



# OpenMBEE

Open Model-Based Engineering Environment

**Connected engineering  
information for a  
connected world**

**Robert Karban, Chris Delp**

*Jet Propulsion Laboratory, California Institute of Technology*

[OpenMBEE.org](http://OpenMBEE.org)

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.

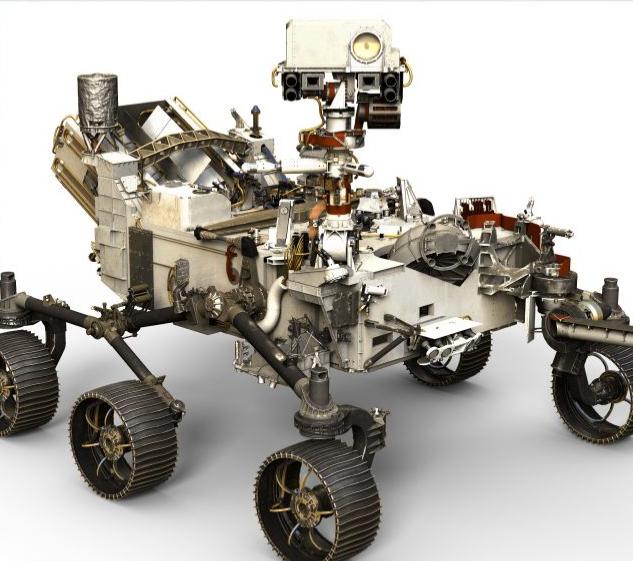
The views and opinions of contributors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.



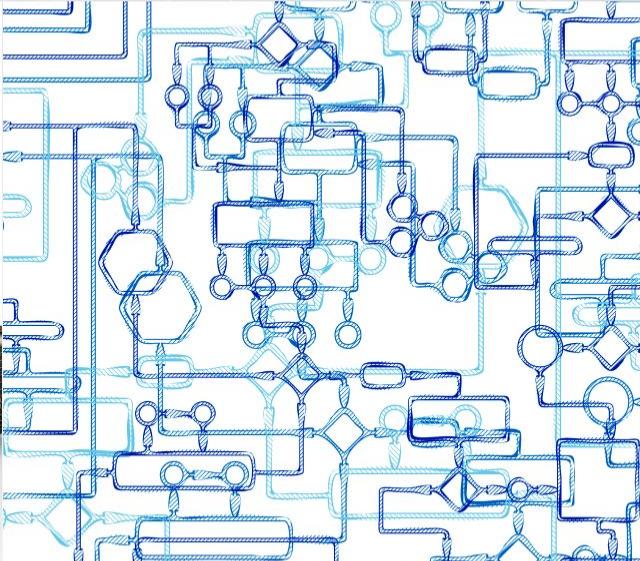
**Systems Engineers guide the  
concurrent collaborative design  
of complex technical systems**



**Leadership**



**Architect and Design  
Cyber-Physical Systems**



**Manage Complexity**

# Flight project teams are large



# A project starts simple



# Engineers iterate on their models



# Systems engineers enter this data into their rollup



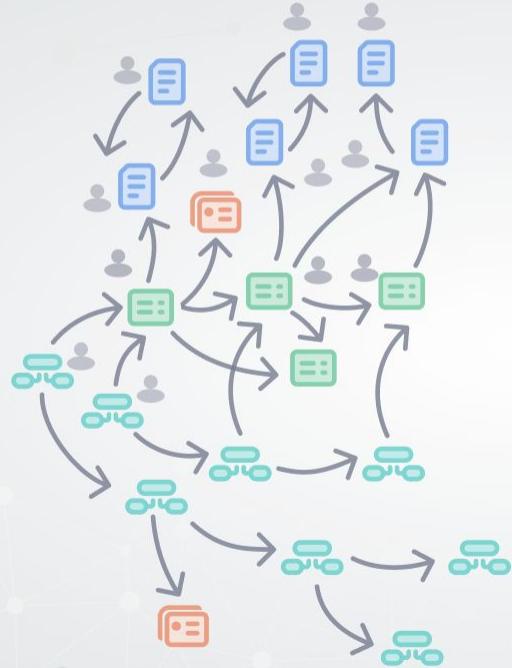
# They add it to a document and get inputs from others



