Bidirectional Graphical Modelling
Supporting Concurrent Spacecraft Design

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Motivation: Data Model and the References

Hierarchical decomposition

Focus for diagrams
### Current State

#### Output Parameters of this System Component

<table>
<thead>
<tr>
<th>Name</th>
<th>Current Value</th>
<th>Unit</th>
<th>Shared</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_p$</td>
<td>207.88</td>
<td>kg</td>
<td></td>
<td>yes</td>
<td>mass of the required propellant</td>
</tr>
<tr>
<td>$\Delta v$</td>
<td>165.00</td>
<td>m/s</td>
<td></td>
<td>no</td>
<td>required change of velocity to fulfill the mission</td>
</tr>
<tr>
<td>$c_0$</td>
<td>23000.00</td>
<td>m/s</td>
<td>yes</td>
<td>no</td>
<td>exhaust speed of the nozzle</td>
</tr>
<tr>
<td>$m_0$</td>
<td>30000.00</td>
<td>kg</td>
<td>yes</td>
<td>no</td>
<td>total mass of the system (launch mass)</td>
</tr>
<tr>
<td>$p_{BH}$</td>
<td>1008.00</td>
<td>kg/m³</td>
<td>no</td>
<td>no</td>
<td>density of hydrazine</td>
</tr>
<tr>
<td>$p_{burst}$</td>
<td>52000000.00</td>
<td>Pa</td>
<td>yes</td>
<td>no</td>
<td>burst pressure of the tank</td>
</tr>
</tbody>
</table>

#### Calculations for this System Component

<table>
<thead>
<tr>
<th>Calculation Type</th>
<th>System-Component</th>
<th>Parameter</th>
<th>Current Value</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math - Assign</td>
<td>MissionAnalysis</td>
<td>$\Delta v$</td>
<td>165.00</td>
<td>m/s</td>
<td>required change of velocity to fulfill the mission</td>
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</table>
Inspiration

External tools

Not synchronized automatically

Good Overview

Improve Understanding and Communication

Repetitive update work

Standardized Notations / Symbols

Not Model-based!
Quasi standard data model
No calculations
But subscriptions
Only recently available
Not in our tool!
Improved Systems Engineering with Diagrams

- Filtering / layouting
- Bidirectional Graphical Modeling
- Integrated in process and tool
- Synchronized
- Dependency visualization
- User friendly
- For early phases!
Interface Diagram

MissionAnalysis

\[ \Delta v \]

Discipline providing the inputs

Input Ports

Propulsion

requirement from external

Disciplines requiring the outputs

Output Ports

System

\[ m_p \]

\[ V_t \]

\[ p_{burst} \]

Structure

Disciplines requiring the outputs

Output Ports
Internal Block Diagram

$\Delta v \rightarrow m_p \rightarrow V_t$

**Flow**

**Internal Parameters**

**Calculations**
Functional Block Diagram

Dependencies

Subsystem level
Implementation and Used Technologies

Graphiti

eclipse

etricle

Welcome to the KIELER Project
Integration in the Software

Create Commands

Tooltips

Automatic Update

Property View
Summary

Bidirectional Graphical Modeling

Integrated in process and tool

Synchronized

Filtering / layouting

Dependency visualization

( User friendly )

For early phases!

Basic
Questions?

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