Editorial

José Ríos*

Department of Mechanical Engineering,
ETSI Industriales, Universidad Politécnica de Madrid,
Calle José Gutiérrez Abascal 2, Madrid, 28006, Spain
Email: jose.rios@upm.es
*Corresponding author

Fernando Mas

Airbus Group,
Department of PLM Process and Tool Solutions,
Av. García Morato s/n, Seville, 41011, Spain
Email: fernando.mas@airbus.com

Biographical notes: José Ríos is an Associate Professor in the Department of Mechanical Engineering at Polytechnic University of Madrid. He is involved in research projects related to digital and virtual manufacturing, CAD/CAM/PLM, information modelling, KBE and design integration. He has collaborated with different companies in the aeronautical, automotive, and die and mould making sectors. Along his professional career, he held a Visiting Research position at Penn State University (USA) and a Research Fellow position at Cranfield University (UK). Currently, he is member of the IFIP TC5 WG5.1 Global product development for the whole lifecycle.

Fernando Mas holds a PhD in Engineering from the Polytechnic University of Madrid. He led R&D and PLM activities for military aircraft–operations in Airbus, where he holds a position as Airbus Senior Expert in Virtual Product Engineering. He owns patents in the EU and the USA and has published papers in refereed international journals and conferences. He is member of the IFIP TC5 WG5.1 Global product development for the whole lifecycle. For six months, he was located in San Jose, California as Senior Advisor for Advanced Digital Design and Manufacturing Project in A3 by Airbus office in Silicon Valley.

We are pleased to present the issue of the *International Journal of Product Lifecycle Management* as a special issue entitled ‘PLM for Manufacturing in Aerospace Industry’. This special issue is part of an effort to encourage the submission of works dealing with manufacturing engineering in aerospace within the PLM community.

Product lifecycle management (PLM) is a business solution, which aims to streamline the flow of information about the product and related processes throughout the product’s lifecycle, enabling the availability of the right information, in the right context and at the right time. PLM solutions allow managing large amounts of data generated in the various phases of an aircraft lifecycle to support efficiency, flexibility and efficacy in the business processes. PLM is a supporting pillar for the Aerospace Industry and plays two basic roles. First, it allows the digital integration of processes along the industrial value chain, and second, it serves as a source of true product related data across the aircraft entire lifecycle.

This special issue was initially conceived to address manufacturing engineering aspects in the aerospace industry, which mainly relate to fill the gap between product design and shop floor production. Manufacturing engineering comprises the design of manufacturing and assembly processes with their corresponding jigs and tooling, and the later deployment of aircraft manufacturing related data. PLM enables to perform those tasks in a virtual and collaborative environment, allows managing aircraft configurations for manufacturing (as planned and as built) and contributing manufacturing data to the aircraft digital twin. Really shows that initial limits run the risks of becoming too narrow, and we are pleased to state that was the case for this special issue. The accepted submissions provide a scope wider than initially envisaged.

In the aerospace industry, diverse data from different stages of an aircraft lifecycle are distributed across a wide variety of computer systems, i.e., PLM, enterprise resource planning (ERP) and manufacturing execution system (MES). Defect related data is a typical case. Defect related data could be used to enhance the decision making process when implementing design for manufacturing (DFM) practices. The extraction and linking together of such data to provide valuable new information and insights is still a research issue. The work from El Souri et al. shows the findings of an industrial project carried out at BAE systems. It proposes an approach dealing with defect data management to establish a systematic link between defects, engineering data, and related issues for improving DFM implementations. The proposed approach aims integrating three main software systems: ERP, MES and PLM; in that sense, it can be seen as a contribution to the closed loop PLM strategy.

Knowledge acquisition from unstructured or semi structured sources follows with the closed loop PLM strategy, but with a different perspective in the reuse of existing data. While structured data can potentially be easily extracted, dealing with unstructured or semi structured data embedded in text requires different and more complex approaches, mainly based on the use of natural language processing techniques. The work from Madhusudanan et al. aims reusing issues that occurred during manufacturing and assembly, and were documented into engineering change requests and incident reports, to provide valuable feedback manufacturing knowledge during the assembly planning tasks. It is an effort to contribute to the closed loop PLM strategy and to the implementation of DFM practices. They propose an approach to use natural language processing techniques to extract knowledge from documents written in English language. The proposed method automatically identifies the presence of issues, and the causes of these issues. Their work is based on the development of a domain specific sentiment dictionary and text patterns.

Achieving a closed loop PLM strategy implies integrating and correlating product data across its lifecycle. We have already commented two cases focused on the perspective of extracting data to generate domain specific knowledge, however a standardised infrastructure is needed to achieve such a closed loop and to avoid the creation of information silos. The development of standardised data representations is an ongoing international effort to which several organisations and research groups are contributing. Computer systems interoperability is a topic of major concern for the aerospace industry as is shown by the activities of the AeroSpace and Defence Strategic Standardization Group (ASD SSG). The work from Bernstein et al. investigates this issue. In particular, they propose a contextualisation approach to facilitate the correlation of design, manufacturing and inspection data and to support decision making along the product lifecycle. The approach comprises mapping standard data representations from Standard for the Exchange of Product Data (STEP), MTConnect and Quality Information Framework (QIF), and it is implemented in the National Institute of Standards and Technology (NIST) Smart Manufacturing Systems Test Bed.

When considering the aerospace sector, each physical aircraft is identified by means of a number, typically named Manufacturing Serial Number (MSN), and it is an instance of a reference virtual aircraft. A reference virtual aircraft has views and baseline structures. A virtual aircraft has several views along its lifecycle, typically: as proposed, as specified, as defined, as designed, as planned, as prepared and as maintained. The collaborative work in the development of an aircraft demands the dynamic coordination and integration of such views. The baseline structures are product trees with nodes and components assigned to the different agents involved in the development of the aircraft. Part of the aircraft structure is invariant, independent of the aircraft configuration and therefore it is common to all the aircrafts of the same family. Other part of the aircraft structure depends on the configuration. PLM systems are used to carry out the configuration management tasks to maintain the consistency of the aircraft data that conform such views along its lifecycle. The work from Toche et al. analyses how to incorporate prototyping and testing tasks into such a collaborative environment. To do so, they proposed the definition of a new dedicated ‘as tested’ product structure that complements the already existing ‘as designed’ and ‘as planned’ product structures. The traceability among the product nodes is maintained by linking the three structures. The functionality of the approach is demonstrated in a case study with an aero engine sub-assembly in a commercial PLM system.

So far, we have look into the closed loop PLM strategy from two different research perspectives. One perspective, provided by the first and the second works, was more related to data extraction and reuse to generate DFM knowledge and enhance a decision-making process. A second perspective, provided by the third work, was more related to data interoperability. The fourth work brought onto the scene product structures and views, combining a research perspective and its possible implementation into a commercial PLM system. The next work, with a very interesting industrial perspective based on his experience at Boeing, looks into the aircraft data evolution aspect and how PLM systems support such evolution. Przybylo discusses how PLM systems tends to focus on the management of the latest version of the engineering design, introduces the basic concepts to understand design evolution over time, points out the difficulties to find the data evolution path, and shows a methodology for finding the previous evolutions of the data, storing them in a logical structure and presenting them in an easy to navigate form.

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