D6.1 – Conference disseminating conceptual design of demonstrator

Document Author(s)	Angelos FILIPPATOS
Document Contributor(s)	Dionysios MARKATOS, Anastasios ZAVOS,

Abstract

Deliverable D6.1, titled *"Conference Disseminating Conceptual Design of Demonstrator"*, is part of WP6 of the Fun4Design project. We present two different demonstrators, with emphasis on the conceptual design in the automotive (A-Pillar frame) and aviation (aircraft sustainable design) sectors.

These works were presented at International Conference of Engineering Against Failure (ICEAF) VIII.

This deliverable provides a brief introduction to the conference papers and includes the presentation slides.

Keywords: Conceptual design, Demonstrator, A-Pillar, Aircrafts, Conference papers

Information Table

Project Number	015672
Principal Investigator	ΦΙΛΙΠΠΑΤΟΣ ΑΓΓΕΛΟΣ
Sub-action	Sub-action 1. Funding New Researchers – RRF: Basic Research Financing (Horizontal support for all Sciences)
Acronym	Fun4Design
Proposal Title (EN)	Function-oriented, multi-material design of sustainable mechanical systems
Proposal Title (ΕΛ)	Σχεδιασμός βιώσιμων μηχανικών συστημάτων από πολλαπλά υλικά με προσανατολισμό στις λειτουργίες
Scientific Area	SA2. Engineering Sciences & Technology
Scientific Field	2.3 Mechanical engineering
Scientific Subfield	2.3.5 Manufacturing engineering and machine design
Host Institution	UNIVERSITY OF PATRAS
Department	DEPARTMENT OF MECHANICAL ENGINEERING AND AERONAUTICS
Non-beneficiary Collaborating Organization(s)	TU DRESDEN
Keywords	Sustainable engineering, conceptual design, recycled composites, machine learning, multi-criteria decision making, mechanical systems, function-integration, design-from recycling, recyclability, sustainability
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Deliverable Title	Conference disseminating conceptual design of demonstrator
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Authoring & Approval

Prepared by		
Name and Organization	Position and title	Date
Angelos Filippatos	Assistant Professor, UPATRAS	20.07. 2025
Dionysios Markatos	Postdoctoral Researcher, UPATRAS	22.07. 2025
Anastasios Zavos	Postdoctoral Researcher, UPATRAS	22.07. 2025
George Kouvaras	PhD Researcher, UPATRAS	30.08.2025

Approved for submission by		
Name and Organization	Position and title	Date
Eidikos Logariasmos Kondilion kai Ereunas University of Patras	Coordinator - UPatras	19/11/2025

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Disclaimer

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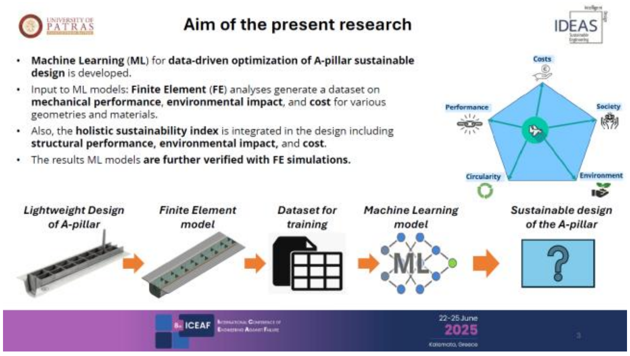
1 INTRODUCTION

