

CHARTING THE PATH AHEAD

BY JOHN F. KROSS

People of a certain age — say, aging baby boomers — had the good fortune to be born before our dreams of spaceflight collided with the prosaic reality of budget resolutions and societal attention deficit disorder. Oh, it was thrilling to listen to the ritualized liturgy of the countdown and witness the launch of a moonship balanced on a pillar of flame. On a hot night in July 1969, millions sat transfixed at the spectacle of flags and footprints on another world.

The intervening 40 years have not been kind to such mid-summer's night dreams. Distracted by domestic turmoil, the American public lowered its gaze from the heavens. The Moon, once the destination of a generation, remains as far away today as it was in 1950.

What cosmic calculus summoned the spirit of Apollo from the "vasty deep"? What summation of factors led us to Tranquility Base?

On May 25, 1961 — the day President John F. Kennedy stood before Congress and committed the United States to the Moon — the impetus came from a combination of political will, economic vitality, and technological drive. It took eight years for the technology for lunar journeys to mature. During that span, political and fiscal support for Apollo faded, but the momentum carried 12 astronauts to the lunar surface.

Forty years on, the scene surrounding human spaceflight is like a photographic negative of the early 60s. Our technological capacity dazzles, but our political will and economic vitality pale in comparison.

The solution proposed by the Bush Administration was the Constellation program, which arose from 2004's "Vision for Space Exploration." For Constellation, NASA gambled that using legacy technology could offset slim budgets and tepid political support. Constellation did indeed trace much of its lineage to the Apollo and shuttle eras, but — not unreasonably — the destinations of the program ultimately shaped the architecture. The shuttle's solid rocket boosters were upgraded and existing space shuttle main engines (SSMEs) were jettisoned altogether. A new vehicle was conceived — the Ares I — and shuttle and Apollo hardware were tailored for the heavy-lift Ares V.

But therein lay a potential flaw to the strategy — possibly a fatal one — as a result of the current economic and political climate. Making these drastic changes required money and continued political support — all factors in short supply. Instead of maximizing the technological factor in the equation by minimizing changes to legacy hardware, Constellation dissipated our modern advantage. The Moon — and other deep space destinations — seemed to recede once again.

By Election Day 2008, it was clear the new Obama Administration was rethinking human spaceflight policy and Constellation in particular.

"AUGUSTINE COMMISSION" REDUX

To evaluate the Constellation program, a Committee — the U.S. Human Space Flight Plans Committee — was created shortly after Obama took office.

Headed by Norman Augustine, former Lockheed Martin CEO, it soon became apparent to the Committee that Constellation had virtually no chance of achieving even interim goals on time in the current funding environment. Technical and other delays also led to the current shortfall.

At a public meeting in August, Committee member Sally Ride, a former astronaut and the first American woman in space, told fellow members of the panel that she did not expect that Constellation's Ares I rocket and Orion capsule would fly to low Earth orbit (LEO) before 2017 — two years after its target date. Meanwhile, the U.S. government's technical analysis organization, Aerospace Corporation, was even more pessimistic. Ongoing technical challenges, insufficient funding, and extending the International Space Station (ISS) to 2020 could delay Constellation's first mission until 2019.

Predictions about human spaceflight beyond low Earth orbit were equally grim. Results from an independent study presented to the Committee offered scant hope of Constellation replicating Apollo's achievements anytime soon. An unpublished part of the study predicted another Moon trip was unlikely until 2028 — nearly 60 years after Apollo 11.

"UNSUSTAINABLE TRAJECTORY"

The summary report from the Augustine Commission — released in September 2009 — adopted an equally jaundiced view and concluded that the U.S. human spaceflight program is on an "unsustainable trajectory." Fiscal restraints bore most of the blame for throwing NASA's plans off course. Committee member Bohdan Bejmuk, a former Boeing shuttle orbiter program director, told a public meeting prior to the release of the report that, "[Constellation's] budget problems are bigger than [its] technical problems."

Unfortunately, the White House instructed the Committee to identify options that fit the current budget (pegged at about \$80 billion total through 2020 or about \$28 billion less than anticipated at the inception of Constellation). In response, the Committee presented two fiscally "constrained" options based on the space agency's current

plan, but also offered three alternatives fitted to a more generous budget profile (\$3 billion above 2010 guidance).

What is striking is that Ares I and Ares V, in their current incarnation, survive in only two of the options. Four options delay retirement of the space shuttle from the end of 2010 as currently planned to some time in 2011, whereas one variant keeps the shuttle flying until 2015. American participation in the International Space Station, slated to end in 2015, is extended to 2020 in three alternative scenarios.

THE “CONSTRAINED” OPTIONS

Option 1: Program of Record

This option essentially continues the current version of Constellation to build and fly Orion and Ares rockets within the budget available. It



Ares V Rocket Illustration

retires the shuttle fleet in 2011 and scuttles the ISS in 2015 (assuming funds are allocated). With the constrained budget, Ares I and crewed Orion vehicles would not fly until 2017 (or perhaps 2019) and Ares V would not launch until the late 2020s. Meanwhile, American astronauts would be reduced to hitching a ride — with the Russians or Chinese — to low Earth orbit for at least 6 years. Worse, real hardware for the Altair lunar lander would not be flight ready until “well into the 2030s, if ever.”

Option 2: ISS + Lunar

The second option identified by the Commission extends ISS operations through 2020, but grounds the shuttle in 2011. Work would begin on a slimmed-down version of the Ares V, but this cargo-carrying “Ares-Lite” vehicle would not be ready until the late 2020s. Option 2 includes a technology development program and pursues a commercial crew capability to low Earth orbit, but does not fund development of lunar landing hardware. “It’s a limiting case,” admitted Committee member Edward Crowley.

