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2ND INTERNATIONAL WORKSHOP

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BOOK OF PROCEEDINGS

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Editors:

João da Rocha e Silva, Instituto Politécnico de Bragança, Portugal

João Eduardo Pinto Castro Ribeiro, Instituto Politécnico de Bragança, Portugal

Jorge Santos, Instituto Politécnico de Bragança, Portugal

Rui A. Lima, Universidade do Minho, Portugal

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WELCOME

In recent years, the manufacturing processes have undergone a profound transformation, driven by the rapid evolution of additive manufacturing (AM) technologies. What began as a tool primarily for prototyping through stereolithography has now expanded into a versatile and innovative field capable of producing functional, end-use components across a wide range of industries. From fused deposition modeling (FDM) to selective laser melting (SLM) and beyond, AM has unlocked new possibilities in design, material utilization, and production efficiency. Today, additive manufacturing encompasses an extensive array of materials, including metals, polymers, paper, and even biological tissues, enabling applications that span from the mechanical industry to the biomedical sector.

One of the most compelling aspects of additive manufacturing is its potential to drive sustainability in modern production processes. Unlike traditional subtractive methods, which often generate significant material waste, AM builds components layer by layer, minimizing excess material and promoting resource efficiency. Furthermore, the ability to use eco-friendly and recyclable materials aligns with global efforts to reduce environmental impact. AM also supports the production of complex, customized parts on demand, reducing the need for large inventories and long-distance transportation, thereby lowering carbon emissions. By optimizing resource use and enabling more efficient production cycles, additive manufacturing is emerging as a cornerstone of sustainable manufacturing practices.

This proceeding book arrests the latest advancements, challenges, and opportunities in the field of additive manufacturing, with a particular focus on its transformative potential and contributions to sustainability. The works presented here reflect the interdisciplinary nature of AM, showcasing innovative techniques, materials, and applications that are shaping the future of manufacturing. From cutting-edge research to real-world case studies, this collection aims to inspire further exploration and collaboration, driving the adoption of additive manufacturing as a key enabler of sustainable industrial progress. We invite readers to probe into these pages and discover how AM is not only redefining manufacturing but also paving the way for a more sustainable and efficient future.

The IWAM 2024 Organizing Committee,

João Rocha

João E. Ribeiro

Jorge Santos

Rui Lima

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Increasing motivation and learning in digital manufacturing: Blended Intensive Programs for STUDENTS

João Rocha[1,3*], Leonel Deusdado[1], Jorge Santos[1], Catarina Rocha[1], Isabel Lopes[1,4], João Ribeiro[1,2]

[1]Instituto Politécnico de Bragança, 5300-253, Bragança, Portugal

[2]Mountain Research Center (CIMO), Polytechnic Institute of Bragança, 5300-252 Bragança, Portugal

[3]Sustainable Construction Research Group (GICoS), Polytechnic Institute of Bragança, 5300-252 Bragança, Portugal

[4]Applied Management Research Unit (UNIAG), Polytechnic Institute of Bragança, 5300-252 Bragança, Portugal

[(*)]***Email***: jrocha@ipb.pt

ABSTRACT

This article explores an innovative approach to teaching digital manufacturing, with a particular focus on additive manufacturing, through a structured set of tasks involving 3D scanning and printing. The pedagogical project stands out for its unique integration of international students from multiple institutions and diverse academic backgrounds, made possible through the Blended Intensive Program (BIP). This program brought together students from various disciplines within Science, Technology, Engineering, Arts, and Mathematics (STEAM), fostering an interdisciplinary learning environment.

By engaging students in hands-on activities that combine theoretical knowledge with practical implementation, the program encourages active participation and collaborative problem-solving. Participants worked in multicultural teams, sharing expertise and experiences to overcome technical challenges related to digitalization and additive manufacturing. Research findings indicate that this approach yields excellent results in terms of student engagement, motivation, and learning outcomes. The structured yet flexible nature of the program allows students to develop both technical and creative skills while working in a dynamic, competitive environment.

Furthermore, the BIP framework enhances students' ability to adapt to real-world scenarios, where teamwork and interdisciplinary collaboration are essential. By integrating practical experience with theoretical instruction, this approach strengthens their problem-solving abilities and prepares them for future professional challenges in the rapidly evolving field of digital manufacturing.

Keywords: Digital Manufacturing; Additive Manufacturing; Blended Intensive Program (BIP); Student Engagement.

INTRODUCTION

The Blended Intensive Program (Commission, 2024) in Digital Manufacturing was organized by the Instituto Politécnico de Bragança with virtual classes between October 23 and December 15, 2023 with the in-person week from January 15 to 19, 2024. The program had a total of 26 registered foreign students: 1 from Hradec Kralove University, 1 from Business and Technology University, 5 from Kaunas University of Applied Engineering Sciences, 2 from Vilniaus Gediminas Technical University, 1 from Vilnius College of Technology and Design, 7 University of Applied

Sciences in Konin, 3 from the Nowy Sacz University of Applied Sciences, 3 from the Opole University of Technology, 3 from the Novia University of Applied Sciences. 20 students successfully completed ERASMUS mobility, one of which did not come from a European Union university .

