

Observations On The Moon

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Looking Forward

- **This Country's Vision for Space Exploration will have periodic human presence on the lunar surface by the last half of the next decade**
- **More challenging than any technical issue is sustaining national support for the development of the Vision**
 - **Providing objectives that Americans (and) the world find are**
 - **Inspirational**
 - **Tangible and**
 - **Have promise**
 - **Building scientific and engineering communities to sustain the public's perception of the Vision's value**

Exploration – Science - Commerce

- To sustain the Vision during development we must modify the traditional paradigm
 - Traditional – Exploration leads to commerce leads to science
 - Commerce provides self-sustaining basis for science
 - New paradigm – Exploration AND Science will lead to self-sustaining commerce and more science
- One of the development sustaining Exploration & Science opportunities is Lunar Observatories
 - The concept could be:
 - Inspirational and therefore provide a basis for sustaining support during development phase
 - Reinforce exploration, scientific and engineering objectives
 - But what would it take to be “real”?

How "Good" Are Lunar Observatories

- Can it be shown that under reasonable assumptions Lunar Observatories could:
 - Be built and return valuable science?
 - A "value-of-science", technology and engineering problem depending upon "when"
 - Augment or supplant Space Based Observatories?
 - A "value-of-science", schedule and budgetary problem
- What would be the basis for comparing future Space Based and Lunar Based Observatories?
 - Sequence of space based observatories versus a "condominium of observatories" on the lunar surface

Comparing a Lunar and a Space Platform for Observation

- Timing
- Reliability
- Lifetime
- Consumables
- Bandwidth ranges
- Extensibility
- Degradation due to environment
- Serviceability
- Operations
- Viewing Opportunities
- Human Interface

Platform Impact on Performance

- Pointing accuracy and stability
- Continuous dwell time on target
- Available power and load management
- Observing opportunities
- Duty cycle
- Earth background interference
- Concurrent observations

Trades

- Alternative platforms offer such different capabilities that cost / benefit analyses at equal levels of performance are probably not reasonable
 - Consider “value” metrics
- Major trades
 - Sequence of observatories
 - Sequence of science return
 - Timing and duration of manned presence
 - Transportation imposed limitations
- Special Lunar base considerations
 - Evolution of Observatories coupled to evolution of manned presence and transportation capability
 - Use of lunar resources to build / supply observatories
 - Technology of lunar based repair vis-à-vis reliability

Assumptions

- Time horizon
 - 20 Years or 50 Years
- Timeline for:
 - Reliable manned presence on the Lunar surface
 - Reliable power source(s)
 - Switching from terrestrial to lunar resources for construction and repair
- How to account for each component of cost over time

Potential Metrics

- **Cumulative science value**
 - Observation opportunities, Wavelengths covered (number of telescopes), Stability / Jitter, Percent of sky covered, etc.
- **Reliability**
 - Transport to destination, Infant mortality, Operations, Upgrades
- **Risk factors**
 - Development, transportation, operations
 - Schedule
- **Cost**
 - Effectiveness
 - Affordability
 - Uncertainty

Need for a Pragmatic Assessment



Enthusiasts



Yet to be
Convinced



Other
Agendas

- The concept of developing “condominiums” of lunar observatories as one of the arguments to sustain America’s Vision of Exploration may have merit
- Need for a compressive, independent analysis to determine the
 - Comparative benefits and costs
 - Sensitivities to assumptions
 - Uncertainty in decision making metrics