AIAA
The World's Forum for Aerospace Leadership

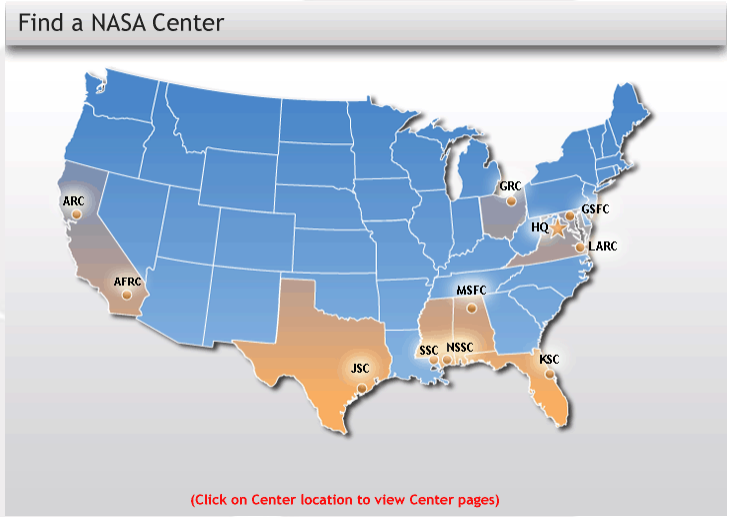
CASE
Complex Aerospace Systems Exchange

Collaborative Engineering in a Large Geographically Distributed Organization

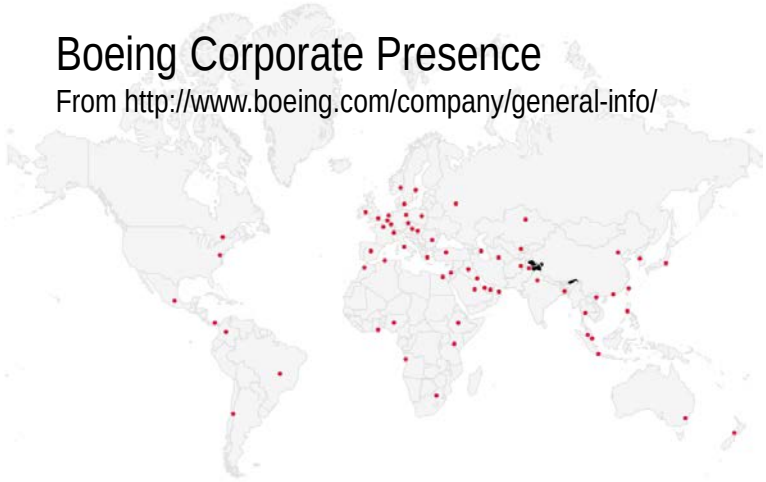
Session: Digital System Integration (DSI) Across a Full Lifecycle

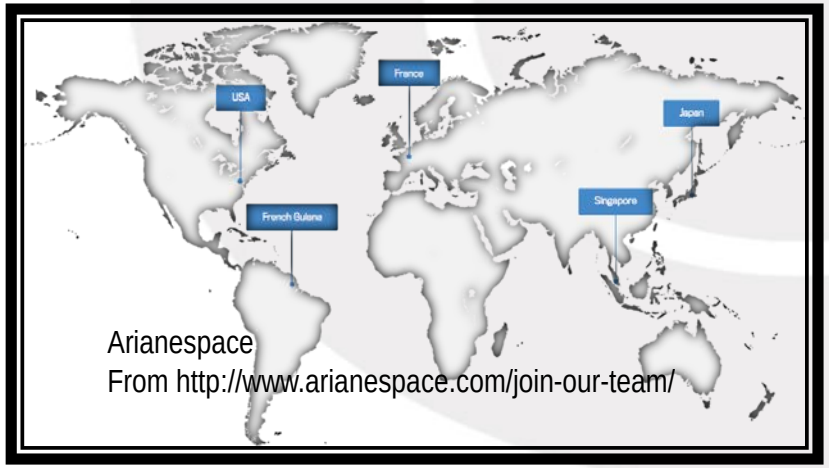
State of the Art

- Many organizations are geographically distributed
  - Nationally
    - Government Agencies
    - Corporations
  - Internationally
    - Multinational ventures
    - Corporations
- Even small businesses often support customers located in different geographical locations
- Engineering projects are distributed across many locations

