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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Yaroslav Menshenin

PhD Program: Engineering Systems

Title of Thesis: Model-Based Framework for System Concept

Supervisor: Prof. Edward Crawley

Name of the Reviewer: Prof. Ighor Uzhinsky

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	Signature: *[signature]* **Date: 22-08-2020**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- *Brief evaluation of the thesis quality and overall structure of the dissertation.*

The reviewed dissertation is a well-written scientific paper. Its structure meets the overall logic of the subject covered. The stated scientific objectives of the dissertation have been sufficiently addressed in consistent and logical ways. "In this dissertation, we develop and present a model-based system concept representation framework that encodes the core information about *the* concept at *of the* conceptual design phase." – Page 35.

- *The relevance of the topic of dissertation work to its actual content*

The dissertation's topics are relevant to the presented content. The stated claims are sufficiently discussed and analyzed resulting into relevant conclusions. The proposed approach "... would allow systems engineer to have a concept classification scheme and searchable database, documenting core information about a concept." – Page 35. A MBSE-

based *system concept representation framework* has been proposed, supported by analysis of its ontology and applicability for a number of concrete business cases.

- *The relevance of the methods used in the dissertation*

The methods used in the thesis are relevant to the stated goals and to the selected methodology. A combination of the Object-Process Methodology (OPM) with the Object-Process Diagrams (OPDs) formalization, Object-Process Language (OPL), and the Systems Modeling Language (SysML) were used as a proposed tool-kit for analysis of represented case studies and in support of derived conclusions and recommendations. The Design Structure Matrix methodology was applied for analysis and for comparison of different conceptual design solutions.

- *The scientific significance of the results obtained and their compliance with the international level and current state of the art*

The most significant result of the work is the developed concept representation framework and demonstration of applicability of the proposed tool-kit for analysis of different design concepts. Another important benefit of the work is in its educational value that is, its material can be used as the basis for a course of studies in applications of the mentioned above methodologies, modeling languages, and of the concept analysis tools.

The whole material presented in the paper is up to the current level of the MBSE scope of research in general and within the INCOSE's Model-Based Conceptual Design initiative.

- The relevance of the obtained results to applications (if applicable)

The proposed methodology and approaches are useful for practical applications providing a consistent way for representation of conceptual design solutions.

The proposed approach's value is limited by descriptive character of the methodologies and tools applied. Final selection of the concept is done, usually, not on the basis of its architectural features or its structural representation but on the basis of quantitative assessments of resulting characteristics of a system to be designed. Transition from qualitative description of the analyzed concept to its even high-level quantitative qualification is in the primary interest for any practically applicable conceptual design tool-kit. An example is the incorporated within Dassault 3DEXPERIENCE platform products of NoMagic.

Another issue with practical implementation of the proposed tool-kit is its dependency on intensive and extensive efforts of the user required for obtaining of the resulting conceptual representation. The proposed in several sections of the work introduction of the Machine Learning and Artificial Intelligence tools for automated use of the proposed methodology may help in the future but it seems that there is a long way ahead for practical applications.

- The quality of publications

The list of publications is impressive. The *Systems Engineering Journal* is a Q1/Q2 magazine with about 1 impact factor. Another magazine publication in the *Journal of Space Safety Engineering* is a decent one as well. Particularly beneficial for the author as a scientist in the MBSE area is his participation in multiple international conferences and

presentations with publications in their proceedings. This activity should help the author in his introduction to the scientific community in the chosen area of science and engineering.

- The summary of issues to be addressed before/during the thesis defense

The presented dissertation can be defended in its current form. The work is a complete and a consistent representation of the proposed concept.

I would like to highlight the author's good level of English employed. Despite of some minor issues with articles (a/the) it is an example of a decent vocabulary and literacy that are necessary for any Skoltech-released paper.

Provisional Recommendation

☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*