

Simulation of Satellite mission using integrated MBSE

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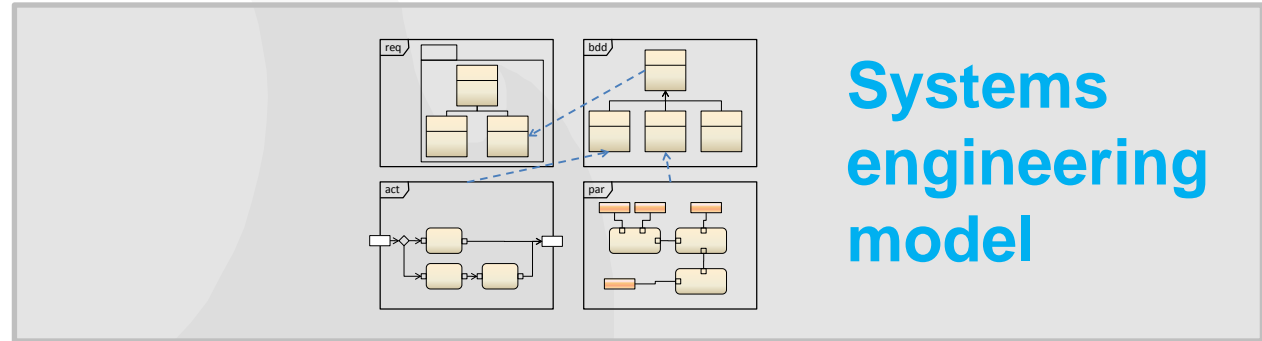


PHOENIX
INTEGRATION

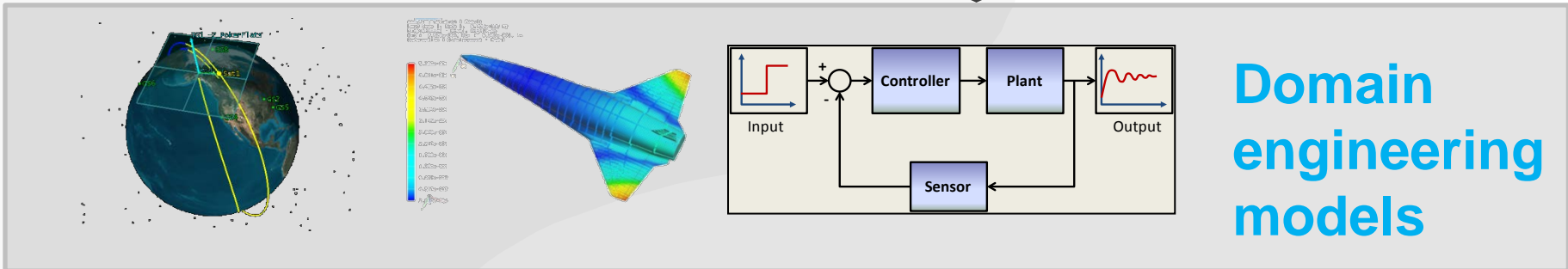
DESIGNPROCESSOPTIMIZATION

Gap Between Systems Engineering and Engineering Analysis

- SysML models are descriptive in nature
- Tools, models, and terminology are different
- The gap causes inefficiencies and errors



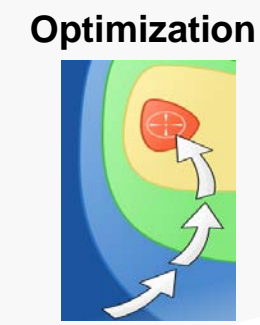
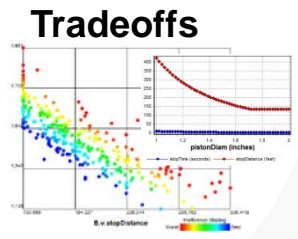
- *Error Prone*
 - *Slow*
 - *Expensive*
 - *Unresponsive to Changes*