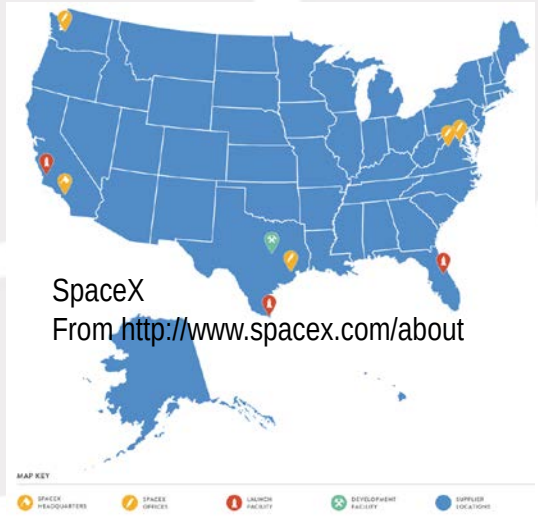


Boeing Corporate Presence
From http://www.boeing.com/company/general-info/





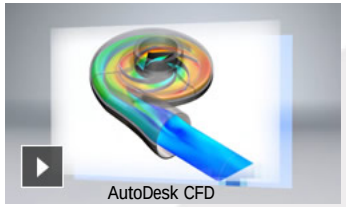
Arianespace
From http://www.arianespace.com/join-our-team/

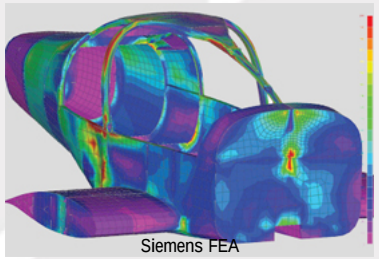


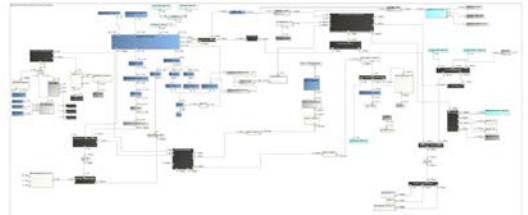
SpaceX
From http://www.spacex.com/about

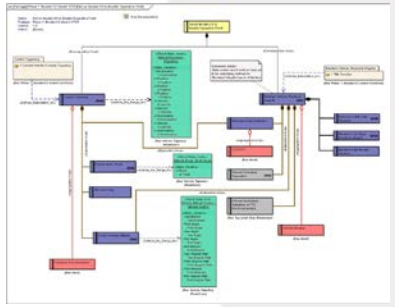
Integrating Geographically Dispersed Engineering Projects

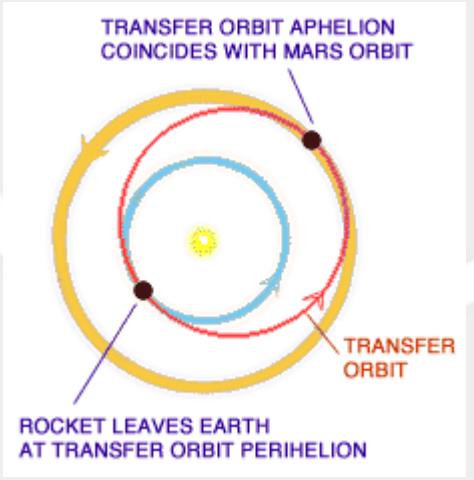
- Engineering work packages are often based on discipline expertise at different locations
  - Avionics
  - Communications
  - Environment
  - Fluids
  - Materials
  - Operations
  - Propulsion
  - Software
  - Structures
  - Test
  - Vehicle Management
- System Models provide the medium to
  - Allocate system functions and Integrate discipline designs
  - Engineer the system at the system level


AutoDesk CFD
http://www.autodesk.com/products/cfd/overview

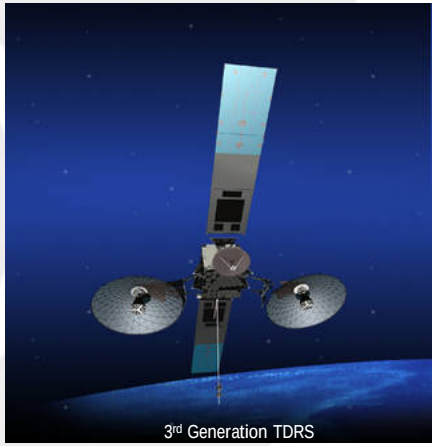

Siemens FEA
https://www.plm.automation.siemens.com/en_us/plm/fea.shtml


Avionics Architectures for Exploration: Building a Better Approach for (Human) Spaceflight Avionics – AIAA 2015





