



2021
Annual **INCOSE**
international workshop
Virtual Event
January 29 - 31, 2021

MBSE Workshop - Production and Logistics Systems Modeling Challenge Team



Currently Active Contributors

ARLIS, UMD

- Tim Sprock, ~~NIST~~: lead on “theory”; contributing everywhere
- Conrad Bock, NIST: technical guru
- George Thiers, ~~MBSE Tools, Inc~~: lead on analysis integration
Fortna Inc
- *Leon McGinnis*, Georgia Tech: lead on “cases”
- Greg Pollari, Eugenio Rios, Collins Aerospace: contributing case study, industry perspective



Other Industry Participants

- Peter Coleman (Airbus)
- Darold Davis (Replicant-AD)
- Emmanuelle Garcia (Airbus)
- Bob Malone (Boeing)
- Lindsey Maso (Boeing)

Production and Logistics Systems Modeling Challenge Team



Increase the availability of reference models, awareness of these models and methods, and successful use of MBSE in the production, logistics, and industrial engineering communities.

Specific challenges in providing a foundation for production and logistics [systems] engineering are the lack of:

- Standard reference models
- Well-structured engineering design methodologies
- Integrated analysis models and tools available to support design and operational decision-making.

<http://www.omgwiki.org/MBSE/doku.php?id=mbse:prodlog>



What has been our focus?

- Foundation -- reference models, semantics
- Application Modeling -- best practices
- Analysis Integration/Automation

In the production and logistics systems domain!





Acknowledgements

- Collins Aerospace
- McKesson High Value Solutions
- NIST
- Boeing
- Airbus
- Physical Internet Center, GaTech
- MBSE Tools, Inc.





Framework

- Discrete-event logistics systems semantics
- RFLP design methodology
- Systems Analysis Integration



Summary of P&L-related Products



- DELS SysML Model Libraries
 - <https://github.com/usnistgov/DiscreteEventLogisticsSystems>
- Documentation of SysML Model Libraries
 - <https://doi.org/10.6028/NIST.IR.8262>
- Central Fill Pharmacy Case
 - <https://doi.org/10.6028/NIST.GCR.19-022>
- MBISE Playbook – How to apply DELS model libraries
 - Overleaf (DRAFT): <https://v2.overleaf.com/read/rsjqhqzmxtxq>
- Electronics Assembly Case
 - <https://github.com/usnistgov/DiscreteEventLogisticsSystems/blob/master/ElectronicsAssemblyCaseStudy.html.zip>
- Reference Implementation of SAI (Matlab)
 - <https://github.com/usnistgov/dels-analysis-integration>
 - <https://doi.org/10.6028/NIST.IR.8326>

SysML Model Libraries

Two libraries focused on today:

- *Network Abstractions*
- *DELS Abstractions*

usnistgov / DiscreteEventLogisticsSystems Private

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25 commits 1 branch 0 releases 1 contributor GPL-3.0

Branch: master New pull request Create new file Upload files Find File Clone or download

timothysprock Update README.md Latest commit df47595 a minute ago

.gitattributes	.git and readme files	2 years ago
.gitignore	.git and readme files	2 years ago
CentralFillPharmacy.mdzip	Offloaded Functional Arch Package	6 months ago
DELS_ReferenceModel.mdzip	updates to flow and process networks	17 minutes ago
DiscreteEventLogisticsSystems.mdzip	Offloaded Functional Arch Package	6 months ago
Functional_Architecture.mdzip	Offloaded Functional Arch Package	6 months ago
LICENSE.md	Update LICENSE.md	2 years ago
Manufacturing_RefArch.mdzip	Tim Push Misc Changes	8 months ago
README.md	Update README.md	a minute ago
SupplyChain_RefArch.mdzip	updates to flow and process networks	17 minutes ago
TokenFlowNetwork.mdzip	updates to flow and process networks	17 minutes ago
Warehouse_RefArch.mdzip	Offloaded Functional Arch Package	6 months ago

<https://github.com/usnistgov/DiscreteEventLogisticsSystems>

DELS Model Libraries Documentation

Documentation:

<https://doi.org/10.6028/NIST.IR.8262>

Detailed development of the DELS semantics and syntax, from the most abstract level to the application to production and logistics.

NISTIR 8262

Theory of Discrete Event Logistics Systems (DELS) Specification

Timothy Sprock
George Thiers
Leon F. McGinnis
Conrad Bock

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.IR.8262>

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce



Formalizing ISA-95 Level 3 Control with Smart Manufacturing System Models

Prepared for
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School of Industrial and Systems Engineering

September 2019

Report—current version—is 75 pages, with 72 illustrations. The companion SysML model has 72 diagrams, 88 activities and 151 blocks.

Shows how the SysML models can be used to support operational control system modeling and design. Relationship between DELS and ISA-95.

Report Available Here:

<https://doi.org/10.6028/NIST.GCR.19-022>

Models Available Here:

<https://github.com/usnistgov/DiscreteEventLogisticsSystems/blob/master/CentralFillPharmacy.mdzip>



Model-Based Systems Engineering
Applied to a Hypothetical
Composite Wing Production System

Leon McGinnis
Georgia Institute of Technology
Atlanta, GA 30332

January 15, 2020

Document Version: 1.0
Tool Version: MagicDraw 18.5 sp3
Modeling Language Version: SysML 1.4, UML 2.5

Report—current version—is 90 pages, with 74 illustrations. The companion SysML model has 5 tables, 64 diagrams, 36 activities and 215 blocks.

