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Virtual product development and production of
all types of electrified vehicles and components

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Written By	Betty LEMAIRE-SEMAIL (ULille) Alain BOUSCAYROL (ULille)	2020-01-10 2020-02-14
Checked by	Daniela CHRENKO (UBFC)	2020-02-25
Approved by	Cristi IRIMIA (SISW) Miroslav NIKOLIC (TY) Alain BOUSCAYROL (ULille) - Coordinator	2020-02-26 2020-02-27 2020-02-27
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Publishable Executive Summary

The objective of PANDA is to provide a disruptive and open-access model organization for an easy interconnection and exchange of models in the development process of EVs, with the goal to help reducing the time to market by 20%, thanks to advanced methods. Indeed, within the W-model process of product development, two testing stages occur, the virtual testing stage which needs off line simulation, and the real testing stage which needs real time simulation. Within the PANDA project, a unified model organisation has to be developed for both stages.

This deliverable is related to the development of a "PANDA" methodology able to unify the organisation for flexible N-level models of electrified vehicles and their components. The objective of this deliverable is to provide a common methodology to PANDA partners in order to develop the simulation of the reference vehicles using a unified model organisation. For that aim, a common approach has been chosen, based on the EMR (Energetic Macroscopic Representation) formalism as a graphical guideline.

The main principles of EMR are pointed out in the deliverable: it is a functional description (not structural), relying on the natural physical causality (i.e. integral causality), and the action-reaction principle. The advantages provided by the respect of the natural causality are reducing the solver computing time during simulation on one hand and one the other hand, to deduce systematically the control structure of the system thanks to the inversion principle. The drawbacks of EMR are linked to the integral causality respect which sometimes induces conflict of subsystems' association, which has to be solved thanks to the physical knowledge of the system. Nevertheless, once this step is performed, the EMR of the system is ready for simulation (and control) with a minimal computing time.

The simulation of a systems is generally a consequence of a modelling action (selection of the main phenomena to consider) and a representation action (organisation of the model). In structural software packages, an integrated approach is generally used mixing modelling, representation and simulation. In the PANDA methodology, these different steps are clearly defined and EMR is used as representation formalism. A key point is that the representation does not interfere with the modelling: a phenomena should not be neglected because of a difficulty to interconnect two different subsystems due to the representation. The so-called conflicts of association should be solved without changing the modelling assumptions but by defining new equivalent functions in a holistic philosophy.

The main idea of EMR is the natural integral causality respect and the PANDA model organization has to follow this rule, whatever the complexity level of the modelling: inputs and outputs have to be chosen in agreement with integral causality. Then, the different existing simulation tools have to be analysed according to this question: is it possible to apply the EMR principle to any of them? As a results, the last part of the deliverable shows two successful examples of system simulation using EMR: one with Matlab-Simulink©, the other with Simcenter Amesim ©, where adapted libraries have been developed in both cases. As a conclusion, EMR and its principles (functional representation, integral causality respect) constitute accurate guidelines and basis for PANDA model organization. Some questions are still to be answered: the main ones are how to cope with the conflict of associations through a generic approach, how to couple the functional libraries with existing structural models without redevelopment, is there a dedicated solver able to speed up the simulation, what about the non-linear behaviours, etc.?

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Table 1: Project Partners

#	Type	Partner	Partner Full Name
1	UNIV	ULille	Université de Lille
2	IND	SISW	Siemens Industry Software SRL
3	UNIV	VUB	Vrije Universiteit Brussels
4	IND	VEEM	VALEO Equipement Electriques Moteur SAS
5	UNIV	UTCN	Universitatea Tehnica Cluj Napoca
6	SME	TY	Tajfun HIL (Typhoon HIL)
7			
8	UNIV	UBFC	Université Bourgogne Franche-Comté
9	SME	UNR	Uniresearch BV
10	IND	RTR	Renault Technologie Roumanie
11	SME	Bluways	BlueWays International bva
12	IND	TUV-BT	TUV SUED Battery Gmh.

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