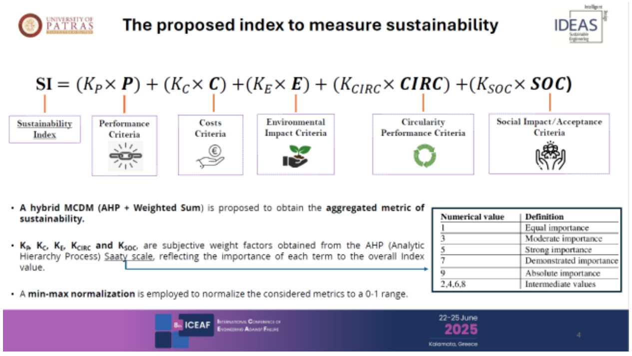
The submitted conference papers focused on disseminating the outcomes of the Fun4Design project. In **M19**, the conference paper (C1), titled: " ***Towards a Machine Learning-Driven Sustainable Design of an A-Pillar Automotive Component*** " was presented at the International Conference of Engineering Against Failure (ICEAF) VIII. This study presents a data-driven approach for optimizing the design of an A-pillar multi-material component by the employment of Machine Learning (ML) models. An extensive series of nonlinear Finite Element (FE) analyses was conducted to generate a dataset capturing the mechanical performance, environmental impact, and cost metrics of various design variants for different geometric configurations and materials. The dataset was then used to train ML models based on linear regression to predict optimal design configurations according to predefined criteria. Design variants meeting holistic sustainability criteria were subsequently evaluated through FE simulations to verify the ML model predictions. The results demonstrate the effectiveness of this demonstrator in facilitating data-driven design optimization for automotive engineering. This design approach provides real-time decision-making support, allowing engineers to identify optimal configurations more rapidly and accurately than traditional design processes.

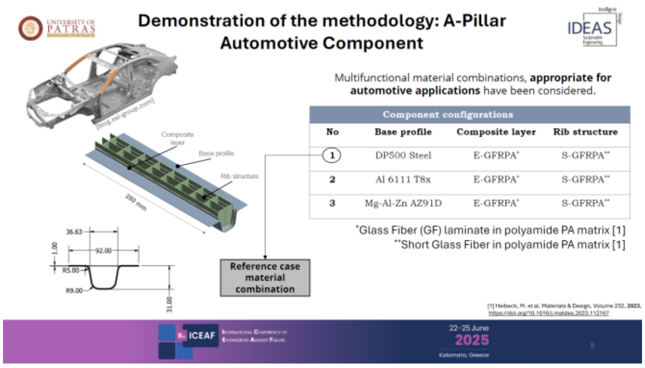
Also, the conference paper (C2) titled *"**Promoting Sustainability in Aviation Engineering Through an Interactive Educational Platform**"*, presented at the International Conference of Engineering Against Failure (ICEAF) VIII, demonstrates a versatile approach to sustainable design that can be applied across multiple engineering sectors. The study, carried out in close collaboration with the Computer Engineering Department of the University of Patras (CEID), focused on sustainable aircraft design by developing a demonstrator based on a holistic sustainability framework encompassing environmental, technical, economic, and social dimensions. CEID contributed expertise in computational methods and VR technology, enabling the development of an interactive platform where users can explore virtual aircraft models and evaluate their sustainability performance across key metrics such as fuel efficiency, emissions, and recyclability. The platform was implemented for educational purposes with students in the Department of Mechanical Engineering and Aeronautics, providing an ideal context to test the methodology beyond automotive applications. Developed within the scope of the Fun4Design project, this work illustrates how its methodology for multi-criteria sustainability assessment is generalizable to sectors such as aerospace, leveraging the host institution's expertise while showing the potential for broader adoption in early-stage design and decision-making across engineering disciplines.

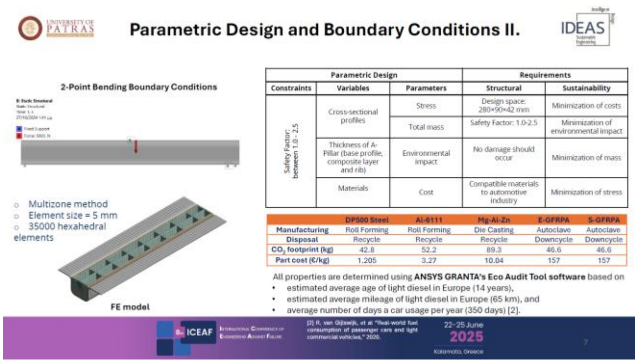
Details of the Conference Presentations can be found in **Annex 1** and **Annex 2**.