MBSE approach to modeling composite parts production and assembly, with integrated capacity analyses.

Companion SysML, Simio and QN models available upon request.

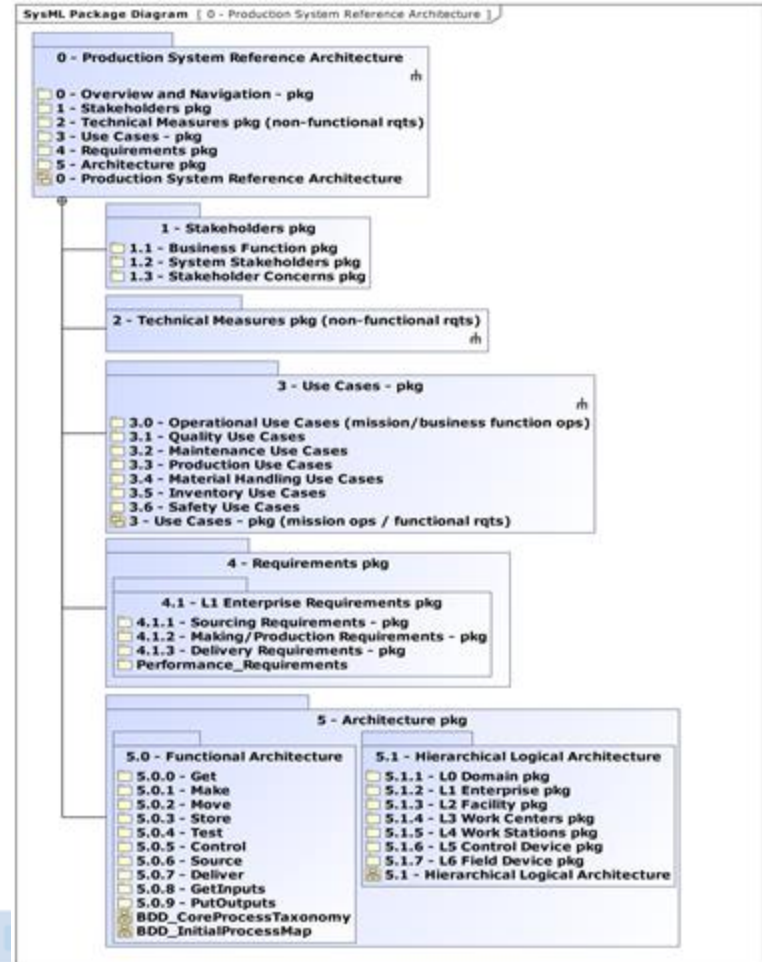
Electronics Assembly Case Study



MBSE modeling targeted at a specific product, process, resources and facility.

Beginning of a set of system models useful for design, (re-) design, and operational decision-making in PCCA.

<https://github.com/usnistgov/DiscreteEventLogisticsSystems/blob/master/ElectronicsAssemblyCaseStudy.html.zip>



Analysis Integration

- Integrate several analysis toolboxes (Matlab)
 - Optimization: CPLEX, OPTI, Genetic Algorithm (MOEA)
 - Queuing network analysis
 - Newsvendor Network analysis (stoch opt)
 - Discrete-event simulation (SimEvents)
- Two test cases
 - Supply chain to flow network optimization to discrete event simulation (multi-fidelity)
 - DELS to queuing network to discrete event simulation
 - (PLANNED) Discrete Manufacturing Example
- Related Projects:
 - Model-based simulation optimization interoperability
 - Repeatable/reusable methods of building discrete event simulation models

The screenshot shows the GitHub interface for the repository 'usnistgov/dels-analysis-integration'. At the top, there are navigation links for Code, Issues, Pull requests, Projects, Wiki, Insights, and Settings. Below this, it states 'No description, website, or topics provided.' and 'Manage topics'. The repository statistics show 33 commits, 1 branch, 0 releases, 1 contributor, and a GPL-2.0 license. There are buttons for 'New pull request', 'Create new file', 'Upload files', 'Find File', and 'Clone or download'. A recent commit by 'timothysprock' is highlighted, showing a merge pull request #4 from 'usnistgov/AddSmartController'. Below the commit list, there is a table of files in the repository:

File Name	Description	Time
AnalysisLibraries	move routing to flowNetworkBuilder class	9 days ago
Classdefs	fixed bugs in process network simulation generation	4 days ago
MiscCode	Add files via upload	a month ago
UseCases	Merge pull request #2 from usnistgov/RefactorflowNetwork2OPT	4 days ago
UtilityFunctions	Add files via upload	a month ago
.gitattributes	Add files via upload	a month ago
.gitignore	Add files via upload	a month ago
License	Add files via upload	a month ago
README.md	Update README.md	a month ago

<https://github.com/usnistgov/dels-analysis-integration>

Disclaimer: Far less mature w/ limited documentation



Other Applications

At Georgia Tech, DELS semantics and MBSE methods currently used in large scale research projects addressing:

- Robotic logistics hub concepts
- Innovative new car distribution logistics





Summary

- Production and logistics *needs* the benefits from MBSE in both system design and system operational control.
- The Challenge Team has made significant progress in both demonstration and technology development.
- Much remains to be done.





Hiatus

The challenge team has made significant progress over the past three years, but job changes have removed the most active contributors. Until new leadership appears, we are in hiatus. If you are interested, contact:

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www.incose.org/IW2021