

Project Title: Development of an Object Process Methodology Matlab Toolbox

Period of Performance: September 1, 2015 to January 31, 2016

Motivation:

One of the key learning objectives of the new MIT System Design and Management (SDM) core class ESD.411/412/413 is for students to learn and be able to model systems using a semantically rigorous set of systems modeling languages and ontologies. There are several such languages that have been proposed and are increasingly being adopted such as UML (software only), SysML (cyber-physical systems) and OPM (general systems). OPM in particular is the main language used to teach systems concepts in Systems Architecture and Engineering at MIT and has been approved as ISO Standard 19450. However, currently the only way that students can generate OPM models is by hand (sketching), using a generic graphics program (e.g. Powerpoint, Visio) or OPCAT. OPCAT exists as a JAVA-based software program, however a professional company no longer supports it and OPCAT-generated models are not easily analyzed and transferred to downstream design activities such as trade studies, detail design (e.g. in CAD) or design optimization. Since Matlab and Simulink have become the de-facto standard for technical computing environments in many industries, there is an urgent need to create a native OPM toolbox in Matlab, with an associated user manual. This toolbox can then be used for teaching in SDM but also used for research theses at MIT.

Requirements:

1. The MATLAB OPM toolbox shall be based on the new ISO/PAS 19450 standard¹
2. The MATLAB OPM toolbox shall be back-compatible with Matlab R2013b and all more recent versions released since then, including the current Matlab R2015a
3. The OPM Toolbox shall be able to represent within it all major elements of OPM including objects, processes, states as well as the various links defined between them.
4. The OPM Toolbox shall be created based on a rigorous object-oriented software engineering approach, including the use of a class hierarchy
5. It shall be possible to generate an OPM model from scratch either by defining it via the command line, importing of a spreadsheet in 'csv' format or by importing a model generated offline in OPCAT (file extension: .opz)
6. It shall be possible to save and export an OPM model in a variety of formats including .mat and .opz, as well as auto-generate a DSM or MDM
7. The toolbox shall have some basic graphical rendering capabilities to show Object Process Diagrams (OPDs) that are auto-generated in terms of their layout.

¹ http://www.iso.org/iso/catalogue_detail.htm?csnumber=62274

8. It shall be possible to manually modify the layout of an OPD in Matlab
9. For multi-layer OPM models it shall be possible to zoom-in and zoom-out of the model to traverse the different layers. Both in-zooming and out-zooming (for processes) and folding and un-folding (for objects) shall be enabled
10. Each function in the Matlab OPM toolbox shall have consistent header formats and help information, consistent with typical Matlab best practices
11. A short user manual with a running example shall be provided in PDF and html formats upon delivery of the toolbox.

Note: A number of functions available in the current version of OPCAT are not necessary for v1.0 of the Matlab OPM toolbox. These include the ability to dynamically animate an OPM model as well as the auto-generation of Object Process Language (OPL). However the toolbox should be created in such a way that such capabilities could be added in future versions.

Schedule:

September 1, 2015	Project Start and Kickoff Meeting
November 1, 2015	Mid-Term Update Presentation (45 min)
December 31, 2015	Completion of v1.0 Matlab Toolbox
January 13, 2016	Delivery and First use during IAP (ESD.412)
January 31, 2016	Final Presentation (45 min)

Funding: The development of this OPM toolbox will be funded by the SDM program as a research assistantship (RA). It is considered as development of teaching materials for the new SDM core

Researchers: PI Prof. Olivier de Weck
 Research Assistant (RA): Sydney Do, PhD candidate MIT Aero Astro
 The expected workload for this RA is 20 hrs/week.
 We will consult with Prof. Dov Dori during this effort.

Key References:

1. Dori, Dov. Object-Process Methodology: A Holistic Systems Paradigm; with CD-ROM. Vol. 1. Springer Science & Business Media, 2002.
2. ISO/PAS 19450 Standard (Final Draft Attached), 2015
3. Dori, Dov, Iris Reinhartz-Berger, and Arnon Sturm. "OPCAT-A Bimodal Case Tool for Object-Process Based System Development." ICEIS (3). 2003.
4. Grobshtein, Yariv, et al. "Systems modeling languages: OPM versus SysML." Systems Engineering and Modeling, 2007. ICSEM'07. International Conference on. IEEE, 2007.
5. Sharon, Amira, Dov Dori, and Olivier De Weck. "Model-based design structure matrix: deriving a dsm from an object-process model." Second International Symposium on Engineering Systems. 2009.

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