MBSE Pak

System Architecture Model

SysML clients



CAD

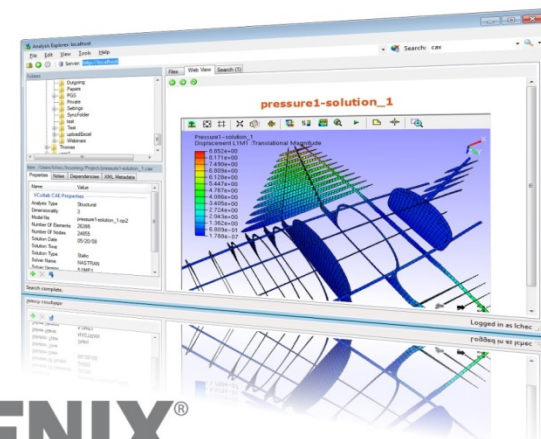
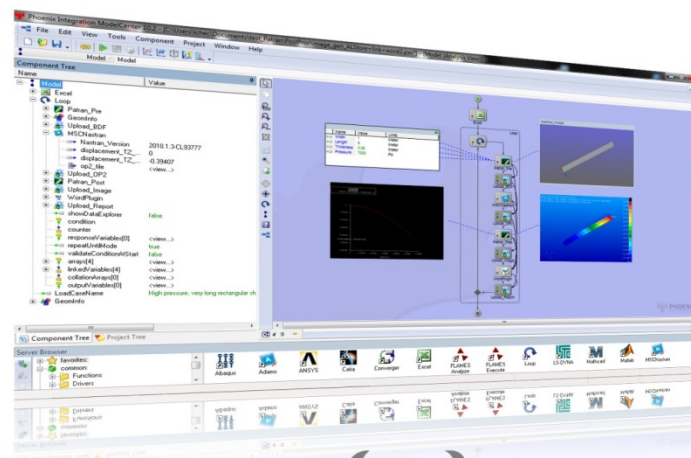
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Analytics

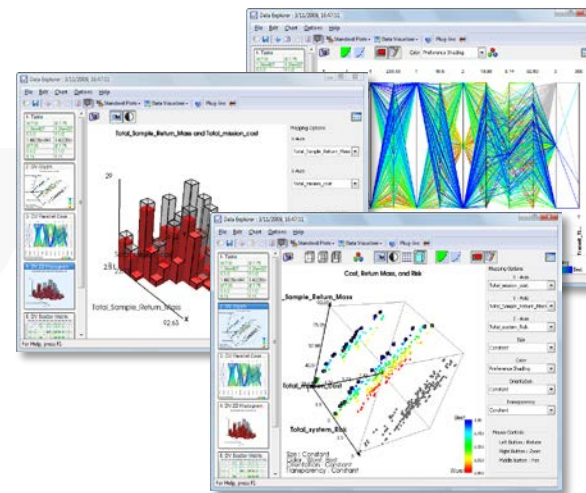
CAE

Mod&Sim

In-House app


PHOENIX
 INTEGRATION

1. Create Models
2. Generate Data
3. Interpret Results

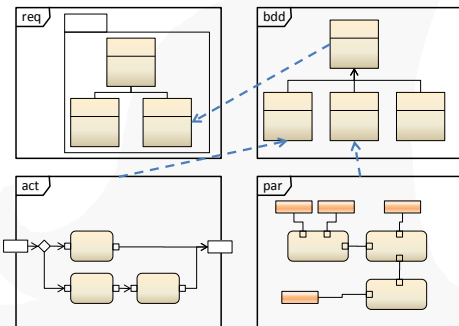
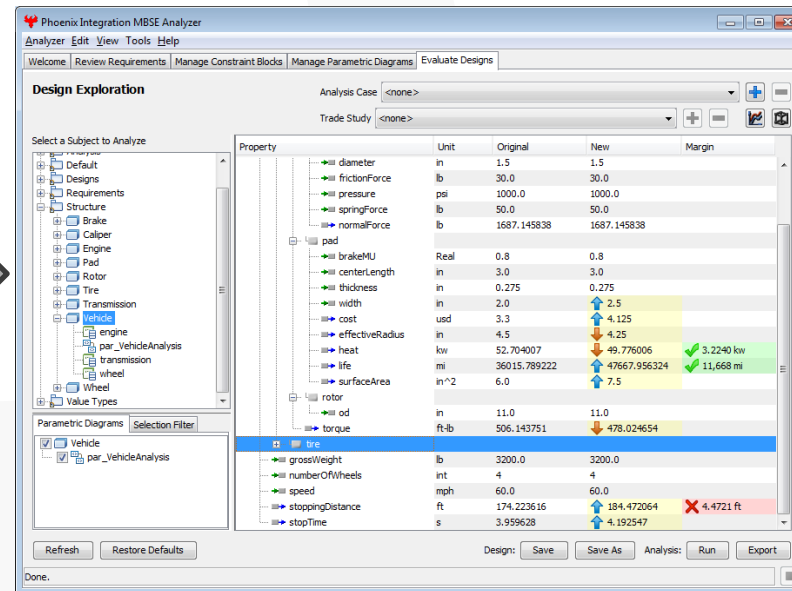


