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AEROSPACE

A M E R I C A

Ready, set EXPORT

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Critics want a complete re-examination of U.S. launch strategy, including the multi-billion-dollar Space Launch System. Natalia Mironova explores whether they have a case.

Choose your launcher

Garry Lyles wanted to build big rockets since he was a little kid. He remembers visiting NASA's Marshall Space Flight Center in Huntsville, Ala., when he was 10 years old and staring in awe at the eight massive engines of the Saturn 5 rocket — the rocket that would carry Apollo astronauts to the moon — and wondering how something that big could ever fly. "It was an exciting time for a 10-year-old. It never left me," he says.

Today Lyles is doing exactly the job he dreamed of as a young boy: Building the biggest rocket ever. Lyles is the chief engineer of NASA's Space Launch System — A 70-meter-tall stack of expendable rocket engines topped by a crew capsule.

If Congress and the White House fund the SLS to completion, it will be a multifaceted workhorse with the brawn to carry cargo and crew beyond Earth's orbit, making it possible for astronauts to travel back to the moon, to an asteroid, and even to Mars.

It looks like completing SLS will require overcoming increasingly vocal critics. A former high-level NASA official has taken

public aim at the policy underpinnings of the SLS program; outside experts are questioning the wisdom of devoting so much of NASA's budget to one program — nearly \$3 billion out of \$17 billion in each of the next five years. The biggest new factor could be this: What once looked like a risky gamble to invest some money in commercially designed rockets and capsules — as opposed to government blueprints like the ones for SLS and its Orion capsule — has paid off with a string of picture-perfect cargo launches to the International Space Station. Still to come are commercial crew flights to low Earth orbit, and anything beyond that is a question mark.

A long-shot policy fight like this one will require branding, and critics are trying to label SLS "a rocket to nowhere." They question the fiscal feasibility of the promised manned trips to deep space, and they note that NASA has plans under way for only one such trip, a mission to an asteroid, notionally targeted for 2021. The money planned for the SLS, they argue, would be better invested in further developing com-



Artist's rendering:
The first unmanned test flight of NASA's Space Launch System is scheduled for 2017.

mercial alternatives for human space travel.

Pushing back

Lyles has heard the criticism, but for him there is no question about the need for SLS. "It will be the most capable rocket ever built," he says. Two incarnations are in the works — an initial one with 70-metric-ton lift capability and an "evolved" 130-metric-ton lift version. Both are being designed to interchangeably carry cargo or the Orion crew capsule, which is currently being developed for NASA by Boeing.

Even the smaller version of the SLS will be a beast of a launcher, taller than the Statue