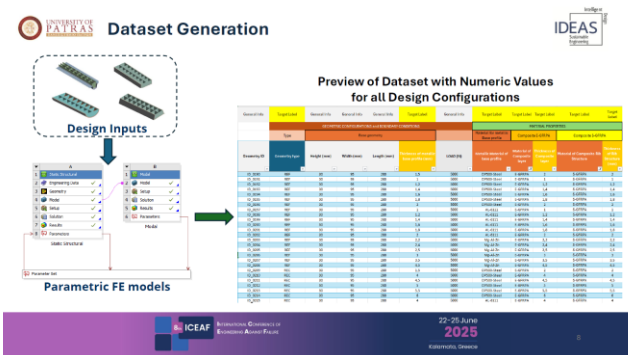
ANNEX 1: Conference Presentation (C1)

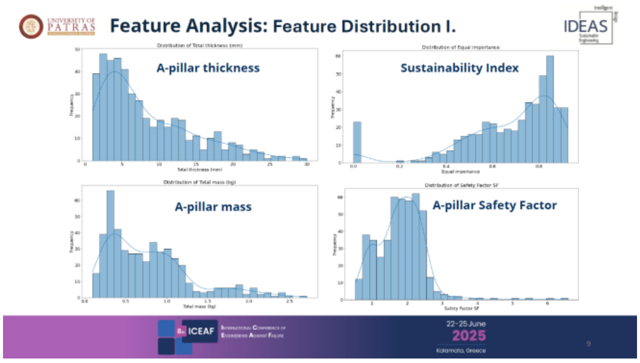


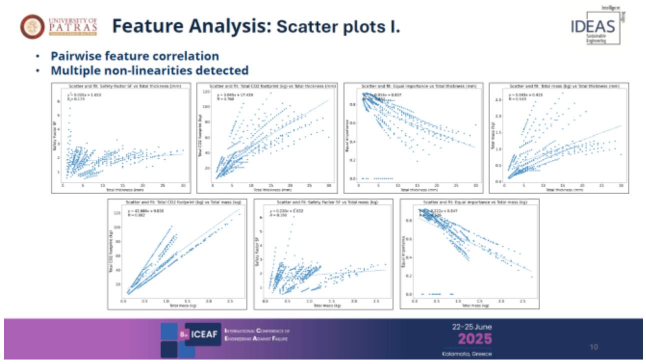


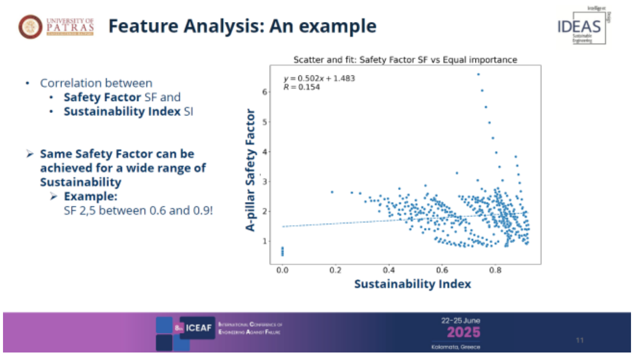


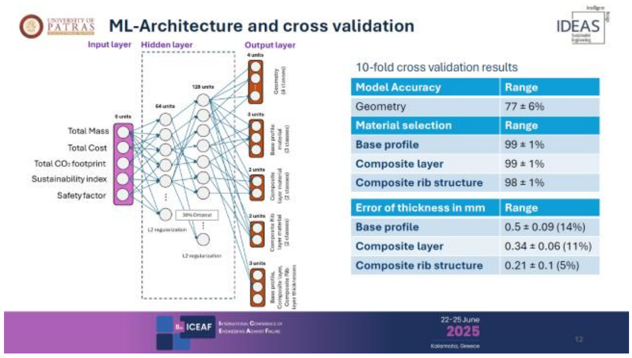


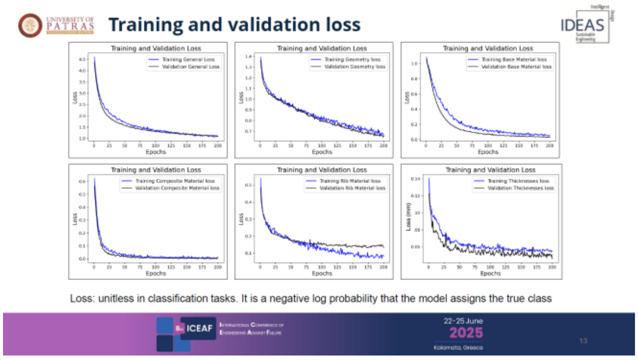


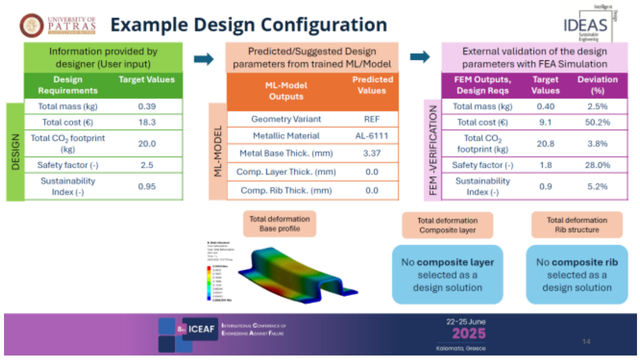


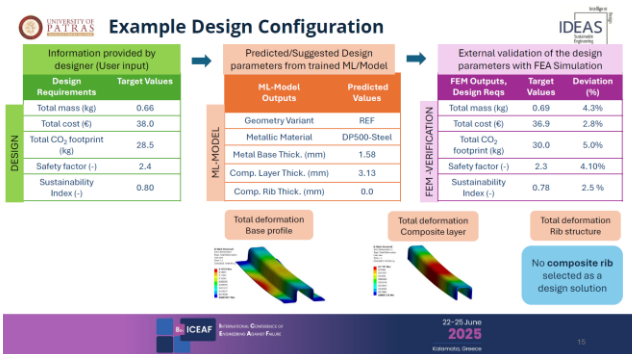


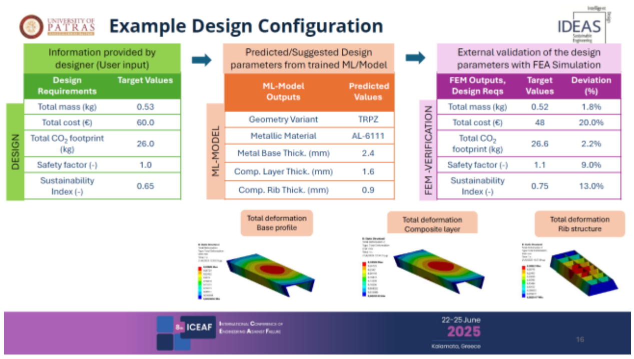












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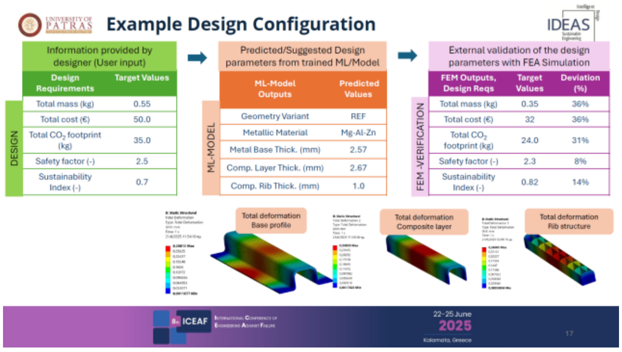
Example Design Configuration
Information provided by designer (User input)
Design Requirements | Target Values
Total mass (kg) | 0.55
Total cost (€) | 50.0
Total CO2 footprint (kg) | 35.0
Safety factor (-) | 2.5
Sustainability Index (-) | 0.7
