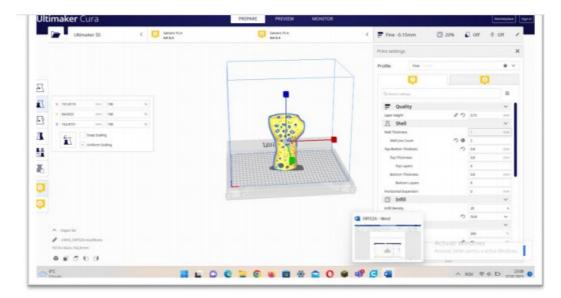


Fig.6. Change the part scale, after X, Y, Z axis





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Fig.7. Rotation of the part after X, Y, Z axis

Properties	Values	Units
Density	1.0-1.4	g/cm3
Poisson's Ratio	0.35	-
Shear Modulus G	1,03-1,07	GPa
Melting Temperature	200	°C
Glass transition temperature	105	°C
Thermal Conductivity	0,25	W/m-K
Extruded Temperature	200-230	°C
Heat Deflection Temperature, 1,81 MPa	81	°C
Young's modulus	1,79-3,2	GPa
Tensile Strength	29,8-43	MPa
Compressive Strength	76-78	MPa
Elongation at Break	10-50	%
Flexural modulus	2,1-7,6	GPa
Hardness Shore D	100	
Izod Impact Strength	58	kJ/m2
Yield Strength	28-120	MPa
Standard Tolerance	+/-0.05	mm
Biodegradable	-	-
Melt flow	12-23	g/10min
Rockwell Hardness	R102-R104	

Table 1. The mechanical properties of Acrylonitrile Butadiene Styrene (ABS)







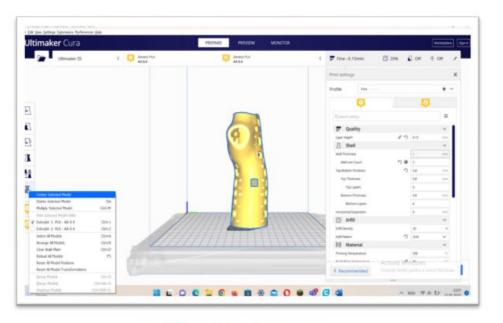


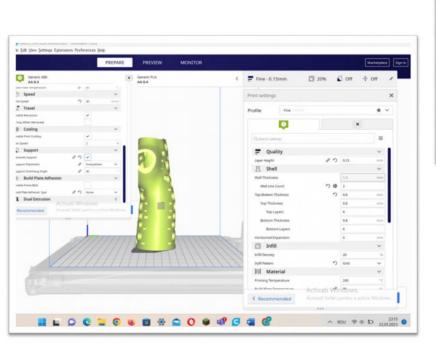
Fig 8. 3D Printing Extruder chosen

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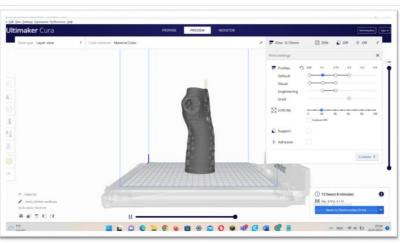
Fig.9. Choosing the ABS filament for 3D Printing













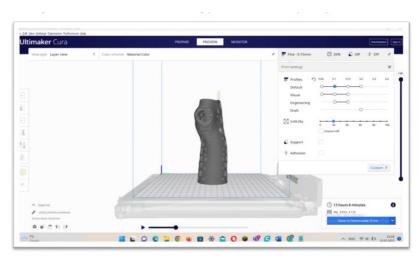


Fig.12. Preview the manufacturing 3D Printing process





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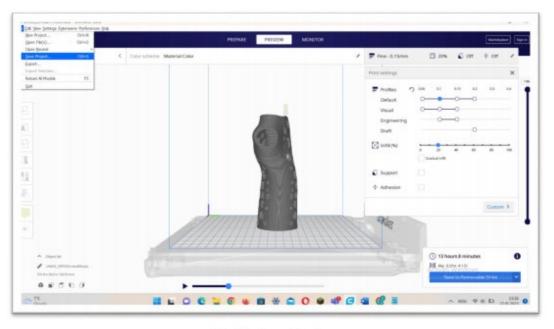