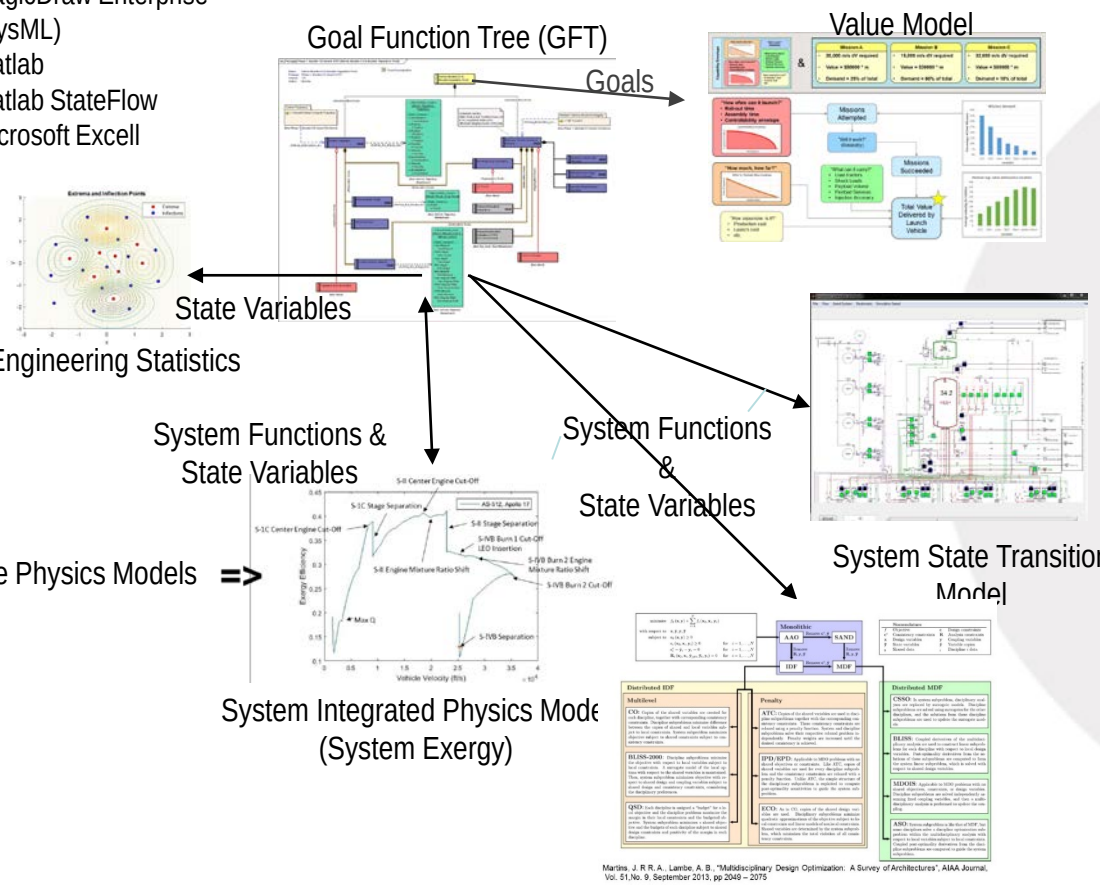
https://solarsystem.nasa.gov/basics/bsf4-1.php


3rd Generation TDRS
http://www.nasa.gov/directorates/heo/scan/services/networks/txt_tdrs.html