DESIGN
Predicted/Suggested Design parameters from trained ML/Model
ML-Model Outputs | Predicted Values
Geometry Variant | REF
Metallic Material | Mg-Al-Zn
Metal Base Thick. (mm) | 2.57
Comp. Layer Thick. (mm) | 2.67
Comp. Rib Thick. (mm) | 1.0
ML-MODEL
External validation of the design parameters with FEA Simulation
FEM Outputs, Design Reqs | Target Values | Deviation (%)
Total mass (kg) | 0.35 | 36%
Total cost (€) | 32 | 36%
Total CO2 footprint (kg) | 24.0 | 31%
Safety factor (-) | 2.3 | 8%
Sustainability Index (-) | 0.82 | 14%
FEM -VERIFICATION
Total deformation Base profile
Total deformation Composite layer
Total deformation Rib structure
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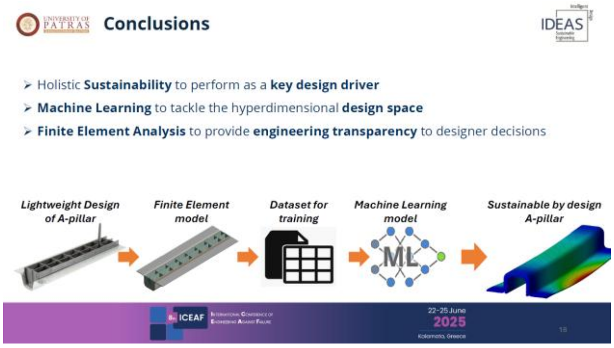
2025