# And add it to a spreadsheet to track it over time



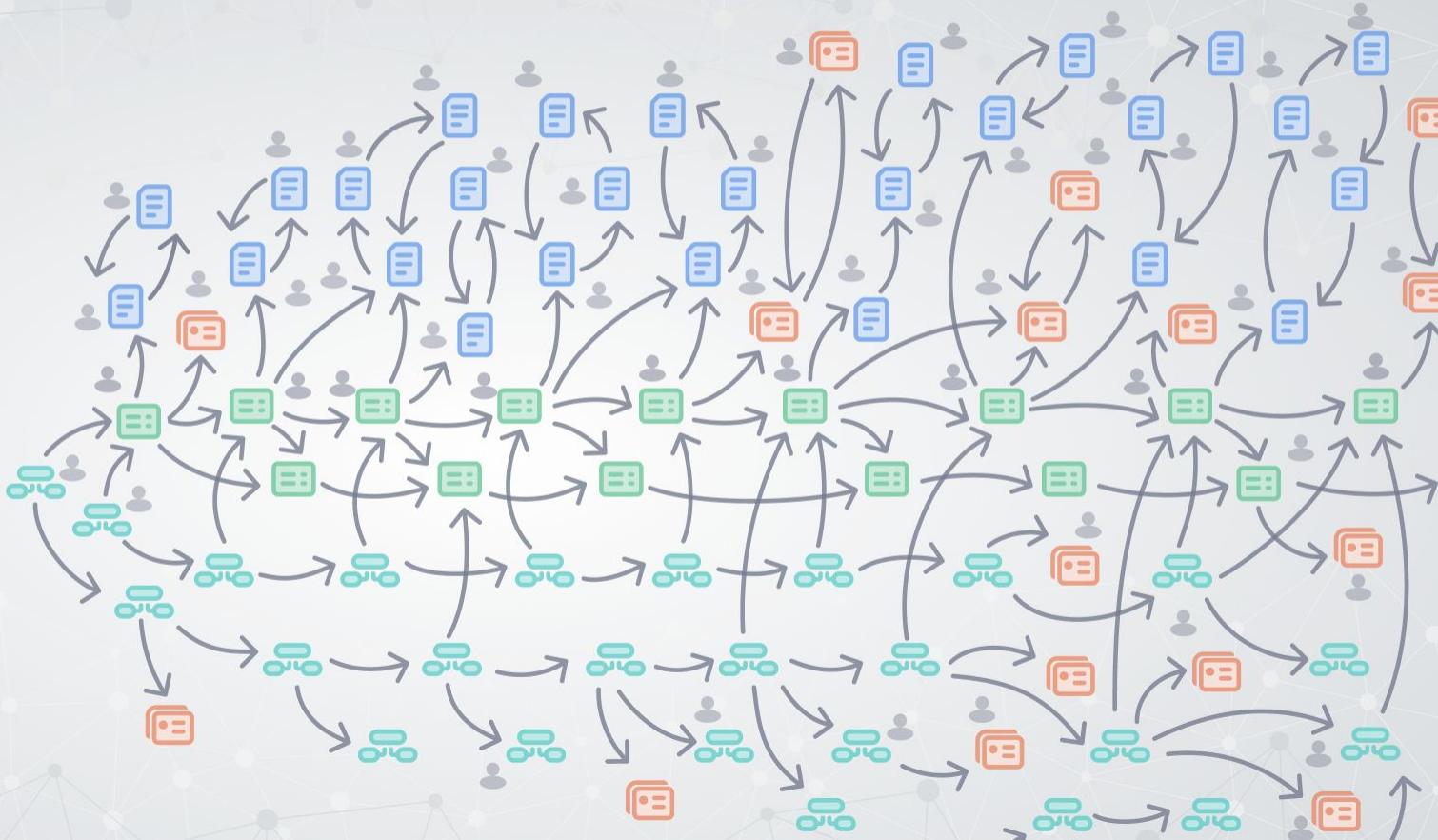
# It can get complicated quickly



# It can get complicated quickly



# It can get complicated quickly



# And become overwhelming...





**Most of my job is data entry.  
I want to do REAL ENGINEERING.**