Fig.13. Save Project

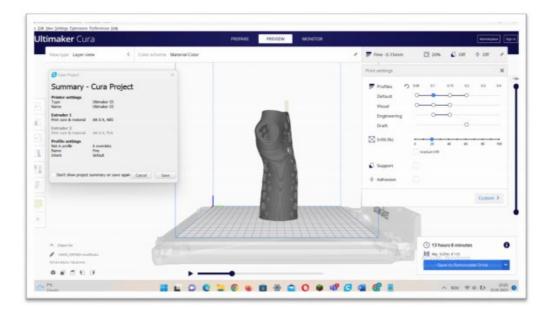
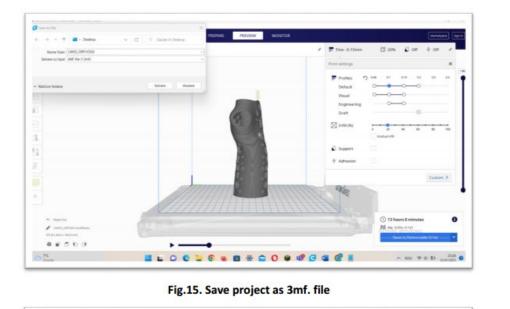


Fig.14. Summary- Cura Project





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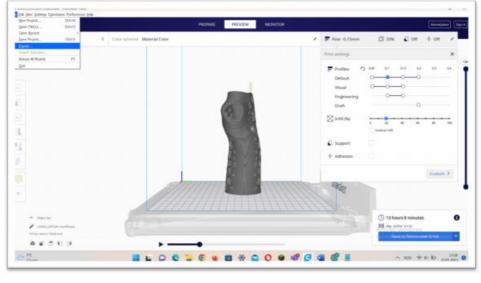


Fig.16. Export file





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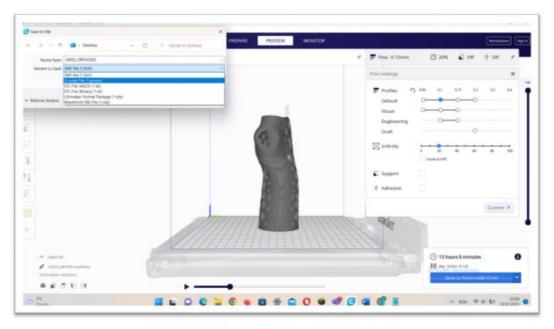


Fig.17. Different extension for file export



Fig.18. G-code file for personalized orthosis part





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Fig.19. Personalized Orthosis printed by FDM technology

Product 2: Robotic Arm – ASM, SLDASM. file Poznan University of Technology Partner





Iceland Liechtenstein

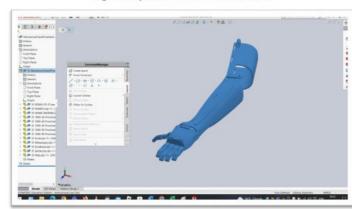
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2.1 CAD Modeling



Fig.20. Exploded View - Robotic Arm



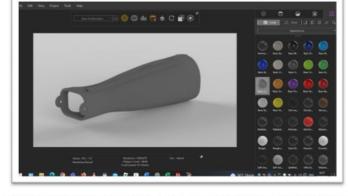
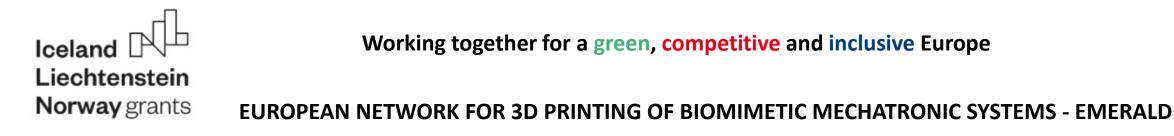


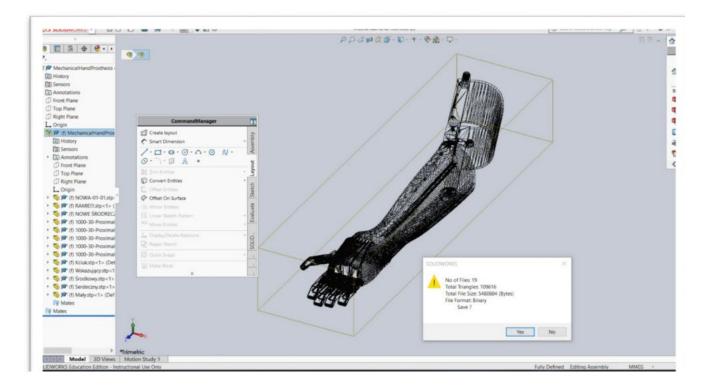
Fig.22. SolidWorks Visualize 2019 - robotic arm with different texture mapping