Conclusions
➢ Holistic Sustainability to perform as a key design driver
➢ Machine Learning to tackle the hyperdimensional design space
➢ Finite Element Analysis to provide engineering transparency to designer decisions
Lightweight Design of A-pillar
Finite Element model
Dataset for training
Machine Learning model
ML
Sustainable by design A-pillar
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Fun4Design
Website: Fun 4 Design | IDEAS (upatras.gr)
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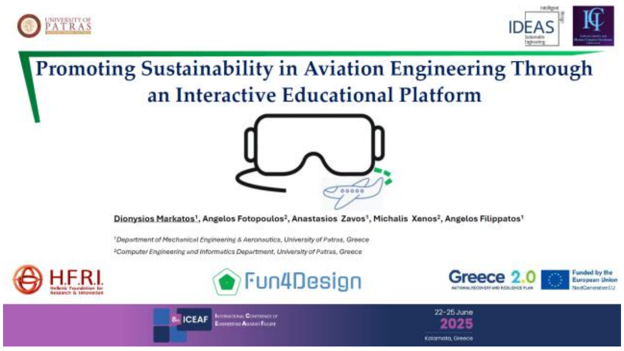
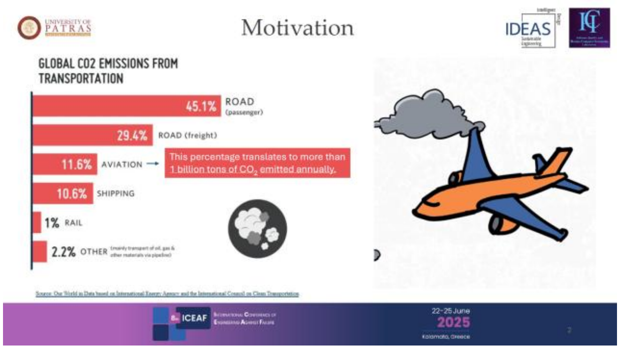
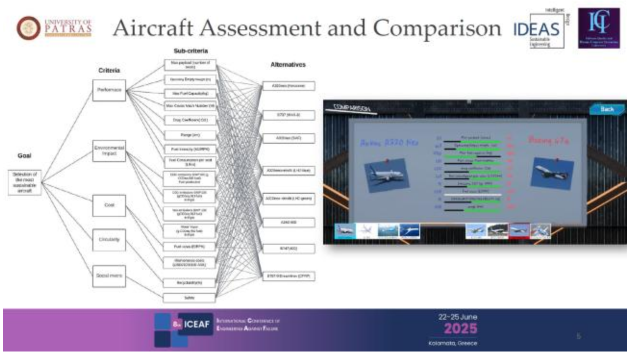
ANNEX 2: Conference Presentation (C2)








