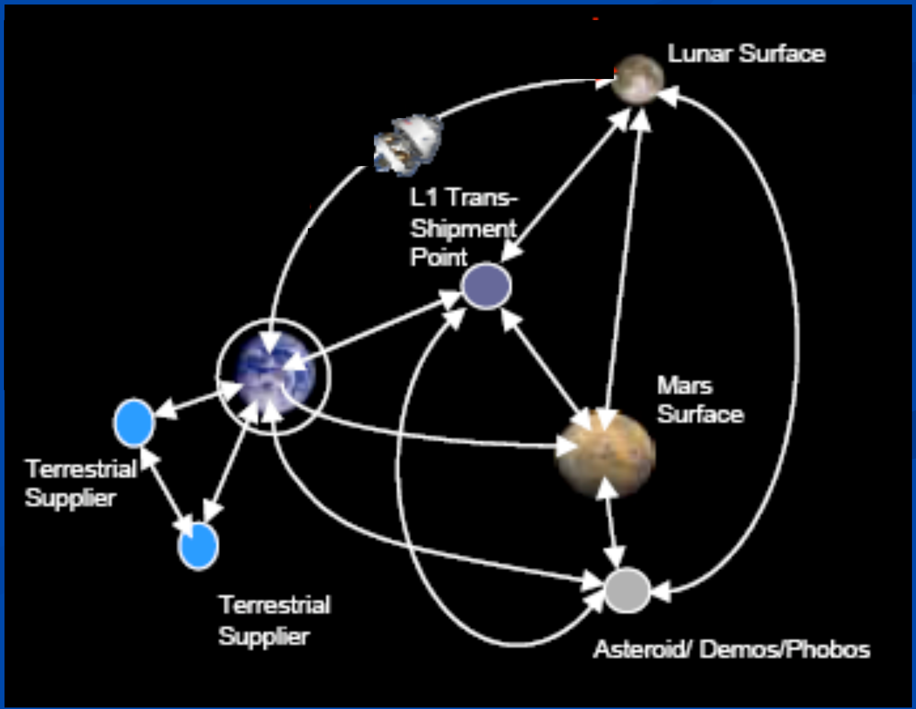
Space Exploration Logistics Workshop

17-18 January 2006

Omni Shoreham Hotel, Washington, DC

Group D

Logistics Implications (or Inputs) for Space Vehicle Design And Manifesting



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Session Overview

- Scope
  - A discussion that covers the 'what, where, when, how many, and how-to' issues of space vehicle design and manifesting to ensure adequate accommodation for logistics
- Goals
  - Identify and define the key issues and impacts and inputs of logistics on space vehicle design and manifesting — so that these implications can be reflected in design requirements, cost estimates, mission architecture development, etc.
- Organization
  - Identify the important issues (starter list + attendee participation)
  - Pick the "top 3" issues/topics relevant to each exploration mission type
  - Discuss potential impacts, mitigations and opportunities, early tests/demonstrations, and interfaces to other systems

Issues -
Common to All Mission Types

1. *Issue:* Need to integrate logistics into vehicle design effort from the beginning -- in particular, as mission duration increases and the supply lines get thinner (ISS -> Moon -> Mars)
   Predicted Impact: Lack of integration results in cost overruns, increased crew risk, budget impact/cost overrun, catastrophic failure potential, erosion of program support
   Potential Mitigation: Incorporate logistics, particularly life cycle cost management, up front in the initial design
   Testing Methods: Cost modeling/overall system modeling projections? (Improve cost modeling relationships and code)
   Impact on Other Systems: System pervasive
   Possible Solution(s): Use cost/system performance data to persuade the decision makers – identify short-term benefits, wherever they occur

2. *Issue:* Past systems have had different components perform similar functionality unnecessarily
   Predicted Impact: Reduces supportability. creates duplication of effort, inefficiency, wasted resources…may increase cost of individual pieces
   Potential Mitigation: System level design requirements: commonality, efficiency, interfaces--Balance of optimization across all elements
   Testing Methods: Inspection/ past performance and metrics (improve on shuttle/ISS) and utilize lessons learned
   Impact on Other Systems: Pervasive, requires and inspires collaboration
   Possible Solution(s): Implement top-down system engineering processes

Examples of Accommodating Commonality, Efficiency, etc.