JPL Systems Engineer



**Using engineers as information  
janitors isn't the best use of  
their skill.**

JPL Systems Engineer

# Real engineering vs. overhead



Repetitive Data Entry

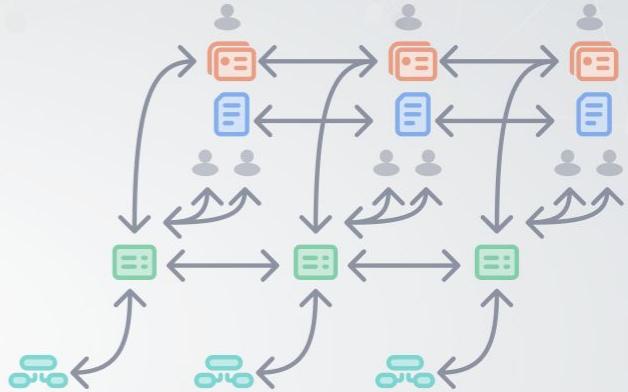
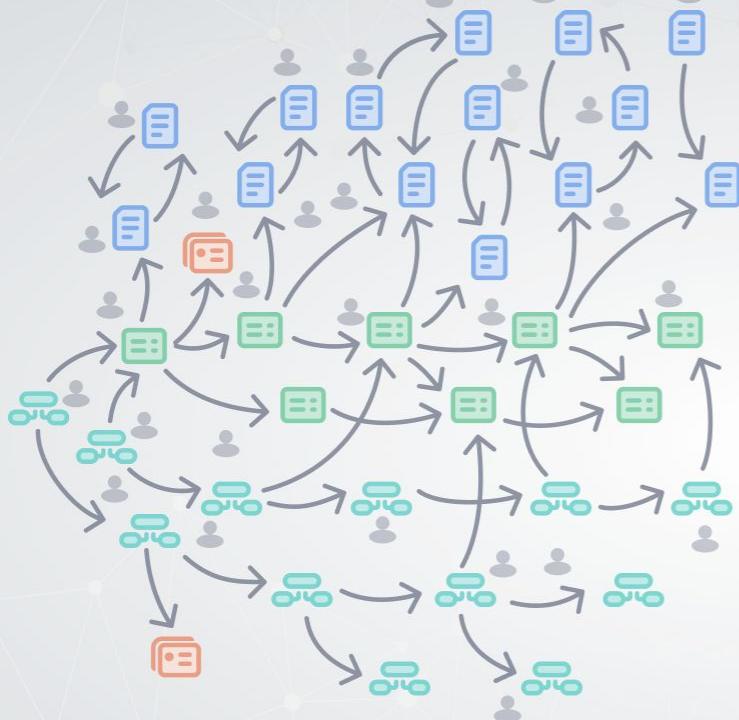