Fig.21. Robotic arm assembly – ASM, SLDASM. File





2.2. STL file







2.3. 3D Printing software's

Table 2. The mechanical p	properties of PLA	(Polylactic Acid)
---------------------------	-------------------	-------------------

Properties	Values	Units
Density	1.25	g/cm3
Poisson's Ratio	0.36	-
Shear Modulus G	2.4	GPa
Melting Temperature	173	°C
Glass transition temperature	60	°C
Thermal Conductivity	0.13	W/m-K
Extruded Temperature	160-220	°C
Heat Resistance	110	°C
Young's modulus	3.5	GPa
Tensile Strength	61.5	MPa
Compressive Strength	93.8	MPa
Elongation at Break	6	%
Flexural strength	88.8	MPa
Hardness Shore D	85	Α
Impact Strength	30.8	kJ/m2
Yield Strength	60	MPa
Standard Tolerance	+/-0.05	mm
Biodegradable	yes	-

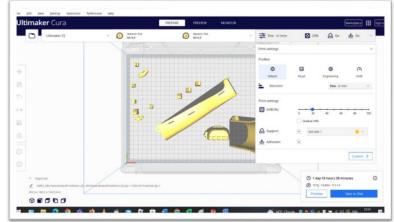


Fig.28. Recommended manufacturing parameters for the part by the software

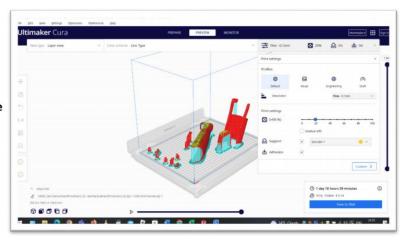


Fig.29. Preview the manufacturing 3D Printing process









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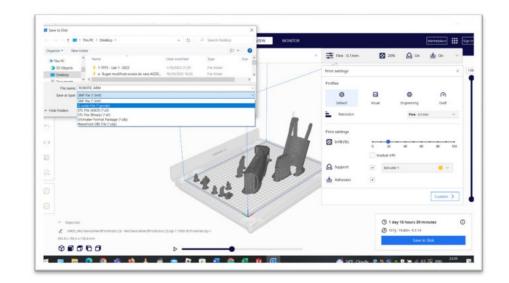


Fig.32. Different extensions for file export

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Fig.33. G-code file for Robotic Arm



Fig.34. Robotic Arm printed by FDM technology and assembled











Product 3: 3D Fresh Printing of organ phantom for surgical applications – site <u>https://www.embodi3d.com/</u>

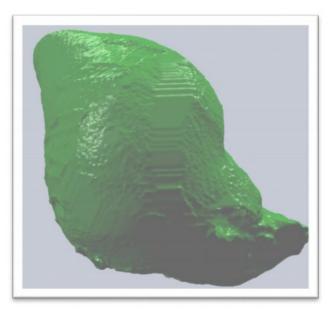
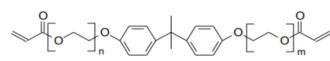


Fig.35. Liver model for printing





Table 3. The mechanical properties of Bisphenol A Ethoxylate Diacrylate





INTRODUCTION	SPECIFICATIONS ⁽³⁾
EBECRYL 150 is an ethoxylated bisphenol A diacrylate commonly used as reactive diluent in UV/EB cure applications. EBECRYL 150 can improve the cure response, hardness, and chemical resistance of UV/EB curable coatings and inks while maintaining good adhesion, and without imparting brittleness.	Acid value, mg KOH/g, max. Appearance Color, Gardner scale, max. Viscosity, 25°C, cP/mPa-s
PERFORMANCE HIGHLIGHTS	TYPICAL PHYSICAL PROPE
EBECRYL 150 is characterized by:	Density, g/ml at 25°C

- High reactivity Moderate viscosity
- High refractive index

UV/EB curable formulated products containing EBECRYL 150 are characterized

Bisphenol A Ethoxylate Diacrylate

- by:
- Hardness
- Chemical resistance Good adhesion
- Improved wetting

The actual properties of UV/EB cured products also depend on the selection of other formulation components such as oligomers, additives and photoinitiators.