- Visual environment for process integration
- Graphically link analyses together
- Automatically transfer data from analysis to analysis
- Reduce data transfer errors
- Save time
- Perform trade studies to find better designs
- Optimization framework

MBSE Pak

MBSE Pak

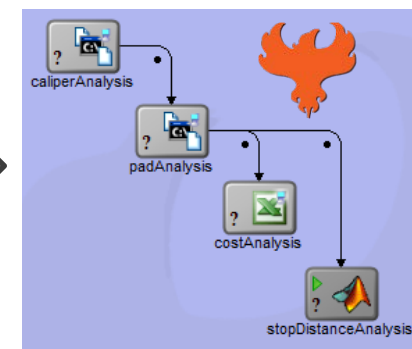
System Architecture Model

Property	Unit	Original	New	Margin
diameter	in	1.5	1.5	
frictionForce	lb	30.0	30.0	
pressure	psi	1000.0	1000.0	
springForce	lb	50.0	50.0	
normalForce	lb	1687.145838	1687.145838	
brakeMU	Real	0.8	0.8	
centerLength	in	3.0	3.0	
thickness	in	0.275	0.275	
width	in	2.0	2.5	
cost	usd	3.3	4.125	
effectiveRadius	in	4.5	4.25	
heat	kw	52.704007	49.776006	3.2240 kw
life	mi	36015.789222	47667.956324	11,668 mi
surfaceArea	in^2	6.0	7.5	
rotor				
od	in	11.0	11.0	
torque	ft-lb	506.143751	478.024654	
grossWeight	lb	3200.0	3200.0	
numberOfWheels	int	4	4	
speed	mph	60.0	60.0	
stoppingDistance	ft	174.223616	184.472064	4.4721 ft
stopTime	s	3.959628	4.192547	

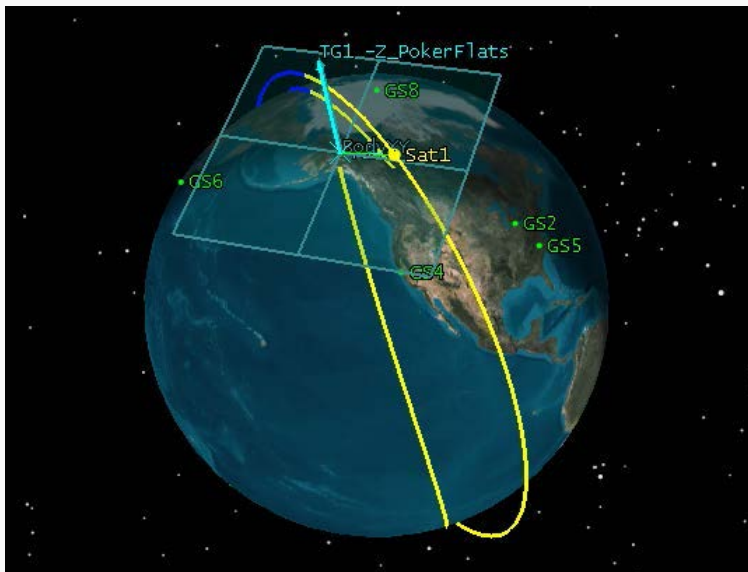
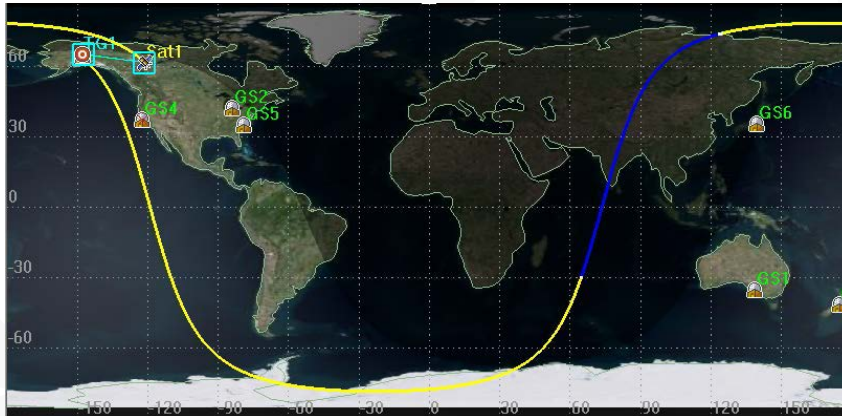