During the face-to-face week, students had the opportunity to put into practice the skills acquired during online learning, ending with the presentation of a solution to a specific problem.

The social part of the program was very important to create a strong group where mutual help was always present. In this multicultural context, the feeling of belonging to the European Union was reinforced (Hamonic, et Al., 2023, IPPortalegre, (n.d.), IPVC, (n.d.), Zabala et Al., 2024).

BIP STRUCTURE

During the period allocated to the online part, several teachers were responsible for one of the planned areas of the program. Groups of students were created, incorporating elements from different countries and cultures, ensuring a rich multicultural experience. This approach encouraged collaboration and exchange of ideas among participants with diverse backgrounds. Support materials, including recorded lectures, tutorial videos, and supplementary readings, were made available by teachers for students who were unable to attend an online class. Additionally, discussion forums and Q&A sessions were organized to help clarify doubts and reinforce learning.

For the students, the face-to-face BIP included the participation of five teachers, who addressed the topics foreseen in the program. These topics encompassed a detailed study of a digitalization case, point cloud treatment, segmentation, and the 3D printing of a building (a small church in the city). Other activities included the design and production of a tactile plant adapted for the blind, using laser cutting and engraving, as well as the design and production of the wooden course logo. Additionally, students explored virtual reality applications developed through digitalization, providing an immersive perspective on their projects.

Student assessment was carried out by all teachers, taking into account the results of the challenges (50% weight) and a presentation made by each of the groups (50% weight). Given the highly practical nature of the course, adapted to each student's previous training and experience, the results were very positive and were shared among all participants. The dynamic environment fostered creativity, teamwork, and hands-on learning.

The face-to-face component consisted of 26.5 hours of preparatory work, which included scanning, modeling, processing, printing, cutting, and laser engraving. Throughout this phase, students worked in multidisciplinary teams, ensuring an interdisciplinary approach to problem-solving. In the final stage, they had 3.5 hours to present their work in groups in an interactive session where they showcased their final projects. This session allowed students to explain their methodologies, discuss challenges faced, and reflect on the knowledge gained throughout the course.

CHALLENGES

The students were challenged to try the software and equipment to understand using the Do it Yourself (DIY) method, taking advantage of the knowledge of students coming from various areas of knowledge (STEAM) (Manikutty et al., 2022).

The groups, previously formed, after the initial challenge, began their work obtaining the point cloud of a building in the city, using the equipment available in the laboratory, FARO Focus Scanners.

Participants were then challenged to work on this point cloud until they obtained a 3D model of the building. Depending on the experience and scientific area of origin of the members of each group, they obtained slightly different models, giving more emphasis to some details and less to others.

Finally, models were created, using different equipment and different materials.

In the time still available after completing the models, tactile plans were created for the blind. In addition to consolidating technical knowledge, participants in this program felt the need to work towards the inclusion of all European citizens in all societal activities. In addition to the scheduled hours, some students requested access to the FabLab IPB laboratory, in order to carry out extra work.

As part of the social program, all participants were invited to take part in a friendly dinner, held in the university restaurant. A visit was made to the city's museums (Iberian Museum of Mask and Costume, Georges Dussaud Photography Center, Graça Morais Museum of Modern Art, Municipal Theater of Bragança and Railway Museum Núcleo Museológico de Bragança, Figure 1) where there are models and tactile plants intended to the inclusion of blind people, and where they observed a practical application of their work (scanning, printing, cutting and engraving).

Figure 4 steam engine on display at the Railway Museum digitized and printed by the FabLab team

There was also time for the tourist component with a visit to the city of Bragança, the typical village of Rio de Onor and the Castro de Avelãs Monastery, both in the municipality of Bragança, important tourist attractions.

RESULTS

Regarding student feedback, they were asked to answer the question, “What did you do?” and “What would you like to have been more developed?”

Some highlights of what they learned: “SketchUP Pro” and other software, “Laser cutting”, “Point

Cloud and 3D models", "What to think about when you want to make, for example, maps for the blind", that is, thinking in different way for inclusion and very important "Local and International Culture", that is, increasing awareness that they are European Citizens!

Some of the "requests" do not depend on the BIP organization, such as "better climate" and "more face-to-face days" or "more trips", but others will be considered in a future edition such as "More VR", "More individual creation".

For the second edition of this BIP program, applications were received from several universities in the European Union and also from outside the Union

Due to the answers given to these questions and the adherence to the second edition of this BIP, due to its geographic and scientific origins, the organization is convinced that this method resulted in the acquisition of skills in digital manufacturing.

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