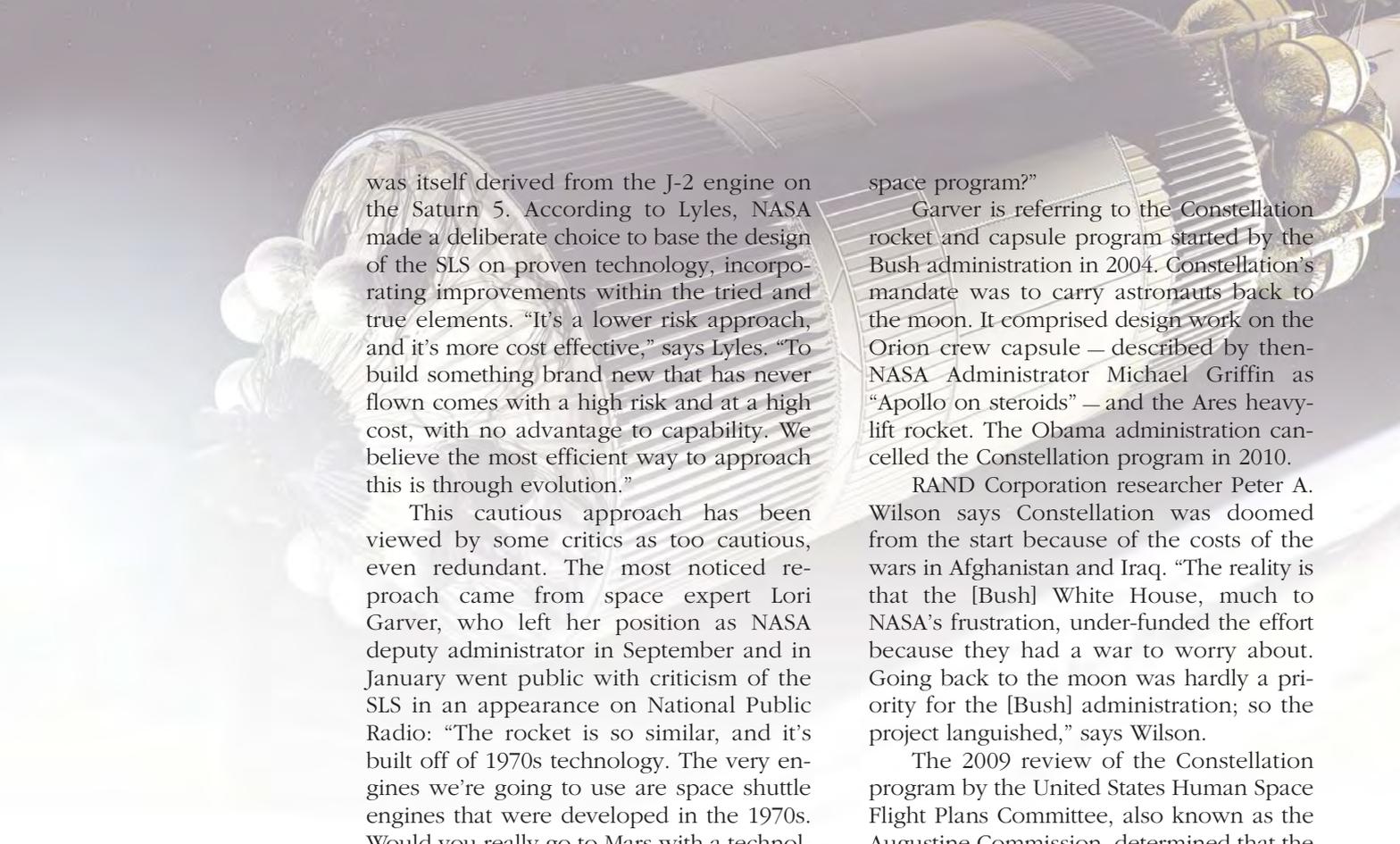
of Liberty and weighing 5.5 million pounds — the equivalent of seven-and-a-half fully loaded Boeing 747 jets. At liftoff it will produce 10 percent more thrust than the Saturn 5, the only

NASA rocket comparable to the SLS. The evolved SLS model will be able to lift the equivalent of 143 one-ton pick-up trucks to orbit, with a cargo compartment big enough to fit nine school buses. In both versions of the SLS, the core stage will be propelled by four RS-25 space shuttle main engines. The 130-metric-ton version will employ the J-2X engine in its upper stage — an updated variant of the engine originally designed for the 1968 Saturn 5 lunar mission.

In fact, engineers consider the SLS Saturn's "grandchild." According to Lyles, its technology was "evolved from the Saturn through the space shuttle program." The SLS has the same sleek look of the Saturn rocket, and it's stacked the same way. Moreover, the space shuttle main engine

The initial version of the Space Launch System will be capable of sending 70 metric tons to low Earth orbit.





was itself derived from the J-2 engine on the Saturn 5. According to Lyles, NASA made a deliberate choice to base the design of the SLS on proven technology, incorporating improvements within the tried and true elements. “It’s a lower risk approach, and it’s more cost effective,” says Lyles. “To build something brand new that has never flown comes with a high risk and at a high cost, with no advantage to capability. We believe the most efficient way to approach this is through evolution.”

This cautious approach has been viewed by some critics as too cautious, even redundant. The most noticed reproach came from space expert Lori Garver, who left her position as NASA deputy administrator in September and in January went public with criticism of the SLS in an appearance on National Public Radio: “The rocket is so similar, and it’s built off of 1970s technology. The very engines we’re going to use are space shuttle engines that were developed in the 1970s. Would you really go to Mars with a technology that’s 50 years old? That’s not what innovation and our space exploration program should be all about,” Garver said on NPR’s Diane Rehm show. She stood by those comments when contacted by Aerospace America.

Lyles has heard the “old technology” criticism before, and he says it’s off the mark: “We’re not flying the same RS-25 engine that flew 30 years ago.” Within the proven elements of the basic design of the liquid-fuel cryogenic engine design lies a tremendous amount of new technology, he says. All of the electronics are state-of-the-art, as are some of the manufacturing technologies like friction stir welding, a U.K.-developed technique in which a rotating head turns metals into a “plastic-like state” that’s mixed into a bond, according to NASA. “We’re using some of the most advanced manufacturing technologies in the world today,” says Lyles.

