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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Manufacturing and industrialization for Launch Vehicle and Space Vehicle Structures and components (High volume production, industrialization, automatization and digitalization) (7)

Author: Prof. Marco Eugeni
Sapienza University of Rome, Italy

Prof. Alberto Boschetto
Sapienza University of Rome, Italy
Prof. Francesco Costantino
Sapienza University of Rome, Italy
Prof. Antonio Culla
Sapienza University of Rome, Italy
Dr. Federica Conti
Sapienza University of Rome, Italy
Prof. Annalisa Fregolent
Sapienza University of Rome, Italy
Dr. Luca Lampani
Sapienza University of Rome, Italy
Ms. Cristina Lorenzetti
beyondgravity, Switzerland
Dr. Franco Mastroddi
Sapienza University of Rome, Italy
Prof. Massimo Mecella
Sapienza University of Rome, Italy
Prof. Silvia Milana
Sapienza University of Rome, Italy
Mr. Giovanni Morabito
Thales Alenia Space Italia (TAS-I), Italy
Prof. Michele Pasquali
Sapienza University of Rome, Italy
Prof. Francesco Saltari
Sapienza University of Rome, Italy
Mr. Andrei Stancu
beyondgravity, Switzerland
Prof. Paolo Gaudenzi
Sapienza University of Rome, Italy
Mr. Vincenzo Di Pietro
Thales Alenia Space Italia (TAS-I), Italy

A GENERAL FRAMEWORK FOR THE INTEGRATION OF INDUSTRY 4.0 METHODOLOGIES INTO THE MANUFACTURING, ASSEMBLY, INTEGRATION, AND TESTING PROCESSES OF THE SPACE INDUSTRY

Abstract

In the rapidly transforming landscape of the space industry, marked by the influx of private enterprises and a growing emphasis on mega-constellations of small satellites for telecommunications and Earth observation, a new commercial paradigm has emerged. To navigate this changing terrain effectively, the space manufacturing sector must swiftly adapt, exploring innovative strategies to enhance the efficiency of both satellite and launcher production processes. Amidst this dynamic backdrop, the Fourth Industrial Revolution, embodied by Industry 4.0 or Smart Manufacturing initiatives, provides the conceptual and technological framework needed to propel advancements in the Manufacturing, Assembly, Integration, and Testing (MAIT) cycles of the Space Industry in the so-called Space 4.0 or the New Space Economy era. Central to this is the realization of Smart Factories, hinging on the seamless integration of Operational and Information Technologies, facilitated by the application of Cyber-Physical Systems (CPS) connecting synergically the physical and digital worlds, replicating and enabling continuous monitoring and data analytics [1]. This work introduces a comprehensive approach to digitizing manufacturing, assembly, and testing processes pertinent to the Space Industry. The proposed methodology begins with an evaluation of the present digitalization level of the selected processes, utilizing the Acatech model to identify areas for enhancement and outline a digitalization roadmap upon establishing production goals. Following this initial assessment, a trade-off analysis among various Smart Manufacturing concepts is conducted to identify those most suitable for achieving the established objectives. Ultimately, an evaluation of the attainable level of digitalization, based on the Acatech model, helps envision the benefits for the production line. Consequently, the proposed approach serves as a crucial tool for designing both new and digitalized production lines, evolving from existing ones. This work presents and extensively analyzes different case studies from both the satellite and launcher industries, providing valuable insights into the practical application of the outlined approach.

Eugeni et al. “An industry 4.0 approach to large-scale production of satellite constellations: The case study of composite sandwich panel manufacturing,” Acta Astronautica, vol. 192, March 2022, pp. 276-290.