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SMART MANUFACTURING IN THE SPACE INDUSTRY. A CYBER-PHYSICAL SYSTEM ARCHITECTURE AND ITS IMPLEMENTATION TO A MAIT PROCESS FOR MEGA CONSTELLATIONS OF SATELLITES

Abstract

Industry 4.0, or Smart Manufacturing, is driving the evolution of industrial scenarios worldwide through an extensive introduction of Information Technologies as an integration to Operational Technologies. Access and use of data have become determinant factors of the efficacy of innovation requested to answer the increasingly urgent need of lowering production costs. Reviewing the State-of-Art of Smart Manufacturing technologies in the space industry and beyond, the authors found that the newest tools, such as Digital Twins, Internet of Things and Cyber-Physical Systems, have started to be applied, following the principles of interoperability, connectivity and modularity. However, still huge improvements are possible to optimize space productions to reach the ambitious efficiency goals of new commercial businesses, first of which the rising trend of mega constellations of small satellites. RUAG's Space satellite composite sandwich panel Manufacturing Assembly Integration and Testing process was selected as reference. The as-is process data measurements and collection nowadays still rely on human workers' long-term expertise, mainly related to visual inspection of defects or physical standard equipment. Data is stored in remote databases, not connected to the process nor easily available to the personnel. Moreover, the process is far from low-cost high-pace mass-market production systems, being materials and processes customized based on the product and heavily depending on procurement logics. Considerable effort has been made toward innovation, resulting for example in the automation of highly repetitive operations, such as insert potting, with the introduction of an Automated insert Potting Machine (APM). Taking as reference this operation to measure process KPIs' improvement, a two-level approach was applied to implement a Cyber-Physical System to the process: first, using the existing measurement systems (e.g. sensors, devices and equipment like APM) to gather data in a digital database and then introducing new data by the addition of new sensing equipment. The CPS is based on the interconnection of sensors through a networking infrastructure managed by a central processing unit. Data flows from physical devices, digitally twinned, up to an operator dashboard, where the results of intermediate processing steps, including normalization, categorization, storage and interpretation by a closed-feedback loop logic based on KPIs' statistical predictive models, are displayed. In this paper, the CPS conceptual and system architecture will be presented: data detection and measurement systems, techniques and strategies for data treatment and correlation, how decision making and process control is activated in the process, how hardware and software components are interrelated.