

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