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
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 affect 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., reduce eI&T cost, reduce inventory, reduce impact of obsolescence

- **Importance of integrating logistics as mission duration increases and the supply line gets thinner\**