

Learning Module Outline

Short Description	
Description of the module	<p>Digital Manufacturing and 3D Printing</p> <p>This module introduces the fundamental concepts of digital manufacturing and 3D printing, with particular emphasis on their application in the aerospace sector. It provides an overview of how digital technologies support the design, simulation, planning, production, and quality assurance of advanced aerospace components. The module addresses the principles of process digitalization and presents the principal software tools used throughout additive manufacturing workflows, including computer-aided design (CAD), simulation and analysis tools, slicing software, and process monitoring platforms. It also examines the role of process modelling and simulation in predicting thermal behaviour, residual stresses, distortion, and overall part performance. In addition, the module introduces design methodologies specifically developed for additive manufacturing, with particular focus on Design for Additive Manufacturing (DFAM). The key stages of the DFAM approach are discussed to illustrate how components can be optimized to exploit the unique capabilities of 3D printing, such as lightweight structures, part consolidation, and increased geometric complexity. The module further explores the integration of additive manufacturing into digitally driven and sustainable production systems, including concepts related to Industry 4.0, digital twins, and resource-efficient manufacturing. By combining theoretical foundations with aerospace-oriented examples, the module prepares learners to address the technical and strategic challenges associated with the digital transformation of additive manufacturing in aerospace applications. The detailed content of the module is presented below.</p> <ol style="list-style-type: none"> 1. Introduction 2. Digital Tools for Additive Manufacturing <ol style="list-style-type: none"> 2.1. Design Tools 2.2. Topology Optimisation 2.3. Modelling and Simulation as Digital Tools for Additive Manufacturing 3. Modelling, Simulation, and Print Preparation <ol style="list-style-type: none"> 3.1. Finite Element Modelling for Additive Manufacturing 3.2. Process Simulation 3.3. Validation of Models and Simulations 3.4. Print Preparation and Slicing (Pre-Printing) 4. Digital Design Methodologies <ol style="list-style-type: none"> 4.1. The Digital Design Workflow in Additive Manufacturing 4.2. Core Principles of DFAM 4.3. Process-Driven Design Strategies 4.4. AI-Driven Design Tools 4.5. Sustainability in DFAM 5. Integration of 3D Printing in Digital Production Systems <ol style="list-style-type: none"> 5.1. Digital Concepts for Additive Manufacturing Integration 6. Conclusions



Funded by
the European Union

Target Groups	
Targets	<ul style="list-style-type: none"> • Engineering students (Aerospace, Aeronautical, Materials and Mechanical Engineering) • Engineers and technical staff in Aerospace and Aeronautical Industries

Learning Objectives	
Learning Objectives for this module	<p>Upon completion of this module, attendees will be able to:</p> <ul style="list-style-type: none"> • Understand the fundamental concepts of digital manufacturing and 3D printing. • Recognize and apply digital tools (CAD/CAM/CAE) in additive manufacturing workflows. • Recognize digital design strategies to optimize 3D printed components. • Understand the influence of process parameters and their control on the printing quality of components for the aerospace industry. • Understand the complete digital workflow required to prepare parts for additive manufacturing. • Understand the integration of 3D printing into digitally enabled and sustainable production systems in the context of aerospace applications.

Learning Resources	
Resources	<ul style="list-style-type: none"> • Scientific articles • Industrial reports • Books • Thesis • Tutorials • Instructional videos

Self-assessment and Learning Activities	
Self-assessment and Learning Activities	<ul style="list-style-type: none"> • Textbook • Lesson presentations • Lesson reviews • Quizzes

This document was prepared by the project team from the University of Aveiro.