System Understanding

- System Models Contain an Understanding of the System

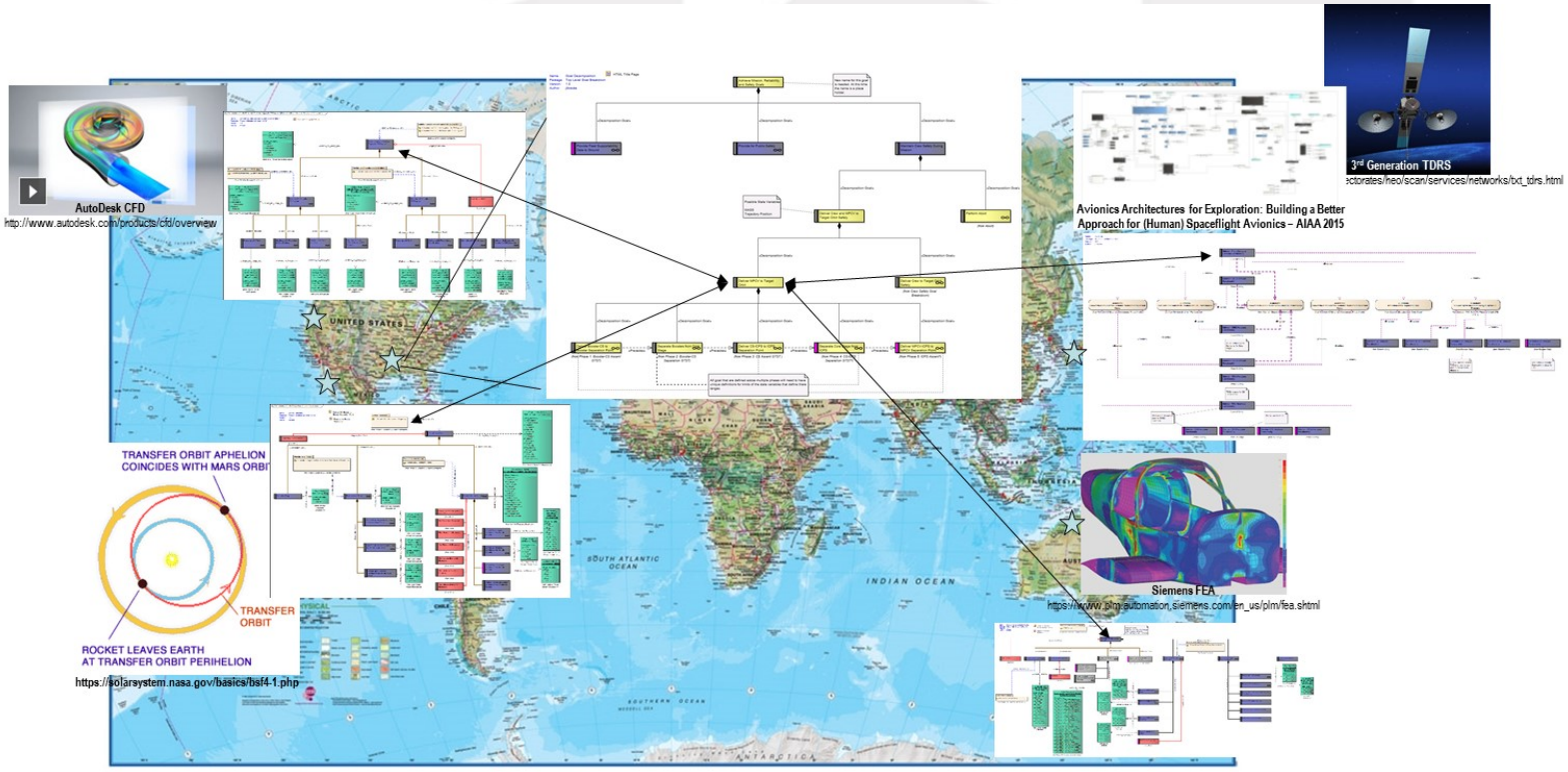
- MagicDraw Enterprise (SysML)
- Matlab
- Matlab StateFlow
- Microsoft Excell



- Allow systems engineers to:
  - Define system functions based on the system state variables
  - Understand stakeholders expectations on system value (i.e., capabilities)
  - Integrate discipline engineering models into a system level physics based model (e.g., system exergy)
  - Design and Analyze system responses and behaviors at the System level