Analytical Models



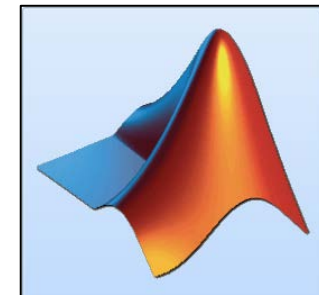
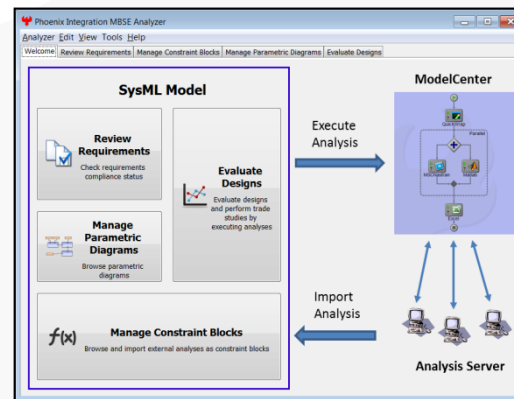
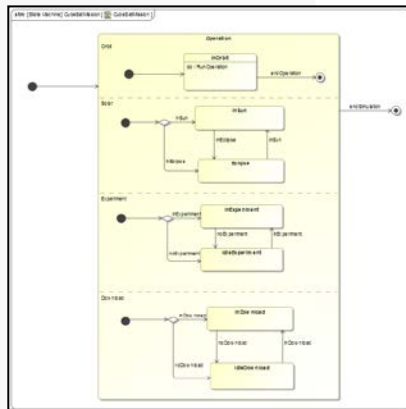
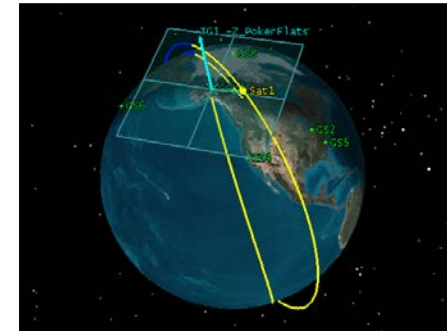
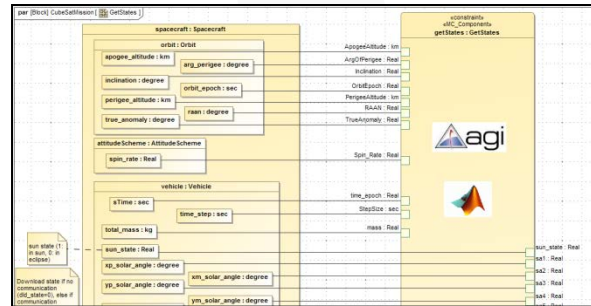
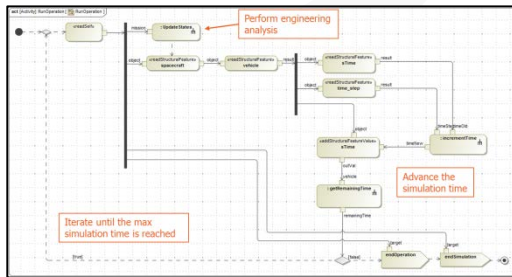
- MBSE Pak connects system architecture models with analytical models
- Enables systems engineers to
 - Evaluate system performance using modeling and simulation
 - Perform requirements compliance analysis
 - Perform system trade-off studies

CubeSat Example



- Science mission of a miniature satellite
- STK was used to calculate trajectory and access information
 - Solar state
 - Access to experimental zone
 - Access to ground station for data download
- Model should answer questions such as:
 - How does the satellite perform during the course of the mission?
 - How would changes in design/mission parameters impact the mission?
 - Does the satellite meet all mission requirements?

