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**A conversation with Buzz Aldrin
Paradigm shift in U.S. space policy**

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Termination of Constellation is not the only drastic change proposed in the Obama administration's new space policy. A larger role for private industry, an extended life for ISS and greater emphasis on robotic and Earth monitoring missions are also in the offing. The policy is continuing to draw extremes of praise and criticism, sometimes from unexpected sources.



Momentous changes are in the making for U.S. space policy, programs and priorities. President Barack Obama's new space strategy, pegged to his proposed cancellation of NASA's Constellation manned spaceflight program, is highly controversial and may yet be modified somewhat by Congress. Even so, the agency's culture and ways of doing business will almost certainly never be the same.

The Obama space plan focuses on finding new and less expensive means of exploring space, extending NASA's responsibility for manned spaceflight to the private sector and lengthening the lifespan of the international space station. It also puts a premium on fostering commercial space transportation, developing heavy-lift propulsion technologies, preparing for scientific robotic missions and developing spacecraft for climate change observation and research.

Dimensions of the space policy and its rearrangement of priorities and financial resources are revealed in the administration's proposed \$19-billion NASA budget for FY11, a 1.5% increase over funding for the current fiscal year. That budget includes substantial additional funding to nurture new technologies for future human space exploration beyond LEO, an endeavor that ended

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Paradigm shift IN U.S. SPACE POLICY

with the last Apollo Moon landing in 1972. It also accentuates Earth observation and planetary science programs.

Intense reactions

From the beginning, the Obama space initiative evoked both strong support and stern criticism. Proponents hailed it as an innovative, realistic, promising and affordable approach to human spaceflight and exploration. Critics deplored it as both too radical and dangerously dismissive of NASA's time-tested priorities and practices for manned missions. They also cast it as the beginning of the end for U.S. leadership in space, saying it would reduce NASA to little more than a technology development and demonstration agency.

The new proposal has been strenuously debated in Congress and elsewhere. Scrapping Constellation, its big sticking point, cannot be done without congressional approval.

The U.S. has invested \$9 billion in Constellation, and the economic and political stakes in the program are high.

NASA implemented the Constellation program in 2004 to meet the Bush administration's stated goals of transporting U.S. astronauts back to the Moon and paving the way for future missions much deeper into space, perhaps to Mars and the asteroid belt. Abandoning the program will end the development of its Ares I and Ares V rockets, Orion crew exploration vehicle and Altair lunar lander.

This will leave NASA with no new manned spacecraft of its own for a long time to come—maybe permanently—and compels the U.S. to turn to commercial companies to take astronauts into orbit for the time being, and perhaps indefinitely.

The space shuttles, which have been NASA's only manned launch vehicles for more than 30 years, would be retired upon

Obama takes aim at asteroids, Mars...and critics

After the hue and cry that greeted President Barack Obama's initial presentation of his plan for early 21st-century human exploration, a conference was hastily assembled to offer some details and perhaps calm some fears. The president's plan, which he explained in some detail in an April 15 speech at Kennedy Space Center, is a gamble that puts U.S. space leadership, and the careers of thousands of aerospace engineers and workers afloat—somewhere between the Moon and Manhattan-sized asteroids that are the new stepping stones to Mars.

Nine previous U.S. presidents supported in principle use of the Moon as the staging point for an evolutionary human push deeper into the solar system. But neither past presidents nor the Congress acted decisively enough for a sustained program. Obama is abandoning the Moon as an evolutionary proving ground for much more complex Mars missions. His strategy trades the Moon for quicker, more revolutionary human exploration of potentially threatening asteroids, as well as access to Lagrangian (L) points about 1 million miles from Earth. Missions to both would be launched from NASA Kennedy by 2025. L points are increasingly important because spacecraft parked there remain basically stationary relative to the Earth, Sun and Moon.