Version Confusion

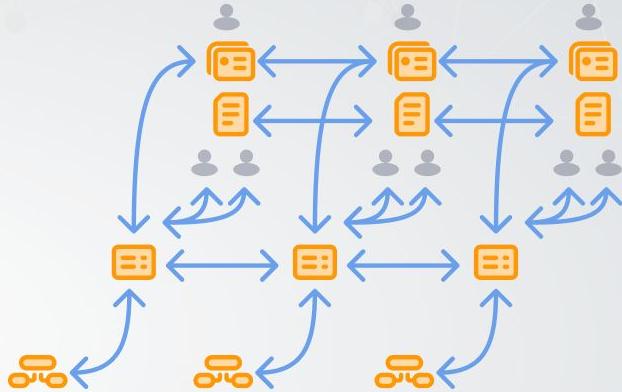


Constant Searching

# A better way...



# A better way...



# Connected information, connected engineers





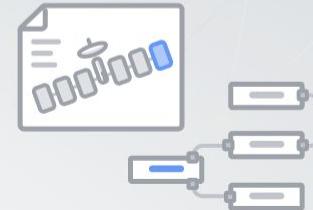
100% **JPL**  
Core Components



**Model Management System**



**View Editor & Platform  
for Model Analysis**



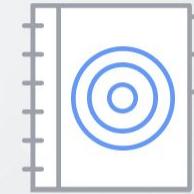
**Model Development Kits**



**Documentation  
and Training**



**Thirty Meter  
Telescope Model**



**OpenSE Cookbook**

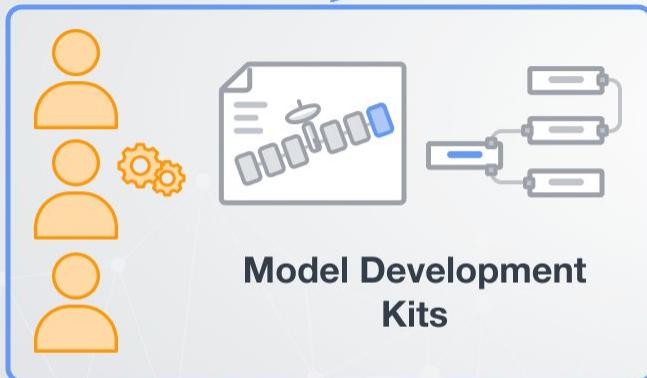


OpenMBEE

Thirty Meter  
Telescope  
Model



Authoritative  
Source



Engineering Modeling

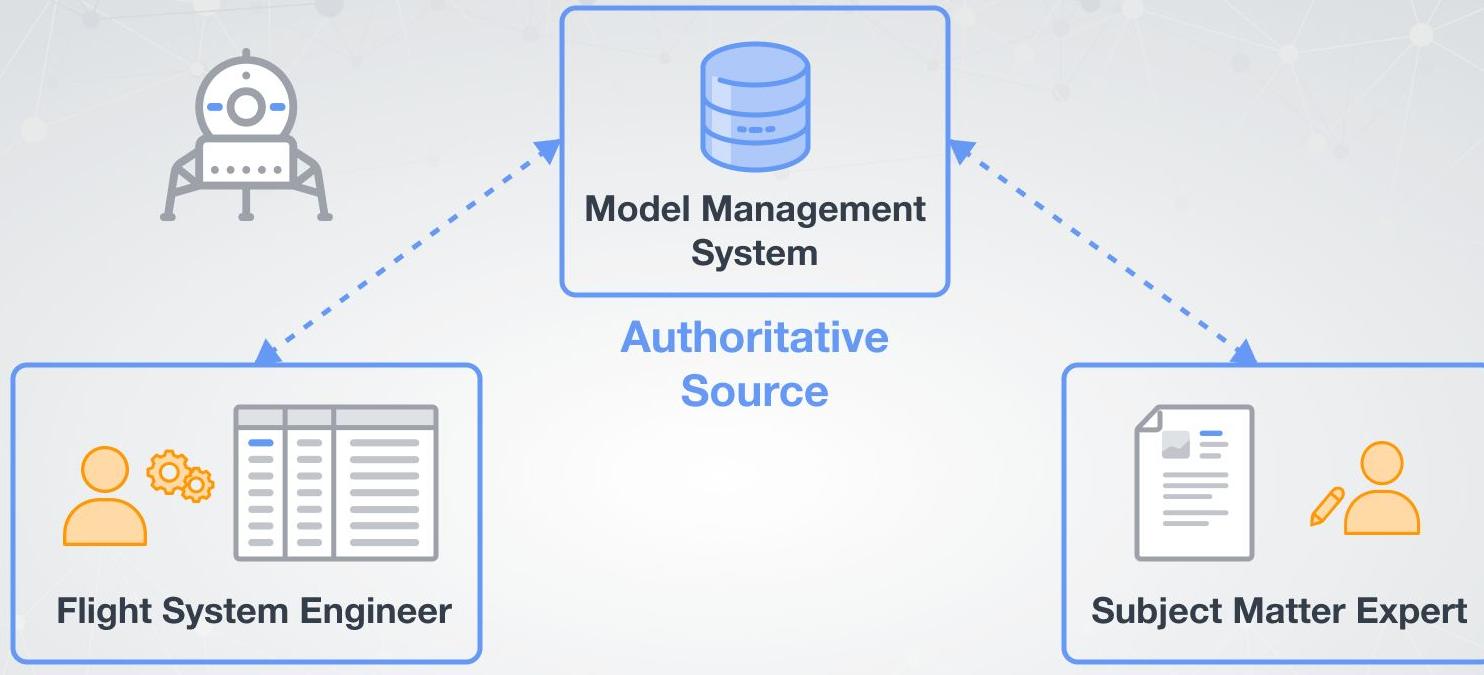


OpenSE  
Cookbook



Document Authoring

# Master Equipment List



# Demo



# OpenMBEE adopters and contributors



## NASA

Mars 2020  
Europa Clipper  
ARRM  
Mars Sample Return  
MAIA  
SWOT  
NASA Pathfinder  
Europa Lander



