The Vision for Space Exploration
Quo Vadimus?

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Outline

What is the VSE?
Where are we in VSE implementation?
What’s NASA doing right?
What’s NASA doing wrong?
If I were king....

Disclaimer: All of the following are my own opinions and do not necessarily reflect those of the organization for which I work
The Vision for Space Exploration

Return Shuttle to flight
Complete ISS assembly and retire Shuttle
Build new human spacecraft (CEV) for transport beyond LEO
Return to the Moon with people and robots to explore and prepare for voyages beyond
Human missions to Mars and other destinations

"It is time for America to take the next steps. Today I announce a new plan to explore space and extend a human presence across our solar system. We will begin the effort quickly, using existing programs and personnel. We'll make steady progress – one mission, one voyage, one landing at a time.

President George W. Bush - January 14, 2004
What’s It All About?

A journey, not a race
Incremental steps, cumulative
No turning back
Build-up space-faring infrastructure
Robotic precursors lead the way
Expanding sphere of human "reach"
Human-robotic partnership and synergy
Can humans thrive off-planet?
Why the Moon Next?

It’s close (3 days) and accessible (as near as GEO)
Alien yet familiar; Earth is visible to crew and TV audiences
Moon can be reached with existing or derived launch systems
Transport system to Moon can also access GEO, cis-Lunar, Earth-Sun Lagrangians, and some NEOs
Retire risk to future planetary missions by re-acquiring experience and testing with lunar missions
Development of lunar resources has potential to be a major advancement in space logistics capability
Advance science, improve engineering state-of-the-art, inspire country
Presidential Space Commission

Created by President Bush in Vision speech
Chartered to advise on NASA’s implementation of the Vision

Principal findings:
Vision for Space Exploration will help the United States protect its technological leadership, economic vitality, and security
Vision requires a shared commitment of the President, Congress, and the American people
NASA relationship to the private sector must be decisively transformed to implement the new Vision
Development of identified enabling technologies will be critical to attainment of exploration objectives
Sustained, exploration requires a robust space industry that contributes to national economic growth, produces new products through the creation of new knowledge, and leads the world in invention and innovation
Implement an architecture that encourages global investment in support of the Vision
Vision will be enabled by scientific knowledge and will enable compelling opportunities for new science
Vision will stimulate mathematics, science, and engineering excellence for America’s students and teachers – and engage the public in a journey that will shape the course of human destiny
NASA and the private sector
Some specifics from the Aldridge Commission Report

NASA should contract for services where possible (e.g., LEO access)
Independent technical, cost and innovation oversight
Use contracting authority and other incentives to nurture reinvigorated space industry
Seek international participation and investment in VSE
Where are we?

One robotic mission in preparation; plans for follow-ons uncertain

CEV, launch vehicle architecture defined (ESAS)

Lunar return goals and objectives identified (LAT)
What is NASA doing right?

- LSAM based around RL-10, cryo propellant
  - Will be able to use lunar products
- Focus on outpost, rather than sortie missions
  - Build-up resources, infrastructure and capability at a single site rather than dissipating them on one-off missions to many locations
- Polar site
  - Near-constant sunlight, volatile enrichment (Grab the low-hanging fruit)
- Involvement of internationals at early stage
What is NASA Doing Wrong?

No robotic exploration after LRO
  Decade-long gap between last robotic flight and first human flight to Moon
LOR instead of L-1 staging of lunar surface mission
  Trades mission flexibility and extensibility for “efficiency”
Ares launch system
  All the disadvantages of Shuttle-derived with none of the benefits
  Two Shuttle-C side-mounts could launch lunar surface mission; lower development costs, ready sooner
Agency still unclear about “mission” on the Moon
  List of reasons to go to Moon are unfocused and peripheral; a catalog, not a rationale
  If “mission” cannot be stated in one sentence, it’s probably not understood (i.e., We’re going to the Moon to learn how to live and work on another world)
Griffin sees his primary responsibility as maintaining an American human spaceflight capability (minimize the “gap” between STS retirement and CEV operations)

“Apollo on steroids” -- VSE does not have same drivers as Apollo

Meanwhile, the world is beating a path to the Moon (China, Japan, India)

Possession is 9/10 of the law

CEV without the Moon is Shuttle without the ISS – a vehicle with no “destination”
Then and Now

“I’m not worried about its “mission” – I’m concerned with building a Shuttle system.” – Jim Fletcher, 1973

“I’m not worried about the Moon; I’m concerned with building Orion and Ares” – Mike Griffin, 2007
Issues in implementing the VSE

How do you forge a collection of fiefdoms into an executing entity?