Politics and priorities

But Garver’s focus in criticizing the SLS went beyond its perceived lack of innovation. In the same NPR discussion, she portrayed SLS as a product of politics. “It was something that Congress dictated to NASA. It had to do with the Orion spacecraft. It is a holdover from Constellation, which the Obama administration tried to cancel. And it’s \$3 billion a year of NASA’s \$17 billion. Is that how you would be investing in a

space program?”

Garver is referring to the Constellation rocket and capsule program started by the Bush administration in 2004. Constellation’s mandate was to carry astronauts back to the moon. It comprised design work on the Orion crew capsule — described by then-NASA Administrator Michael Griffin as “Apollo on steroids” — and the Ares heavy-lift rocket. The Obama administration cancelled the Constellation program in 2010.

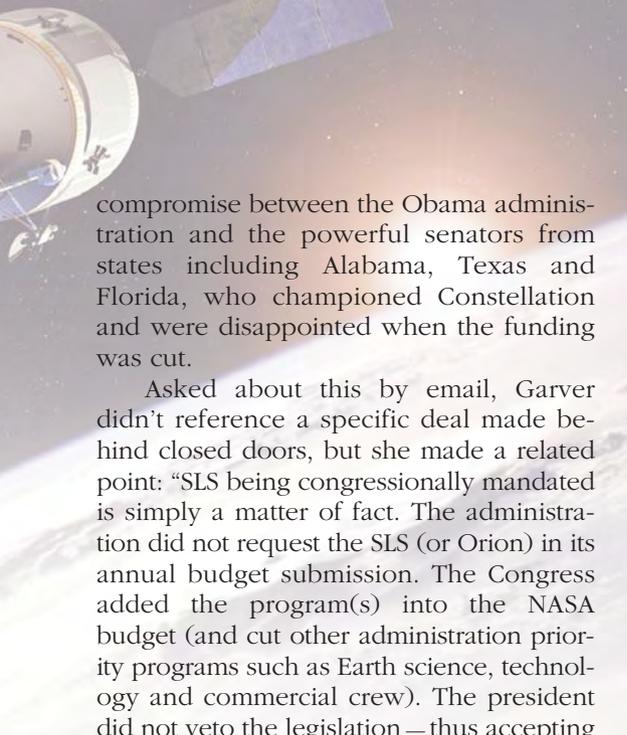
RAND Corporation researcher Peter A. Wilson says Constellation was doomed from the start because of the costs of the wars in Afghanistan and Iraq. “The reality is that the [Bush] White House, much to NASA’s frustration, under-funded the effort because they had a war to worry about. Going back to the moon was hardly a priority for the [Bush] administration; so the project languished,” says Wilson.

The 2009 review of the Constellation program by the United States Human Space Flight Plans Committee, also known as the Augustine Commission, determined that the program could not be completed without major increases in funding. The move triggered some complicated parliamentary maneuvers. The president’s NASA budget request for fiscal year 2011 announced cancellation of the Constellation program, but also called for a total of \$3.1 billion over five years for heavy-lift and propulsion research and development. The NASA Authorization Act of 2010 — the NASA budget bill sent to the president by Congress — added in development of the SLS as a follow-on to the shuttle program.

Congress was first to use the term Space Launch System when it added the program during work on the NASA Authorization Act of 2010, which Obama signed in October 2010.

Wilson’s theory, which could not be independently verified, is that the SLS emerged as a political “senate mandated”





compromise between the Obama administration and the powerful senators from states including Alabama, Texas and Florida, who championed Constellation and were disappointed when the funding was cut.

Asked about this by email, Garver didn't reference a specific deal made behind closed doors, but she made a related point: "SLS being congressionally mandated is simply a matter of fact. The administration did not request the SLS (or Orion) in its annual budget submission. The Congress added the program(s) into the NASA budget (and cut other administration priority programs such as Earth science, technology and commercial crew). The president did not veto the legislation — thus accepting the Congress' direction. This is a matter of record. There were many meetings and discussions during this time, but the simple process is the same as always. The federal budget process is quite simple: The president proposes, the Congress disposes," Garver said in an email.