It is clear that neither Option 1 nor Option 2 includes plans to explore beyond LEO for decades to come. Nor do they reduce the gap in human U.S. spaceflight. Sally Ride, a member of the Committee, said it best: “This budget is just simply not friendly to exploration... It’s very difficult to find an exploration scenario that actually fits within this very restrictive budget guidance.”

Table: Summary of the integrated program options. Used with permission from the Summary Report of the Review of U.S. Human Space Flight Plans Committee.

	Budget	Shuttle Life	ISS Life	Heavy Launch	Crew to LEO
Constrained Options					
Option 1: Program Record (constrained)	FY10 Budget	2011	2015	Ares V	Ares 1 + Orion
Option 2: ISS + Lunar (constrained)	FY10 Budget	2011	2020	Ares V Lite	Commercial
Moon First Options					
Option 3: Baseline - Program of Record	Less constrained	2011	2015	Ares V	Ares 1 + Orion
Option 4: Moon First Ares Lite	Less constrained	2011	2020	Ares V Lite	Commercial
Option 4B: Moon First Extended Shuttle	Less constrained	2015	2020	Directly Shuttle Derived + refueling	Commercial
Flexible Path Options					
Option 5A: Flexible Path - Ares Lite	Less constrained	2011	2020	Ares V Lite	Commercial
Option 5B: Flexible Path - Ares Lite	Less constrained	2011	2020	Ares V Lite	Commercial
Option 5C: Flexible Path - Shuttle Derived	Less constrained	2011	2020	Directly Shuttle Derived + refueling	Commercial



Space Shuttle Challenger

A MODEST INCREASE IN BUCKS EQUALS MORE BUCK ROGERS

While instructed to develop options within current budget guidelines, the blue ribbon Committee also sought and received White House blessing to explore “less constrained” options that exceed the existing budget planned for NASA’s exploration goals. They range from a “Moon first scenario” and “flexible paths” to deep space to a more direct translation of space shuttle technology for a heavy-lift vehicle.

Option 3: Program of Record (Baseline)

The first of these higher-budget options retains the current Constellation architecture — Ares I and V plus Orion — but dates lunar exploration to the mid-2020s. This scenario grounds the shuttle fleet in 2011 and deorbits the ISS in 2015. Despite a boost in funding, Ares I and Orion would not carry astronauts to orbit until 2017, leaving at least a 6-year gap in human U.S. spaceflight.

Option 4: Moon First

The fourth option, dubbed “Moon First,” focuses squarely on Earth’s nearest neighbor as the “first destination” beyond low Earth orbit and relies on commercial vehicles to ferry crews to LEO. The two variants of this option are differentiated by the type of heavy-lift vehicle. Variant 4A funds development of an “Ares-Lite” rocket for heavy-lift duty and grounds the shuttle in 2011, while Variant 4B develops a shuttle-derived heavy launcher and extends the shuttle to 2015. The Committee concluded that Variant 4B is the “only foreseeable way to eliminate the gap in U.S. human launch capability.” Both variants would deliver humans to the Moon by the mid-2020s.

Option 5: Flexible Path

The last option, called “Flexible Path,” represents “a different type of exploration strategy” providing a “series of interesting ‘firsts’” — such as lunar fly-bys, visits to Lagrange points, and near Earth asteroids — to maintain public interest and support. More importantly, in the view of the Committee, “Flexible Path” would “allow many different options as exploration progresses...including a return to the Moon’s surface” or visits to the moons or surface of Mars.

In the “Flexible Path” option, the shuttle would fly until 2011 and ISS would orbit until 2020. Commercial crew services would ferry astronauts to low Earth orbit. The three proposed variants of Option 5 dif-

fer only in the type of heavy-lift launcher. Variant 5A relies on an “Ares-Lite” launcher whereas the Variant 5B heavy-lift rocket is derived from Evolved Expendable Launch Vehicles (EELV) such as the Atlas V and Delta IV. Variant 5C utilizes a shuttle-derived vehicle to boost heavy payloads into orbit and beyond. All variants of Option 5 allow exploration beyond low Earth orbit in the early 2020s.

While the Committee studiously avoided making specific recommendations, prior to the report’s release, committee chairman Norman Augustine stated, “We very much like the deep space option...It’s...doable and viable.” Indeed, of all the options presented, “Flexible Path” perhaps offers the most intriguing possibilities because its goals — human exploration beyond low Earth orbit — are matched by inherent adaptability. Moreover, in the opinion of the Committee, the goal should drive the architecture.

TOUGH CHOICES AHEAD

The Obama Administration faces tough choices with regard to the future of U.S. human spaceflight. The Government Accountability Office (GAO) has emphasized that extending the shuttle’s life could have “significant consequences” on the future of human spaceflight by consuming funds slated for exploration. The same can be said for the International Space Station. Abandoning ISS — after spending decades and up to \$100 billion to build it — is not a palatable option, but sticking with the station pushes back any plans to fly humans deeper into space. That is, unless the administration opts to modestly boost NASA’s budget by \$3 billion annually.

The Augustine Committee clearly favors engagement with other space-faring nations and encouraging commercial vehicles for launching astronauts into orbit. However, the Committee also came to the sobering conclusion that “if after designing cleverly, building alliances with partners, and engaging commercial providers, the nation cannot afford to...pursue the goals it would like...it should accept the disappointment of setting lesser goals.” America should resign itself to wallowing in the



International Space Station

shoals and backwaters of space as others take the lead.

However, despite the controversy, the brave technology of our heritage in space has blazed the path for us. We must take maximum advantage of the legacy of Apollo and shuttle, while finally moving forward. Regardless of how we get there, it is a journey to inspire the mind and kindle the heart. It is doable.

