

Editorial

Introduction to the special issue “Concurrent Engineering 2”

Cees Bil ^a and Josip Stjepandić^{b,*}

^a*RMIT University, Melbourne, VIC, Australia*

^b*PROSTEP AG, Darmstadt, Germany*

1. Introduction

Developed in the late 80ies, the Concurrent Engineering (CE) approach is based on the idea that different phases of a product life cycle should be conducted concurrently and initiated as early as possible within the Product Creation Process (PCP). The primary goal of CE is to increase the efficiency of the PCP and to reduce errors and, subsequently, unnecessary changes in the late phases of the PCP. While starting with a design-manufacturing alignment, gradually the CE way of thinking has been extended to incorporate more lifecycle functions together with a stronger focus on and involvement of both customers and suppliers. In the past two decades CE has become the substantive basic methodology in many industries (automotive, aerospace, machinery, shipbuilding, consumer goods, process industry, environmental engineering, service industry) and has been also adopted in the development of new services [1]. CE was also included in the engineering education.

In the meantime the initial, basic CE concepts have matured and have become the foundations of many new ideas, initiatives, approaches and tools. Generally, the present CE concentrates on enterprise collaboration and its many different elements, from integrating people and processes to very specific complete multi/inter/trans-disciplinary solutions. Current research on CE is driven again by many factors like increased customer demands, globalization, (international) collaboration and environmental strategies. The successful application of CE in the past opens also the perspective for applications like overcoming of natural catastrophes and sustainable mobility concepts with electrical vehicles. CE was also a powerful driver for development on new IT concepts and tools.

With the increasing size and complexity of development projects at large companies and organizations in the aviation industry, CE and integrated aircraft design has become of crucial importance in the design process of new products. In order to remain a competitive position and achieve a customer driven approach, aspects of the product’s life cycle should be adopted at an early stage in the design process. These aspects include, among others: the overall cost performance, the ability of new system

*Corresponding author: Josip Stjepandić, PROSTEP AG, Darmstadt, Germany. Tel.: +49 6151 92 87 363; Fax: +49 6151 92 87 326; E-mail: Josip.stjepandic@opendesc.com.

integration, challenges related to process parallelization and multidisciplinary design, involving the exchange of knowledge and information throughout the design process, exploitation and maintenance [2].

With this issue, we address various areas of Concurrent Engineering research [3]: life-cycle assessment of alternative aviation fuels, risk assessment for aviation operations improvement projects, lessons learned in participative multidisciplinary design optimization, demonstration of a Concurrent Design Facility (CDF) framework for aerospace engineering education, and risk management in the design of engineering as sociotechnical systems.

This special edition includes the second collection of invited papers selected from contributions to the 21th ISPE Inc. International Conference on Concurrent Engineering held in Beijing, China, on 8–11 September 2014 [4]. The first collection has been published in the previous issue 3 (2015) [5].

Cees Bil and Timothy Conroy demonstrate the life-cycle analysis for alternative aviation fuels proposing the design of a dual-fuel system (LCH₄/kerosene) aircraft which minimises design modifications in order to decrease acquisition costs. Airlines globally are affected as the combined impact of rising fuel prices and introduction of CO₂ taxation schemes reduce profit. In the past decade alone, the price of jet-fuel has quadrupled and the fuel component of Direct Operating Cost (DOC) has increased from 14% to a third of total operating expenditure in 2013. Currently, airlines attempt to improve their financial position by downsizing or reconstructing their operations. This strategy has only limited effectiveness and avoids addressing the central DOC problem. With an increasing demand for jet-fuel and a reduction in global supply, the price of fuel is projected to increase further. The air transport sector faces a considerable challenge in reducing its cost base to keep air travel affordable and environmentally sustainable. Aviation is a significant contributor to the emission of carbon dioxide (CO₂), a gas that is attributed to global warming. To address this contribution, International Air Transport Association (IATA) has issued a global commercial aviation mandate to reduce net CO₂ to 50% of 2005 levels by 2050 with carbon neutral growth from 2020. In 2012, IATA stated that air travel capacity increase (5.3% per annum) outpaced percentage efficiency improvements (2% per annum) resulting in 20 million tonne increase in net CO₂ emissions. If compared to conventional kerosene-based A320, the new design results in a predicted savings of US\$33.5 million per aircraft in airline DOC by 2026 with a breakeven point during the first year of operation. As a fuel source, LCH₄ induces a 20% reduction in CO₂ emissions compared to current aviation fuel. Most importantly, the introduction of liquid bio-methane offers a sustainable alternative to LCH₄ and promotes price stability for the long term.