The SLS will be using the Orion crew capsule originally commissioned for the Constellation program and designed by Boeing, and a very similar engine technology derivative from the space shuttle and the Saturn 5, giving its critics reason to argue that the SLS is basically Constellation redux.

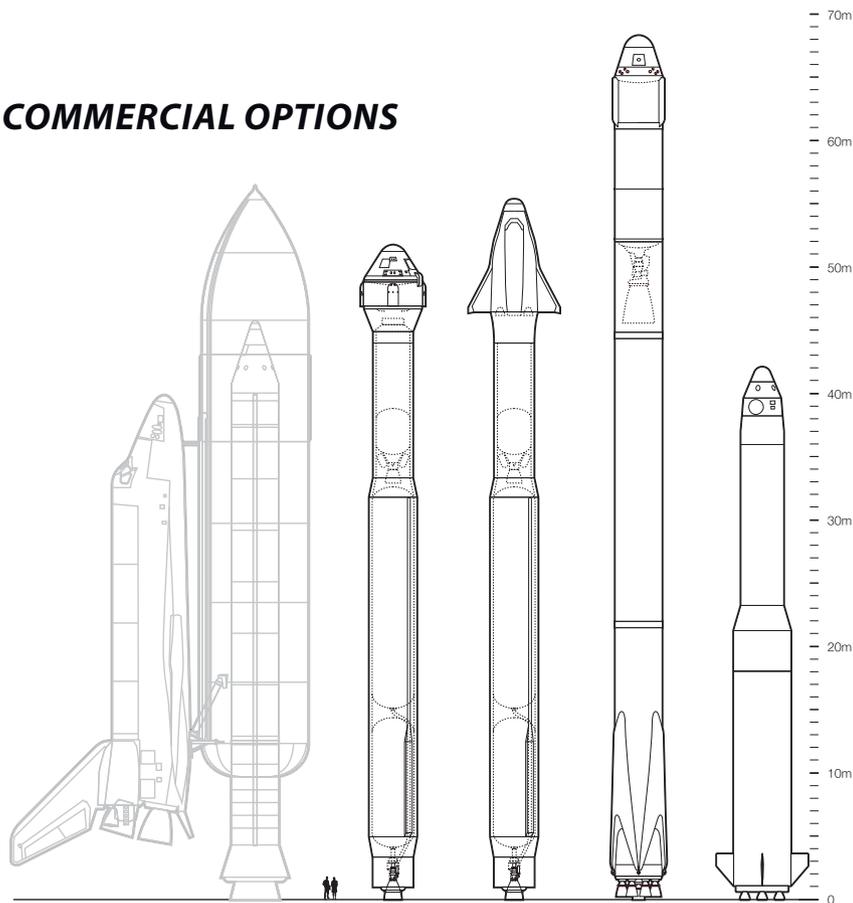
Affordability factor

Wilson is not a fan of the SLS, to put it mildly. He penned an op-ed for an April issue of *Aviation Week & Space Technology*, titled: "Kill the Space Launch System to save human spaceflight." He calls the SLS "a 15-billion-dollar mistake." He said in an interview, "It's a 'field of dreams' strategy: If you build it, they will come." Wilson argues that spending money on a huge undertaking like the SLS is a luxury the U.S. taxpayer simply can't afford in this day and age.

"The manifest for this very large rocket, as we speak, is two flights. One [unmanned flight] in 2017, which is ridiculously close at hand. And then another flight which is supposed to take place sometime in 2021 with some human beings on board; initially it was supposed to be just a fly-by around the moon, and then NASA realized that seemed ridiculous since they've done that in 1968. And now they took up this asteroid mission to at least have the justification to why you'd want to carry it out. The Congress itself is skeptical

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COMMERCIAL OPTIONS



Four main contenders for NASA's Commercial Crew Development program, with the space shuttle shown for scale.



Illustration by John Bretschneider

A Boeing's Crew Space Transportation-100

The CST-100 would accommodate up to seven people. It would be reusable for up to 10 missions and has a weldless design, according to the company. The first test flight is currently scheduled for late 2016, the first manned mission for 2017.

B Sierra Nevada's Dream Chaser

The Dream Chaser would hold seven people within its reusable winged lifting body. It would maneuver through space, dock with other spacecraft, including the International Space Station, and land on a conventional runway.

C SpaceX's Falcon 9v1.1/Dragon

The SpaceX Falcon 9v1.1 is a larger successor to the original Falcon 9. In 2012 the Dragon capsule became the first commercial spacecraft to deliver cargo to the International Space Station and return to Earth. Dragon's first manned test flight is expected to take place in two to three years.

