**New opportunities: exploiting Concurrent Design tools in the Model Based Systems Engineering Approach**

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Skoltech Concurrent Design Facility (known as Concurrent Design Engineering Lab – CEDL) has been established and in operation ([1]–[3]) since 2014. This work builds on previous experiences developed at the Space Center in the Ecole Polytechnique de Lausanne (EPFL) [4]–[6]. The next steps for the process are in closer integration of techniques in the academic process in the Master in Space and Engineering Systems. In this paper, we will outline the flow of students in our program through the V-diagram, starting from project formulation and stakeholder analysis all the way to implementation and operation of the system. We have also developed relationship with Russian space and aviation industry, however, the road to technology transfer will be difficult.

Concurrent design approach has already found its way into educational practices of many universities. With support of the technological headquarters in ESTEC, educational facilities have been established in ESA Education center in Redu. There is a number of classes offered to students train in tools, approach and procedure. Notable events include PostAlpbach sessions in the fall of 2016 and 2017.

At Skoltech, we aim to give students an experience with full cycle of systems engineering starting from mission formulation and stakeholder analysis, through concurrent design and multidomain optimization (MDO) to introduction to Product Lifecycle Management (PLM), creation of prototype and its operation. The process includes a number of classes (Fundamentals of Systems Engineering, Spacecraft Mission Analysis and Design, Space Sector course and others) as well project oriented activities. During two years of the master program, students participate in a variety of project following CDIO (Create Design Implement Operate) principles culminating in Master thesis. Normally, these projects are implemented as a part of long term projects implemented in the Skoltech Space Center. Currently, MBSE approach is applied to projects related to a small remote sensing drone, stratospheric observation platform and small satellite constellation for scientific purposes.

Both European and Russian industry needs students educated on principles of Model Based Systems Engineering. This approach aims to replace current document cycle with version controlled models that follow the project during all phases. Additionally, Russian government has announced a number of initiatives related to “Digital Economy”. MBSE approach is a perfect industrial application to support renovation of Russian industries. We will also discuss recent significant events in tooling and especially open source projects CEDESK, CDP4 and OpenMBEE [7], [8]. Finally, we will conclude how university processes can drive industrial development, fueled by open source software.

[1] C. Fortin, G. McSorley, D. Knoll, A. Golkar, and R. Tsykunova, “Study of Data Structures and Tools for the Concurrent Conceptual Design of Complex Space Systems,” 2017, pp. 601–611.

[2] A. Golkar, “Concurrent Engineering Design Laboratory: Pioneering Concurrent Engineering in the Russian Federation,” no. SECESA 2014, pp. 1–21, Oct. 2014.

[3] D. Knoll and A. Golkar, “A coordination method for concurrent design and a collaboration tool for parametric system models,” *Concurr. Eng.*, vol. 26, no. 1, pp. 5–21, Mar. 2018.

[4] A. Füglistaler and A. B. Ivanov, “Conception of nano-satellites in a concurrent design environment,” EPFL, Lausanne, 2009.

[5] A. B. Ivanov, V. Gass, M. Richard, S. Rossi, and F. Belloni, “Concurrent design facility in an academic environment,” in *Proceedings of the International Astronautical Congress, IAC*, 2013, vol. 12, pp. 9590–9594.

[6] A. B. Ivanov, L. Masson, and F. Belloni, “Operation of a Concurrent Design Facility for university projects,” in *IEEE Aerospace Conference Proceedings*, 2016, vol. 2016–June.

[7] R. Karban, F. G. Dekens, S. Herzig, M. Elaasar, and N. Jankevicius, “Creating system engineering products with executable models in a model-based engineering environment,” in *Proceedings of SPIE - The International Society for Optical Engineering*, 2016, vol. 9911.

[8] B. Cole and J. Simmons, “An Integrated systems Modeling and analysis platform for flight project work,” in *AIAA Space and Astronautics Forum and Exposition, SPACE 2016*, 2016.