John P.T. Mo and Boyd Nicholds address the risk assessment for aviation operations improvement projects. No decision maker willingly sets themselves up for failure. However setting targets too high without considering the company's capability when introducing new operations or making changes to existing operations will have little chance of success. An executable model using a capability score integrated with the performance and anticipated value has been proposed to assess the likelihood of success and failure of meeting performance gain targets from improvements for new aviation operations development. The method computes a probability value that indicates to companies their chance of meeting the target performance. Based on this indicator, company management can avoid taking on risky projects. This alleviates the problem aviation services providers have when they embark on operations improvement initiatives with an organisational setup that limits their chance of success. By matching the performance targets for operations improvement projects to organisational capability score, a higher hit-rate of success to change can be achieved.

Evelina Dineva et al. discuss recent achievements in participative Multidisciplinary Design and Optimisation (pMDO). Research into future air vehicles incorporating novel technologies is characterized by a high number of interacting disciplines which need to be considered. Despite advances in numeric interfacing techniques for pMDO, it is not well understood how to build a team of specialists who jointly operate shared tools and gain system level insight. This contribution shifts focus to the human

MDO participants and their working environment. Three aspects of collaboration are considered: (a) design of cognitive experiments to measure engineering performance in different settings; (b) integration of prior experience through a Lessons Learned process; and (c) the application of the above into the enhancement of Integrated Design Laboratory (IDL). The pronunciation of competence and working environment, rather than software tools or data, opens opportunities for attractive use cases. The outcome of is a comprehensive manual consisting of a technical system description, best practices and a generic laboratory blueprint for the generation of similar research facilities.

Dajun Xu et al. refer the Concurrent Design as well. Concurrent Design Facility (CDF) is an effective IT environment to apply Concurrent Engineering principles. In aerospace engineering education, CDF can be invaluable by enabling student teams to gain cross-discipline skills and at the same time stay at the cutting edge of technology. This paper gives an overview of CDF configurations in use at different industries, research organisations and universities around the world and concludes with a proposal for a relatively a low cost CDF framework based on cloud computing which is particularly suitable for aerospace engineering education. An important aspect of CDF is collaboration between multidisciplinary specialists or virtual specialists within one environment, which requires dedicated hardware or software to exchange file, manage knowledge, collaborative work on writing report, and even remote communicate with other work teams. Emergence and development of cloud computing has made these requirements relatively easy to be fulfilled. Some public cloud computing servers, such as Google Drive, SkyDrive, Dropbox, Mendeley, can be used in CDF to save cost on hardware and software related to data, file, and information exchange. Google Talk and Skype can be used for communication with remote work teams. This CDF framework has many potential benefits, such as reduced cost of hardware, software and support, reduced preparation time, and easy to deploy.

Bryan Moser et al. review risk management as commonly applied in engineering projects, addresses shortcomings, and introduces additional thinking on uncertainty in engineering projects. Despite practices in risk management, unexpected events leading to unacceptable outcomes continue to occur. As practiced, common methods rest upon input and judgement from experts, in particular to evaluate the exposure and systemic effects of risk. Limitations are well known, including errors, disparate use of qualitative measures, biases and overconfidence, prioritization and focus on local effect rather than systemic value, and meaningless combined exposure scores. By viewing the engineering project as a sociotechnical system, we place human expertise not as constraint but as fundamental to the system. Rather than removal of human judgment, we seek to position people to leverage existing judgment within limits of relevance while stimulating attention and learning towards systemically relevant options. The design of projects is proposed that incorporate human attention in identification and response to risks as learning and coordination within the project's broader sociotechnical architecture.

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