## Science & Engineering

Thirty Meter Telescope  
Japan Aerospace Exploration Agency  
Stevens Institute of Technology  
Systems Engineering Research Center  
Georgia Tech Research Institute  
Georgia Tech Aerospace Systems Design Laboratory



## Industry

Boeing  
Ford Motor Company  
Lockheed Martin Corporation



## Standards

Object Modeling Group  
INCOSE



## Vendors

Dassault Systemes  
IncQuery Labs  
Capella  
Intercax  
Tom Sawyer  
Phoenix Integrations  
Maplesoft

# Flight Project Impact: Reduction of Overhead



Europa Clipper

**100**

Concurrent users



**230+**

Documents and decision  
gate deliverables including



**445,000**

Connections between elements





“

**The Mass and Power Equipment Lists produced by the model provided crucial support to the key mission architecture trades... A key enabler of this modeling capability came from components of OpenMBEE.**

Todd Bayer, Flight System Engineer, Europa Clipper/JPL

”

# Flight Project Impact: Technical Rigor



Mars 2020

50

Concurrent users



90+

Documents and decision  
gate deliverables including



Reference Designator List



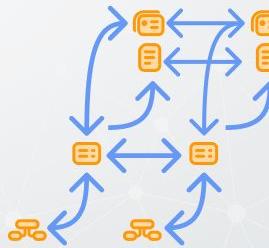
Electrical Function List



Electrical Functional Block Diagram

180,000

Connections between elements





“

**...documents that were shared with the entire project and were used as the authoritative source of truth for key FSSE deliveries such as the: Reference Designator List, Motor MUX table, Electrical Function List.**

---

Elyse Fosse, Mars2020 Flight System and Mission System Systems Engineer

”

# International Standards Impact: Digital Transformation



OBJECT MANAGEMENT GROUP®



Systems Modeling  
Language V2

60+

Organizations

30

Contributors

100+

Consumers

6

Documents  
including



SysML v2 RFP



SysML v2 Submission



SysML 1.x Specification

10,212

Connections between elements





The capability that OpenMBEE provides is helping to dramatically shape the direction of MBSE, and is turning out to be a critical enabler of MBSE as part of the digital transformation.

Sanford Friedenthal, Founder of SysML, INCOSE representative and Systems Engineering domain-specific interest group lead at Object Modeling Group

# Aerospace Industry Impact: Enterprise Scalability



**1,000**

Concurrent users



**50**

Programs

**100**

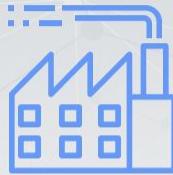
Concurrent users

**50**

Projects



“



**The architecture of OpenMBEE proves to be enterprise scalable and has so far greatly satisfied our operational needs.**

---

Brittany Friedland, John Herrold, Barry Overcash  
Systems Engineering Architects  
The Boeing Company

”

# Academia Impact: Inter-Organizational Collaboration



## NAVAIR Model-Based Acquisition Strategy

- Surrogate Pilot RFP delivered to NAVAIR
- Data Item Descriptions (DIDs)
- Contract Data Requirements List (CDRL)

A screenshot of the "Surrogate Pilot RFP Response in View Editor" software interface. It shows a navigation tree on the left with items like "Introduction", "Technical Description", and "Requirements". In the center, there is a 3D model of a propeller-driven aircraft labeled "Tiltrotor/CRStructure".

A screenshot of the "Transform CDRLs and DIDS using Digital Signoff in Model Through View Editor" software interface. It shows a "Digital Signoff" section with a list of steps: "1) Enable Editing", "2) Add Risk", and "3) Add Approval Status". Below this, there is a "Digital Signoff get pushed back into Model (continuing theme of AST)" section.



---

**...use OpenMBEE View and Viewpoints as a means for placing a Digital signoff directly with model information that provides the needed evidence.**

---

Mark Blackburn, Senior Research Scientist at Stevens/SERC,  
Key enabling research on proving MBSE and MBEE for US Navy



# Intra-Organizational Environment Today



# Inter-Organizational Concept



# Mars Sample Return Concept



# Global Engineering Ecosystem Vision



**Connected engineering information  
for a connected world**



# OpenMBEE

Open Model-Based Engineering Environment

## Questions?