VALUE
5
Clear liquid
2
1150-1650

PERTIES

Density, g/ml at 25°C	1.14
Flash point, Setaflash, *C	>100
Functionality, theoretical	2
Refractive index (np at 20°C)	1.5294
Vapor pressure, mm Hg at 20°C	<0.01

TYPICAL CURED PROPERTIES[©]

Tensile strength, psi (MPa)	6300 (43)
Elongation at break, %	9
Young's modulus, psi (MPa)	180000 (1241)
Glass transition temperature, °C ⁽³⁾	41



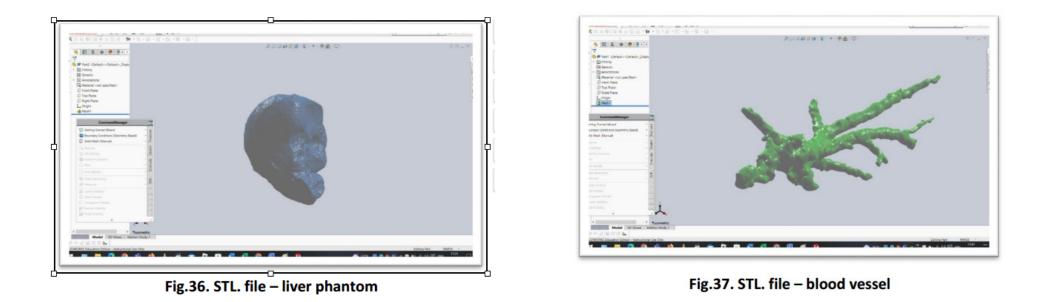






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3.1. CAD Modeling







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3.2. STL file

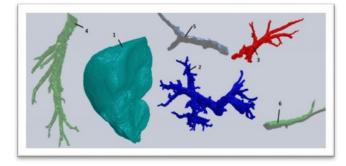


Fig.38. Exploded View – Liver phantom

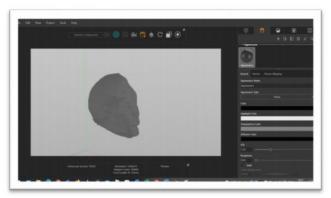


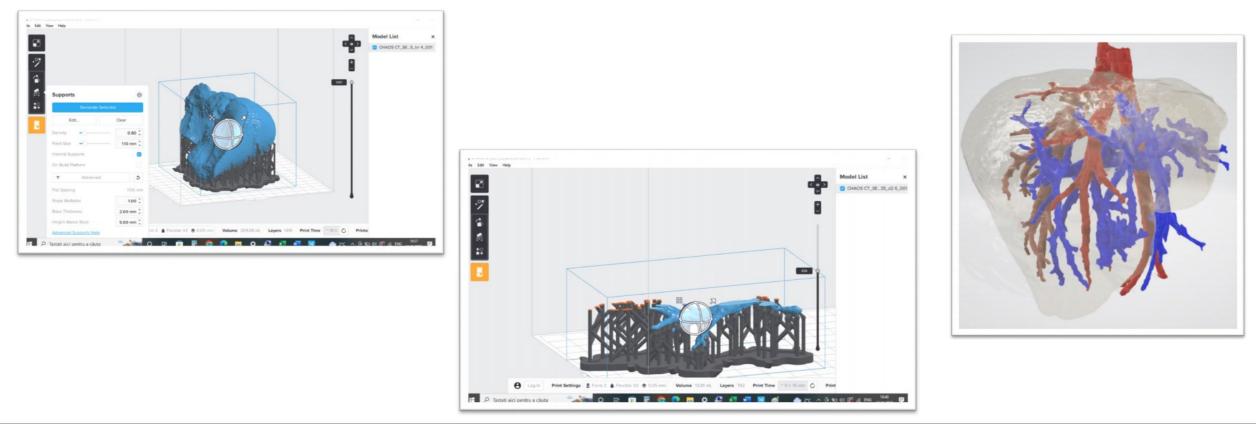
Fig.39. SolidWorks Visualize 2019 – Liver phantom with different texture mapping





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3.3. 3D Printing software's







4. Conclusions

In the future, further research on both multi-material and multi-colour prototypes could be performed, focusing on additive manufacturing technologies based on different silicones and plastic materials with different colours, necessary for different medical prothesis and devices.

The use of different silicones would be interesting in order to manufacture more complex phantoms, in which not only the desired organ is 3D printed, but also the surrounding anatomical structures. For example, the tumour or blood vessels by changing the component ratios.

The implications of the present research would be interesting for the manufacture of phantoms to be used in research and industry: medical imaging, preoperative surgical planning in hospitals, etc.