The president announced several spacecraft and launcher goals:

•**Orion Lite:** Lockheed Martin development of Orion spacecraft will continue, but with initial versions planned for use as crew rescue vehicles, parked at the ISS. They would be launched unmanned by Atlas V or Delta IV EELVs. The craft will be built at Kennedy, which will become much more of a development site for numerous technologies rather than just a launch facility. Use of Orion as an ISS lifeboat would negate the need for U.S. astronauts to rely on Russian Soyuz craft for reentry in an emergency. Several will be built to enable periodic change-out and refurbishment. Continued development also makes Orion available for future upgrade to a crew launcher, as originally intended in the Constellation program. That means that NASA will lead development of a vehicle that could possibly be used in place of commercial spacecraft, should commercial development fall dangerously behind. Obama also said Orion could be one element of spacecraft configured specifically for trips to asteroids or L points. Once stationkeeping with an asteroid, astronauts would only need to use simple manned maneuvering units to fly over to land on it.

•**ISS transportation node:** Obama did not say it specifically, but his vision for Orion Lite includes using the ISS as an implicit transportation node for deep space missions. Some or all manned missions would stop at the ISS, then depart for distant destinations.

•**Heavy-lift launch vehicle:** Obama said that to replace the canceled Ares V, NASA will finalize the design of a new heavy-lift launch vehicle no later than 2015, "and begin to build it." He added, "I want everybody to understand: That is at least two years earlier than previously planned—and that is conservative, given that the previous program was behind schedule and over budget." More than \$3 billion is being poured immediately into new heavy-lift options. That will be to develop "a vehicle to efficiently send into orbit the crew capsules, propulsion systems and large quantities of supplies needed to reach deep space," Obama said. "In developing this new vehicle, we will not only look at revising or modifying older models; we want to look at new designs, new materials, new technologies that will transform not just where we can go but what we can do when we get there."

•**Kennedy modernization:** An additional \$3 billion will be pumped into the center over the next five years to modernize the infrastructure.

The shift from the Moon to asteroids was made because the administration believes a return to the Moon would not have driven technology. It would have been an evolutionary program, and Obama is willing to trade a longer post-shuttle flight gap for more advanced technology development leading to the new targets. This shift is the single largest shakeup in American space planning history. Early planetary scientists believed that lunar samples would provide major insight into the forma-



tion of the solar system. That proved not to be the case, although Moon rocks have provided major new information on the formation of the Earth/Moon system.

The science community now believes that sampling asteroids can help solve major questions about the solar system. Exploring and sampling both solid-body and much less dense "rubble pile" asteroids can also be "the ultimate 'green' missions," providing critical information about how to divert asteroids threatening life on Earth. Accessible asteroids and L points are about three to four times farther away than the Moon, requiring new life support systems to support a crew for several weeks, a significant step toward even more capable systems to support multimonth missions to Mars.

The administration does not want the future space program to become "Moon stuck"—bogged down with a major manned lunar infrastructure, much like the shuttle and space station development have kept astronauts trapped in LEO for 35 years. In addition to advanced environmental systems, the administration believes the asteroid/Lagrangian goal will enable faster development of propulsion technologies that would enable U.S. astronauts to begin asteroid and L point missions by 2025, and missions to Martian orbit with landings on its moons Phobos and Demos by the mid 2030s. There is nothing in the Obama strategy that puts the Moon off limits, and indeed some lunar orbit missions will likely be flown by the early 2020s to prove out asteroid mission spacecraft while only three days from Earth instead of three weeks of travel time from an asteroid.

Manned Mars missions in the latter 2030s and after 2040 would be far more complicated, with heavier spacecraft that would dive through the Martian atmosphere for landing. After surface explorations lasting weeks or months those manned vehicles would climb back out of the Martian gravity well for return to Earth, stopping possibly in Martian or Earth orbit. There will be an increased number of unmanned Martian precursor missions such as more advanced rovers, and by later this decade and in the 2020s unmanned sample return flights.

Obama aimed part of his message directly at congressional delegations that, without regard to new exploration strategy, seek to extend the Constellation contracts now canceled by the customer—NASA. He said, "There is a sense that people in Washington—driven sometimes less by vision than by politics—have for years neglected NASA's mission and undermined the work of the professionals who fulfill it.