- Space Vehicle Design Implications
  - Stowage areas
  - Hatch size
  - Crew resources for inventory tracking and management
- Carrier Design Implications
  - Pressurized cargo
  - Unpressurized cargo
  - Heritage from Shuttle, ISS, etc.
- Manifesting Implications
  - Consumables/spares estimating
  - Manifesting approaches to accommodate logistics

Issues -
Short Lunar Mission

1. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

ACCEPTING THE FACT THAT THERE ARE MULTIPLE SHORT MISSIONS, LOGISTICS CONSIDERATIONS FOR SHORT LUNAR MISSIONS CAN BE HANDLED AS IS

Issues –
Long Lunar Mission

1. *Issue:* Crew Autonomy
   Predicted Impact: Reduce life cycle cost by reducing reliance on ground resources
   Potential Mitigation: Extensive Training-interfaces
   Testing Methods:
   Impact on Other Systems: High impact (increased near-term design cost) on hardware and software design – but failure to provide autonomy requires LOTS of mission controller support (increased long-term operations cost)
   Possible Solution(s):

2. *Issue:* Reusable Infrastructure
   Predicted Impact: Increase in cost across multiple expendable missions
   Potential Mitigation: Open architecture, Reusable infrastructure
   Testing Methods: Utilize simulation and analysis methods to demonstrate broad applicability
   Impact on Other Systems: Reduces mission costs, increases interdependence of systems
   Possible Solution(s): Accumulate and maintain infrastructure at an accessible node in network to minimize access cost; amortize infrastructure across decades, with multiple users

3. *Issue:* System/Component Lifetime
   Predicted Impact: If lifetime too short, major replacement required
   Potential Mitigation: Plan for maintenance and upgrade, cost of minor repair is much less than major replacement
   Testing Methods: Simulation and statistical analysis of cost
   Impact on Other Systems: Increased up-front cost due to modular design, recouped later in lifecycle
   Possible Solution(s): Modular system design for efficient maintenance

Issues –
Mars Mission

1. *Issue:* Crew Survivability…reliability, spares, consumables
   Predicted Impact: Catastrophic failure, loss of crew
   Potential Mitigation: Design redundancy/reliability, provide spares and training for Maintenance, medical diagnosis and treatment
   Testing Methods:
   Impact on Other Systems: Ensuring critical spares/consumables to ensure crew survivability can potentially dominate Mars mission design
   Possible Solution(s):

Discussion Points

- Design criteria and requirements to support logistics
  - Commonality between different sub-systems of same vehicle and across vehicles (elements) for spares
  - Common interfaces
- Lifecycle cost and figures of merit….use these to drive design
  - Acquisition vs. Operations cost
  - Expand understanding of lifecycle from lifecycle of individual instantiation to lifecycle design concept
  - Political cycle can drastically effect performance of space systems
  - For logistics to be effective and considered as primary lifecycle costs need to be used
- Reusable infrastructure
  - Modularity…etc
- NASA Organizational Cultural Issues: Top down vs. Systems Engineering (which needs to include logistics/operations)   tension between separation of design and operations organization discourages integration
  - Need Program-level authority to commit to investment and promote discipline
- Remember that non-technical issues can greatly effect designs!!!! (e.g., policy, market projection, sponsor risk tolerance)
- Long term view reflected to policy makers (overcome short term)
  - Show short-term and intermediate-term benefits wherever they can be found – e.g., reduc eI&T cost, reduce inventory, reduce impact of obsolescence
- Importance of integrating logistics as mission duration increases and the supply line gets thinner