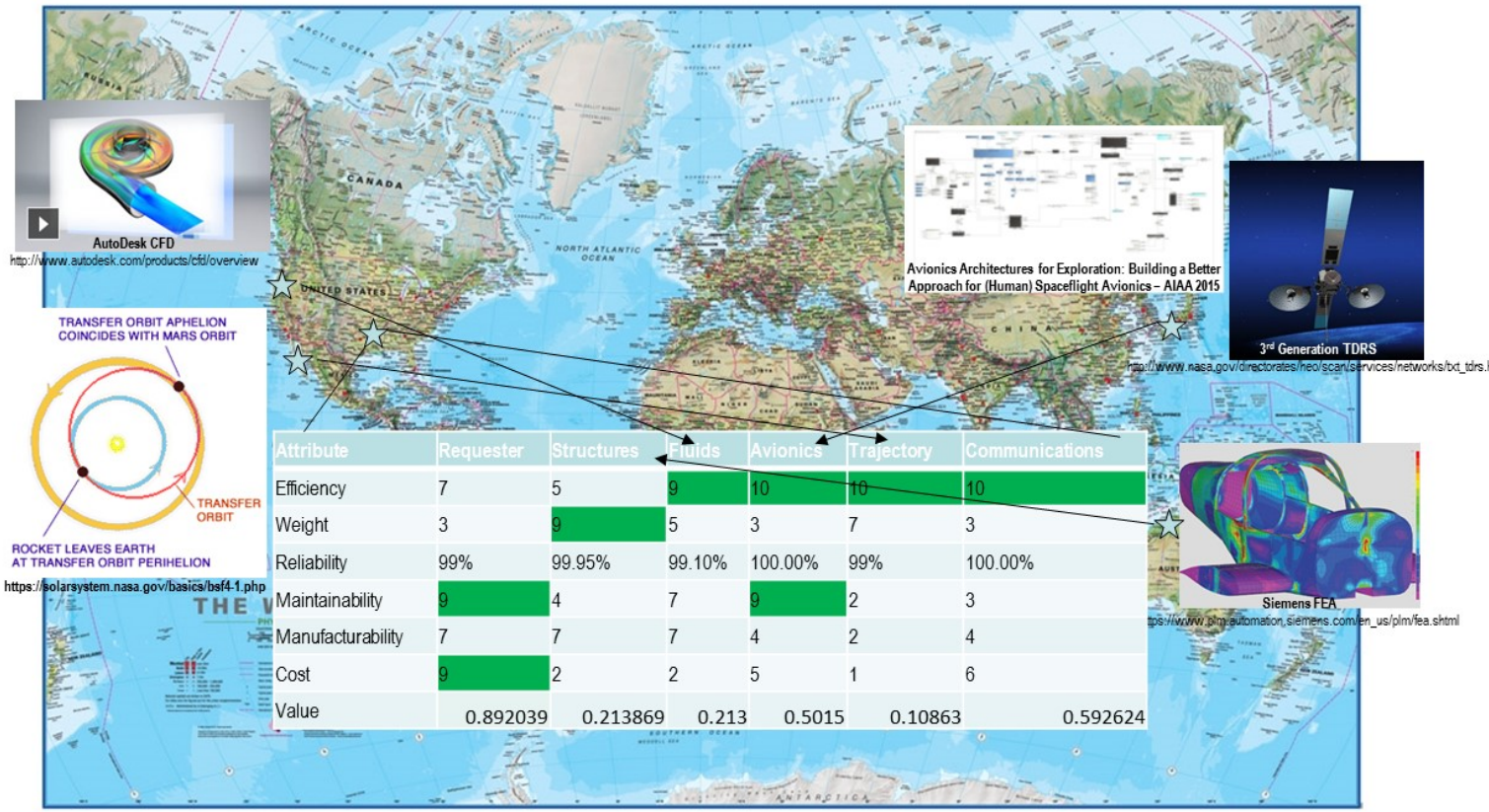
System Modeling

- Modeling at the system level enable collaborative engineering across discipline locations
  - Each location can work on their portion of the system within the defined system constraints
    - Goal Function Tree provides the integrating structure for the development and operational support
      - » System Goals provide overall system integration objectives
      - » System functions provide system development and support allocation across geographic locations
      - » System state variables provide context for geographically dispersed activities
        - Disciplines own state variables and ranges
        - Systems Engineering owns the interaction of state variables which leads to constraints on ranges



System Modeling

- Modeling at the system level enable collaborative engineering across discipline locations
  - Each location has a different value understanding of the system which can create system integration issues
    - Can be discipline based
    - Can be corporately based
    - Can be geographical region or national based
    - System value models provide a medium to incorporate these values into a common understanding
      - » Differences can be recognized and managed
      - » Possible path to a normative system value representation (research topic)



Attribute	Requester	Structures	Fluids	Avionics	Trajectory	Communications
Efficiency	7	5	9	10	10	10
Weight	3	9	5	3	7	3
Reliability	99%	99.95%	99.10%	100.00%	99%	100.00%
Maintainability	9	4	7	9	2	3
Manufacturability	7	7	7	4	2	4
Cost	9	2	2	5	1	6
Value	0.892039	0.213869	0.213	0.5015	0.10863	0.592624