"Some have had harsh words for the decisions we've made, including some individuals who I've got enormous respect and admiration for," he continued, referring in part to astronauts and shuttle designers who spoke against his changes. "But what I hope is that everybody will take a look at what we are planning, consider the details of what we've laid out, and see the merits as I've described them. The bottom line is nobody is more committed to manned spaceflight, to human exploration of space than I am. But we've got to do it in a smart way, and we can't just keep on doing the same old things that we've been doing and thinking that somehow is going to get us to where we want to go."

Craig Covault

Kennedy Space Center

completion of three more flights scheduled through this year. Once that happens, NASA will have to rent space on Russian Soyuz spacecraft to ferry U.S. astronauts to the ISS, an inevitable turn of events that rankles many U.S. space officials and aficionados. Obama proposes to give the ISS a new lease on life, committing the U.S. to extending its operational duration through 2020.

The new NASA strategy marks a sharp break with the standard practice of the past, in which the government funded, controlled and conducted all manned space launches and operations. The change signals “the entrance of the entrepreneurial mindset” into the space arena, and has the potential to create thousands of high-tech jobs while providing affordable access to space, according to NASA Administrator Charles Bolden.

Review findings

The U.S. space initiative is derived from the findings of the 10-member blue-ribbon Review of U.S. Human Spaceflight Plans Committee—known as the Augustine committee. John Holdren, director of the White House Office of Science and Technology Policy, assembled the panel early last year to review NASA’s programs and assess its future. Chaired by former Lockheed Martin CEO Norman Augustine, the committee concluded that the Constellation program was badly underfunded, that its key milestones were slipping, and that it would not succeed in resuming U.S. manned spaceflight to the Moon or anywhere else at an affordable cost or within a reasonable timeframe.

The Augustine panel estimated that Constellation’s heavy-lift Ares V rocket, designed to launch astronauts to the Moon, would not be available until 2028 or 2030, and that “there are insufficient funds to develop the lunar lander and lunar surface systems until well into the 2030s, if ever.” The committee report asserted that “whatever space program is ultimately selected, it must be matched with the resources needed for its execution.”

Industry’s role

Amid the debate over the plan, one thing seems certain: The U.S. space program sooner or later will require launch vehicles capable of carrying human crews into and beyond LEO. The fundamental question is whether those vehicles should be built under the auspices of the government or private industry—or both.

Speaking shortly after the plan’s release, Bolden emphasized that NASA’s long-time launch contractors, such as Boeing and Lockheed Martin and their joint venture United Launch Alliance (ULA), will be eligible to take part in the privatized space operations of the future, along with such relative newcomers as Space Exploration Technologies (SpaceX), Orbital Sciences, Sierra Nevada and others.

The NASA administrator said there is a misconception that the safety of the crews of private-sector spacecraft will be jeopardized in the hands of untested space launch companies. On the contrary, he declared, NASA’s commercial partners in human spaceflight will be the same as those already entrusted with “transporting our multibillion-dollar satellites.”

Work on Ares I will be terminated, despite one successful test flight.





The Augustine panel estimated that the heavy-lift Ares V rocket would not be available until 2028 or 2030.

“Commercial launch vehicles have for years carried all U.S. military and commercial satellites and most NASA satellites to orbit,” Bolden said. And just as it did 50 years ago in upgrading existing rockets for the pioneering Gemini orbital spaceflight program, “NASA will set standards and processes to ensure that these commercially built and operated crew vehicles are safe,” he asserted.

The NASA FY11 budget provides \$6 billion for continued development of commercial space transportation. It also includes \$3.1 billion through FY15 to develop new engines, materials and propellants for heavy-lift launchers to take astronauts beyond LEO. In the same time frame, roughly the same level of funding is projected for scouting possible space exploration targets and identifying their hazards and resources for human habitation. Programs to develop advanced communications, sensors and robotics are slated to receive \$4.9 billion.

Budget increases and cuts

The new space plan marks the beginning of NASA’s “transformative technology initiative,” an endeavor slated to receive \$7.8 billion over the next five years. Its goal is to develop and demonstrate spaceflight technologies that presumably will cut the costs and increase the capabilities of future space systems—rendezvous and docking, orbital fuel storage and life support are examples.