Parts of agency have been fighting VSE since Day One

Focus NASA on creating a true space-faring infrastructure

How best to transition STS/ISS to CEV?

Need incremental, cumulative program
Creating a space-faring infrastructure
Skills to master, Assets to acquire

Reusable and serviceable systems in cislunar space and planetary surfaces
Extracting useful products from planetary materials
Handling and using cryogenic fluids in microgravity and on the Moon
Transportation architectures and nodes in cislunar space
Comm, navigation and data systems; extend GPS to cislunar space
If I were king...

CEV: Develop launch system alternatives
    Shuttle-C, EELV, new commercial
Create incremental robotic “presence” on the Moon
    Orbiters, soft-landers, rovers to survey and prospect
    Engineering tech demos for ISRU, habitat placement, site preparation
    Infrastructure emplacement: landing pads, roads, hab sites, power and thermal control systems
Use private sector to augment capabilities for both of above
    Per Aldridge Commission recommendations; greatly expand data purchase, LEO access contracts, prizes
    Need to re-build aerospace industrial base
Sustainable Exploration

Hypothesis: This percentage is “politically” sustainable

If true – How does one move out “into the cosmos” without another “Apollo spike”?

Will Space Industrialization Work?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Full space settlement</th>
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<tbody>
<tr>
<td>No</td>
<td>Research and Tourism</td>
</tr>
<tr>
<td>Yes</td>
<td>Robot mines, factories and labs</td>
</tr>
<tr>
<td>No</td>
<td>Space science only</td>
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Can extraterrestrial resources be used to support humans in space?

Sustainability

Defined in different ways, but basically means survival of VSE over several Congressional and Presidential terms

Original concept: constant budget + inflation; phase out Shuttle/ISS and use those funds for exploration

Revised concept: less money than hoped; tear up STS infrastructure, build new system. Assume Congress/President unwilling to terminate human spaceflight
Sustainability: An Alternate Concept

True Shuttle-derived + commercial
- 2 Shuttle-C side-mount launches to L1 staging node
- CEV adaptable for Shuttle-C, EELV, or commercial LV
- ISS used for technology research, demos (e.g., experimentation with cryogenic liquids in microgravity)

Early and continuing robotic presence
- Use robotic missions to establish presence on Moon, characterize resources, demonstrate processing
- Multiple and continuing series of robotic missions maintains program momentum, new discoveries, prep for humans
- Develop large cryo-based lander (lunar “Progress”); 2 mT delivered to lunar surface
- Prepare outpost site for human arrival

Pace program to available resources
- We’ve survived previous “human spaceflight gaps”
- If major goal is to revitalize aerospace industry, must create incentives for them to invest IR&D in program (e.g., tax breaks, prizes)
Differences between now and Apollo era

Sense of urgency, shared sacrifice, national commitment
Management bloat; legalistic view of technical projects
Post-Cold War deterioration of technical infrastructure and industrial base
Space program paradigms

Saganite
Priesthood of science; make universe safe for robots

von Braunian
Technocracy; science and engineering in service of national goals

O’Neilllian
Entrepreneurial; use space resources for human expansion into the universe
Saganite (priesthood)

Planetary Society

JPL

Goldin

GSFC

Old NASA

Bush VSE

Webb

JSC, MSFC

USSR

China

von Braunian (technocrats)

O’Neillian (capitalists)

SS-1

SFF
The Strategic Value of the Moon

A way-station and stepping-stone into the Solar System

A logistics depot for cislunar space
   Change paradigm of spaceflight by using lunar products to create a transportation infrastructure in cislunar space

A laboratory and platform for science

A planetary space station where we can learn to live and work productively off-planet
Can we pull this off?

The glass is half-empty and half-full
Primarily, this is NOT about money
   It’s about understanding your “mission” and a determination to do it cleverly, despite obstacles
Have we reached a “point of no return” on a strategic path?
   I don’t think so, but we are getting damn close to it
Make no mistake, someone is going to the Moon
   The only question is whether USA will be a part of it
**Space – A New Rationale**

*Explore* to broaden our knowledge and imagination base

*Prosper* by using the unlimited energy and materials of space to increase our wealth

*Secure* our nation and the world by using the assets of space to protect the planet and ourselves