Perform Mission Simulation



MagicDraw CST
(Behavioral diagrams)

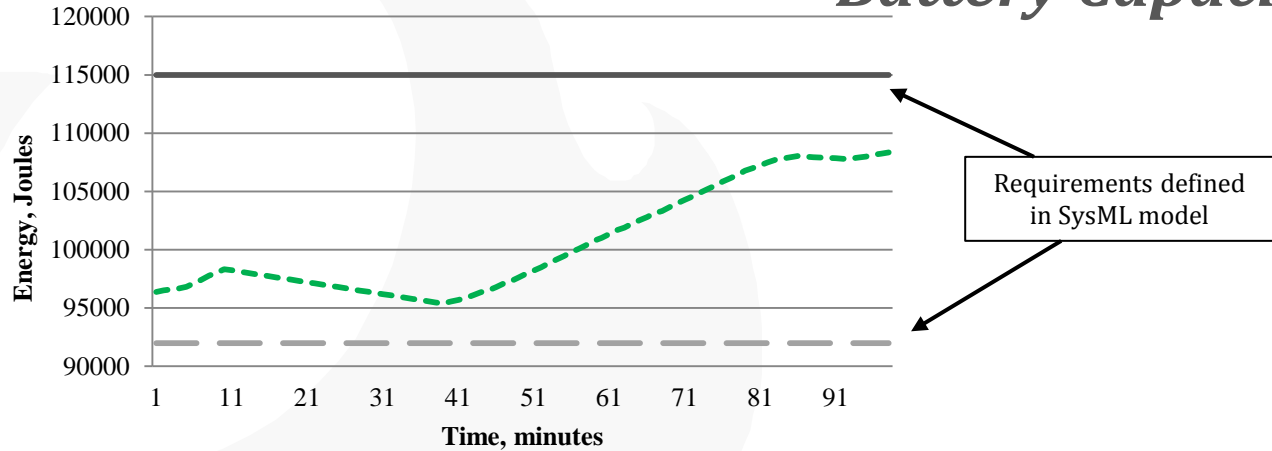
MBSE Analyzer/ModelCenter
(Parametric diagrams)

STK, Matlab, etc.
(Analytical models)

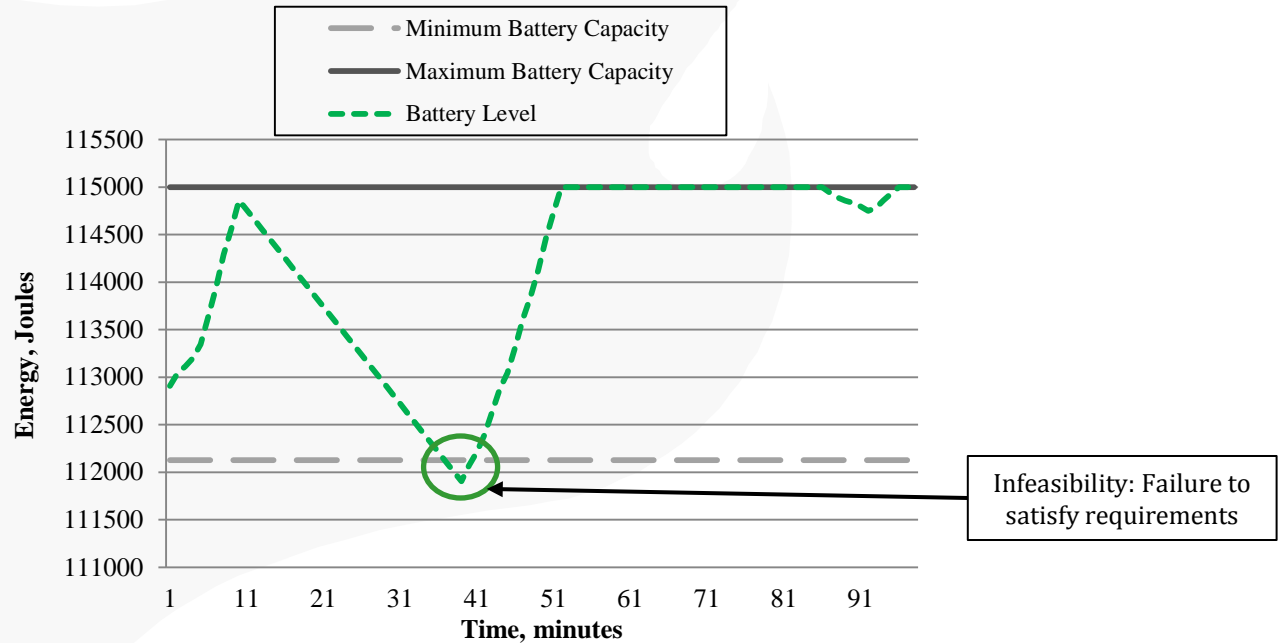
Mission and Design Trade-Offs

Battery Capacity

**Nominal
Battery
Capacity**



**1/8 Battery
Capacity**



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