NASA’s Exploration Systems Directorate takes a big hit. Its sharply reduced and redirected funding is a major issue in the debate over the Obama space policy. The directorate was created in 2004 to follow through on the Bush administration’s plan to send U.S. astronauts back to the Moon and then on to Mars. It was to have received \$5.5 billion in the coming fiscal year to continue developing the Ares I and Ares V rockets and the Orion vehicle.

The new budget cuts the directorate’s

funding to \$4.26 billion. Almost half that—nearly \$2 billion—would be spent on closing out the Constellation program. An additional \$600 million is allocated to continue the close-out in FY12. Moreover, NASA is requesting permission from Congress to divert some of the directorate’s current funding to begin phasing out Constellation in this fiscal year.

NASA’s Science Missions Directorate gets a hefty 11% funding increase in the new budget, to a level of \$5 billion. Most of the \$512 million in additional funds is allocated to the directorate’s Earth Science Division. The agency’s Planetary Science Division also receives an 11% increase to \$1.485 billion, but the division’s astrophysics budget, which funds the Hubble Space Telescope and other programs, is slightly cut.

Stimulus contracts

Along with its new strategy and budget, the agency announced contract awards totaling \$50 million to five companies under the economic stimulus package provided by the American Recovery and Reinvestment Act of 2009. The companies—Boeing, Blue Origin, ULA, Sierra Nevada and Paragon Space Development—will develop crew module and safety concepts and demonstrate new technologies for future commercial support of human spaceflight.

Boeing, NASA’s teammate in developing the ISS, is designing a module to carry crew and cargo to the station and to commercially built and operated orbital stations aboard various launch vehicles, including the SpaceX Falcon 9 and the ULA Delta IV and Atlas V. Boeing’s principal partner in the crew capsule project is Bigelow Aerospace, which is independently developing and testing three- and seven-person Sundancer space habitats.

Sierra Nevada will spend its NASA stimulus funds on development of its Dream Chaser commercial crew taxi, a derivative of the HL-20 space vehicle that NASA conceived many years ago to rescue ISS crews. Sierra Nevada is redesigning the HL-20 for launch as a lifting body aboard an Atlas V rocket and carrying a crew of up to seven astronauts bound for the ISS or other space stations.

Orbital Sciences and SpaceX, among the forerunners in creating private-sector space enterprises, are on the leading edge of commercial crew-capsule development, with their respective Cygnus and Dragon capsules already in the works. Both projects have made use of NASA’s commercial orbital transportation services funding, which NASA plans to



Sierra Nevada’s SpaceDev will spend its NASA stimulus funds to develop the Dream Chaser.

increase by \$300 million in FY11 to keep Orbital Sciences and SpaceX on schedule to deliver cargo to the ISS next year under previously awarded contracts with the agency.

Expanding opportunities

The Augustine Committee's 2009 report took note of the "burgeoning commercial space industry" in the U.S., and declared that "if we craft a space architecture to provide opportunities to this industry, there is the potential—not without risk—that the costs to the government would be reduced."

As he unveiled NASA's new budget and rearranged priorities in February, Bolden, a former astronaut, cited the Augustine panel's findings as validation of NASA's proposed re-orientation, and asserted: "The truth is that we were not in a path to get back on the Moon's surface, and as we focused so much of our effort and funding on just getting to the Moon, we were neglecting investments in the key technologies that would be required to go beyond."

Rid of the Constellation program, NASA will have greater resources and be in better position to explore the cosmos, develop innovative technologies, foster commercial partnerships and enhance human understanding of our planet by flying Earth-observation systems aboard the ISS, Bolden claimed. NASA will use the station as a testbed for future exploration technologies, he said.

"All kinds of educators, colleges, science institutions and other government agencies will be using the ISS for research," he added. "There's so much we need to know before we can venture safely out of low Earth orbit for the long term. We're going to address practical medical questions about astronaut bone density and the effects of radiation—how we can reach destinations sooner to mitigate the effects on space travelers of long journeys."

Opposing views

The new strategy was widely endorsed in both government and private circles by such prominent figures as Holdren, Augustine and former lunar astronaut Buzz Aldrin. But it drew criticism from previous NASA administrator Michael Griffin and segments of the space launch industry, and from members of Congress from states with high stakes in the Constellation program.

