

- Advanced Life Support Modeling for
NASA

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ALS Modeling

- Looked at various options for providing air, water, and food, and dealing with wastes
- Crews of 4 to 6
- Durations from 3 days to 15 years
 - Relevant duration is usually facility occupancy, not tour of duty of personnel
 - Logistics pipeline from days to years
- Locations from low Earth orbit to Mars
- Timeframe from 5 to 30 years in the future

Approaches

- Looked at various modeling tools and techniques
 - Purpose built tool written in LISP
 - Models written in G2, Aspen, Simulink
 - Models written in EXCEL
- More detailed models were fun to do, and provided lots of data, but were not necessarily cost effective
 - Good if you have specific questions that can only be answered by dynamic models

Importance of Assumptions

- In general, you could get whatever answer you want by picking assumptions
- Reasonable assumptions are hard to determine for missions many years in the future
- Important to discuss assumptions before looking at results

Differing Assumptions

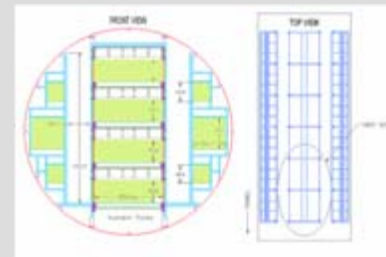
- Mass is a good substitute for cost for NASA
 - Cost of delivery is about \$10k/kg to LEO, perhaps ~\$50k/kg to Moon surface
- Cost of structures (pressurized) is in the range of 2 to 200 kg/m³
- Cost of energy ~ 1 to 1000 kg/kWh
- Cost of heat rejection similar to cost of energy
- Cost of crew time is about 1 to 100 kg/mh

Results of Interest to NASA

- Benefits of supply vs physicochemical vs bioregenerative approaches
- Break-even points for various technologies of interest
- Parameters driving results

Supply vs Regeneration

- Regeneration becomes attractive for space missions longer than a few days
- PC regeneration of water and air becomes cost effective for durations from 3 days to about a year, depending on the technologies
- Bioregeneration might be cost effective for missions longer than 2 years



Potential Synergy between NASA and Army Base Camps

- Durations are comparable
- Air revitalization is probably not too interesting, but trace contaminant control could be related to bio/chem warfare
- **Water regeneration** could be useful for cleaning up available water and dealing with effluent water



Synergy (continued)

- Food regeneration is difficult for missions lasting less than 5 years, but might be relevant for longer missions in isolated places, particularly for providing fresh veggies
- **Waste disposition** might be relevant, especially water and solid waste



Limits to Synergy

- NASA has much smaller population sizes (6 vs 170)
- NASA has both shorter (~3 d) and longer (~15 y) missions of interest
- Cost factors very different. Even cost of shipping to Antarctica is only about \$5/kg – over 3 orders of magnitude less than to LEO
 - This drives cost of hardware also

Summary

- NASA and the Army have some similar problems
- There may be some synergy
- However, the cost factors are very different, which will limit benefits of synergy
- May be useful to develop some cost factors relevant to the Army and do a quick look at NASA technologies for applicability