D Blue Origin

The dimensions of Blue Origin's yet-unnamed orbital spacecraft have not been revealed — the artist's rendering is notional only. The company says only that the craft would be launched on a reusable first-stage booster that would separate from the upper stage, descend to Earth, and perform a powered, vertical landing. Blue Origin was established by Amazon.com founder Jeff Bezos.

LAUNCHER

(Continued from page 37)

about the asteroid rendezvous mission because it's a multi-billion-dollar effort. The question is, how is that going to be paid for?" said Wilson.

Wilson questions the need for a heavy-lift space launch vehicle destined for what he calls dubious deep space missions, when there is a promising program focused on manned flight within low Earth orbit that could use the funding currently being directed to the SLS: NASA's Commercial Crew Development program, or CCDev.

Closer to home

CCDev is an effort coordinated by NASA with private contractors bidding to develop a "space taxi," a crew vehicle that would ferry astronauts and potential space tourists to the International Space Station or any other future installations in low Earth orbit. The four main contenders in the program are Boeing's CST-100 spacecraft, SpaceX's Dragon, Sierra Nevada's Dream Chaser space plane and Blue Origin's orbital vehicle. The CCDev program's first scheduled flight was supposed to take place in 2015, but it has fallen behind schedule, with NASA Administrator Charles Bolden blaming funding issues. For fiscal year 2012 Congress appropriated only \$406 million in funds, less than half of the \$850 million requested by the Obama administration.

Proponents of CCDev look with envy at the money slated for SLS. According to Lyles, pitting the two against each other would be like comparing apples to oranges. Though the SLS can stand in as a space taxi if need be, its main purpose is deep space exploration: "The commercial launch vehicle industry is very complementary to the SLS. SLS is focused on beyond lower orbit," he says. "The commercial companies are taking over what NASA used to be responsible for — which is space travel to the lower orbit, essentially to the International Space Station, whether it be crew or cargo. The complementary effect is that we gain a large industry to go into lower orbit; at the same time we can now focus on beyond lower orbit with our launch system," says Lyles.

Reaching higher

And for going beyond low Earth orbit, Lyles says the SLS is the only game in town: "There is nothing there today that I know of that has the payload capability of SLS in its fully evolved configuration." There are commercial heavy-lift rockets

currently flying or in development — Delta 4 Heavy, Atlas 5 and the Falcon Heavy. But experts say neither has enough payload capability to get a crew mission to the moon or beyond without resorting to alternative mission architectures that would involve, for instance, "fuel depots" — in-space "gas stations" where the launch vehicle would stop to pick up the additional fuel needed to proceed. The SLS is big enough to carry all the fuel it will need for a deep space mission.

Mission capability is key, according to Lyles. He says the SLS wasn't designed with a specific mission in mind, but as an evolvable rocket that could service any potential future mission — whether a manned flight to Mars, delivery of cargo to a future lunar orbital station or putting in orbit a large space telescope. In his view, just because NASA hasn't defined all those missions doesn't mean SLS is a rocket to nowhere. "The only reason we don't specify one mission is because we don't want to lock the capability" to one particular mission. Once specific missions are selected, NASA wants to feel confident that "we built in to SLS [the] capability to do any of those. So I don't have to spend money next time to develop something totally new," says Lyles.

For all the criticism, the SLS program seems to be chugging along, hitting the project milestones on schedule and getting its yearly funding approved by Congress. In fact, the SLS has some powerful backers on the Hill. Republican Senator Shelby of Alabama, home to NASA's Marshall Space Flight Center, where NASA is managing the program, is a strong, politically powerful supporter. Shelby said in an email, "If we are to maintain our proud role as the global leader in human space flight, then we must continue to push the current boundaries. Aside from SLS, there is no credible, near-term option to travel beyond low-Earth orbit. That is why I strongly support it." Shelby is vice chairman of the Senate Committee on Appropriations.

One industry veteran says that in a time of over-stretched budgets, having "friends in high places" is what will ultimately assure longevity for a NASA program like the SLS. Despite the heated discussion around the SLS, he says, what matters are the votes of the majority of the U.S. Senators on the Commerce, Justice and Science Subcommittee. If they are on board, the program will proceed. "The rest of the conversation, frankly, is just a bunch of hot air," he says. ▲