Griffin, who backed the Constellation program while at NASA, was widely quoted in his opposition to the administration's strategy. He contended that it puts the U.S. "on a path



Orbital Sciences' Cygnus (top) and SpaceX's Dragon crew capsules are already in the works, making use of NASA's COTS funding.



that can't work," and that it means the nation is "not going to be a significant player in human spaceflight for the foreseeable future."

Griffin noted that during his tenure as administrator he favored NASA's funding of cargo-carrying spaceflights by commercial companies. But he said that commercial firms are not yet ready for the risky venture of launching humans into space.

This viewpoint is disputed by champions of the new plan. Bolden noted that commercial companies already launch all U.S. communications, weather, imaging, navigation and intelligence satellites "upon which our lives depend at home and abroad." He promised that the commercially built space vehicles "will be safe." John Gedmark, executive director of the Commercial Spaceflight Federation, declared, "If the Pentagon can trust private industry with this responsibility, we think NASA can too."

Salvage attempt?

Some critics of NASA's big changes insist that the Constellation program is not too far off track and can yet be made to work. In a statement, Alliant Techsystems (ATK), the prime contractor on the first stage of the Ares I rocket, questioned "why at this time the nation would consider abandoning a program of such historic promise and capability—with so much invested." ATK claimed that the Ares development program "is meeting all major milestones" and that "NASA and its industry partners have made significant progress in Constellation's development, culminating in the successful Ares I-X test flight."

In the speech President Obama gave on April 15 he called for a version of the Orion capsule to be parked at the ISS as an emergency escape vehicle.



The company described Ares I as “innovative” and “10 times safer than any launch vehicle in existence or on the drawing board,” and stated, “To abandon Ares I as a baseline vehicle for an alternative without demonstrated capability or proven superiority (or even equivalence) is unwise and probably not cost-effective.”

The company said it intends to continue developing Ares I in the hope that Congress and the administration will work together on a revised space budget that “capitalizes on the investments the nation has made in the Constellation program.”

Lawmakers from Constellation states, including Florida, Alabama, Louisiana, Texas and Utah, were quick to call the space policy too radical and misguided. Notable among them were Sen. Richard Shelby (R-Ala.) and Sen. Bill Nelson (D-Fla.), chairman of the Senate Commerce Committee’s science and space subcommittee.

Shelby declared that the new space budget “begins the death march for the future of U.S. human spaceflight.” Nelson accused the Obama administration of shortchanging NASA by budgeting roughly \$10 billion less for human spaceflight programs than the Augustine Committee had recommended spending through the next five fiscal years.

“You can’t do it on the cheap,” Nelson asserted at a Senate Budget Committee hearing the day after the new space policy was announced. “The problem is that you have put all the eggs in the basket of assuming that those commercial rockets are going to work, and that NASA is not going to have to spend a lot more on making sure those commercial rockets are safe for humans.

“If those commercial rockets don’t work, then for the foreseeable future we’re going to be relying on the Russians just to get to our space station,” he continued. NASA should continue developing and testing the Ares I rocket just in case, he said.

Bolden said NASA intends to salvage the advanced technologies being nurtured in Constellation’s Ares rocket programs and Orion crew vehicle, and will apply them in the development of new human spaceflight systems, including a heavy-lift rocket. Noting that the agency has begun working on a plan and timetable for transporting astronauts beyond LEO, he claimed that resistance to canceling Constellation will only serve to delay development of that plan.

The sooner Constellation is abandoned, “the sooner we’re going to go to the Moon and Mars and other places,” Bolden said.

Job losses, and some gains

Bolden also deplored the loss of jobs that will result from phasing out Constellation, which employs 11,500 people in 12 states—Alabama, Arizona, California, Colorado, Connecticut, Florida, Louisiana, Mississippi, Ohio, Texas, Utah and Virginia—but claimed that the administration’s commercially oriented manned spaceflight strategy and the budget increases proposed for NASA in the years ahead will create many new opportunities and plentiful jobs for the industry.

“This is a good investment for America,” Bolden said. “There will be jobs in propulsion, communications and other industries. Exploration programs drive innovation throughout our economy, and NASA will be leading this economic competitiveness and growth.” ▲