Cabin Interior View
IDEAS
Realistic Cabin Interior View 1
Realistic Cabin Interior View 2
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Interactive Nature
IDEAS
Interaction with NPCs (non-playable characters) – mini games (aircraft maintenance tasks, participation in quizzes, etc.)
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Interactive Nature
IDEAS
Visualization of flight range
Set up the Departure
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Piloting of the Platform
IDEAS
Where
Arsakeion of Patras is considered one of the most modern schools in Greece and the Balkans
Participants
Over 200 gymnasium and lyceum students from 5 different schools of the Patras region:
• Arsakeion Gymnasium (17 students – 1 teacher)
• Rion Gymnasium (45 students – 3 teachers)
• Rion Lyceum (44 students – 3 teachers)
• Agios Vasilis Gymnasium (49 students – 4 teachers)
• Patras 7th Gymnasium (51 students – 4 teachers)
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Piloting – High school students
IDEAS
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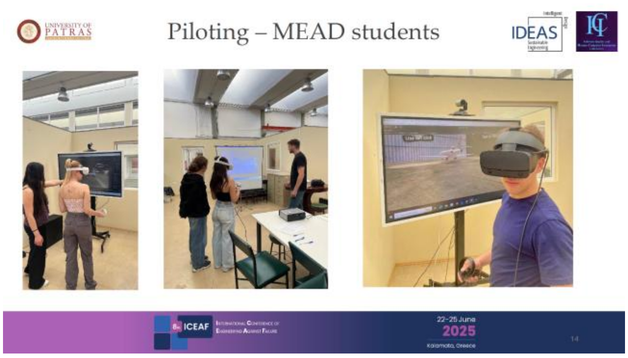
Piloting – MEAD students
IDEAS
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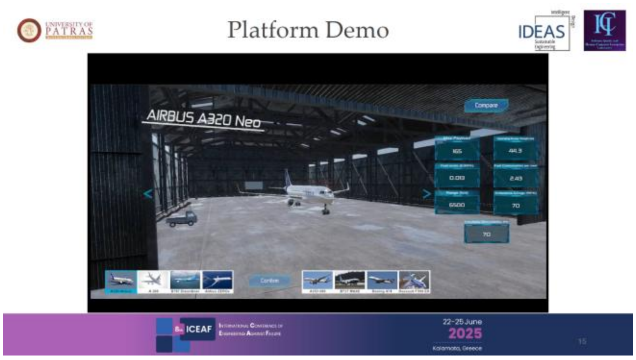
Platform Demo
IDEAS
AIRBUS A320 Neo
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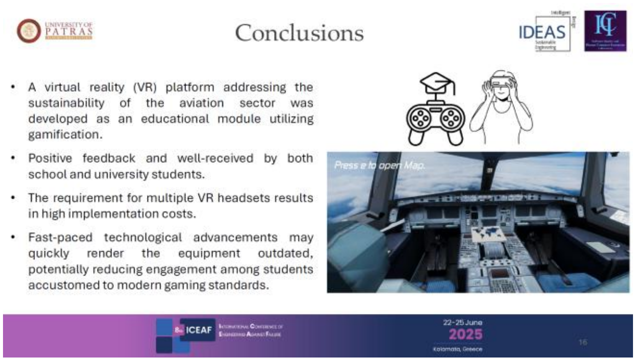
Conclusions
IDEAS
• A virtual reality (VR) platform addressing the sustainability of the aviation sector was developed as an educational module utilizing gamification.
• Positive feedback and well-received by both school and university students.
• The requirement for multiple VR headsets results in high implementation costs.
• Fast-paced technological advancements may quickly render the equipment outdated, potentially reducing engagement among students accustomed to modern gaming standards.
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What's next
IDEAS
• Further development and enrichment of the platform (incorporation of more mini-games relating to sustainability, increased interaction for the students and experimenting with aircraft characteristics, new environments and features, and additional aircrafts.
• Continue the demonstration of the platform to school and college students through the 'students go to university' initiative and in the frame of other research and teaching frameworks, e.g. through Erasmus projects.
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IDEAS
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