

Safety

**in the New
Exploration Age**
Assessing the risks
to astronauts

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Revive the space shuttle

*Not everyone is content to let the space shuttle recede quietly into history. **Don Nelson**, a NASA veteran of the Apollo and shuttle programs, argues the agency's Space Launch System rockets and Orion crew capsules will turn out to be financially untenable and not as safe as promised. He is among the experts who are advocating for development of a fleet of privately operated Commercial Space Shuttle freighters.*

VIEWPOINT

There are two basic options for ferrying humans between the ground and low Earth orbit as part of a deep-space transportation system: construct a heavy-lift Saturn 5-class launch vehicle with an Apollo-like module, or build a vehicle similar to the space shuttle.

The country's space-launch visionaries have long wrestled with this choice. In 1990, with the loss of the Challenger crew a vivid memory, NASA and the U.S. Air Force proposed building a family of expendable rockets called the Advanced Launch System, including a version for human trans-

portation to LEO. After ALS was abandoned, NASA began an Access to Space study, which recommended developing a reusable, single-stage-to-orbit vehicle that was meant to lead to a privately operated replacement for the space shuttle fleet. This was the ill-fated X-33 Venture Star.

NASA's current space transportation plan abandons reusability and private operations, the exceptions being the two Commercial Crew capsules that will serve as space station ferries. For deep-space missions, the agency is leading development of the Space Launch System rockets and Orion

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...but with a commercial twist

NASA

crew capsules, and it plans to operate them when they are completed.

Unfortunately, this plan, like those before it, is based on flawed economic and safety assumptions. A human launch transportation system cannot be operated by the government because there is no incentive to control costs. An affordable, sustainable and safe 21st-century space transportation system must consist of commercially operated, reusable vehicles, derived from existing technologies.

In light of this situation, I am working with an informal group of current and for-

mer aerospace engineers to advocate for development of a small fleet of Commercial Space Shuttle freighters. An initial fleet of three would be operated as a commercial venture similar to Europe's Ariane 5 rockets or United Launch Alliance's marketing of services to the U.S. Air Force. We are convinced that the CSS is the only option that can provide safe and affordable LEO transportation for astronauts on their way to deep space via space tugs and deep-space cruisers.

It's important to keep history in mind. The Saturn 5 and Apollo flew their last mission in 1972. The space shuttle fleet was

retired in 2011. Despite those operational experiences, NASA continues to promise that its Space Launch System rockets will be safe, affordable and sustainable. A reasonable person must wonder: How can SLS be affordable given that all previous U.S. heavy-lift, human-rated systems have proven to be unaffordable?

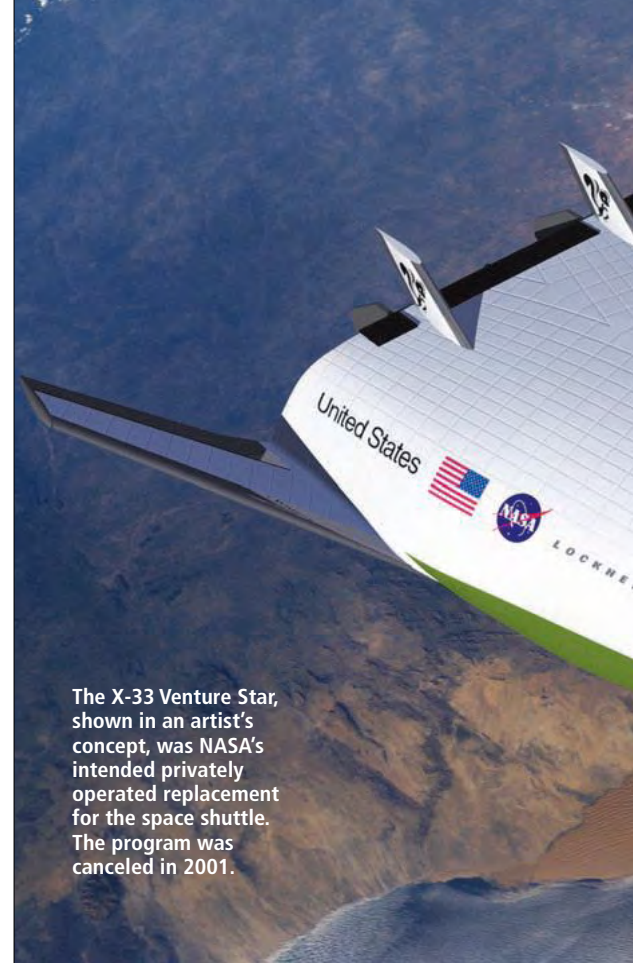
Here is a difficult reality that NASA's plan ignores: Neither the 70-metric-ton nor the 130-metric-ton version of SLS has any significant military or commercial applications. But such launches would be needed to cover the enormous annual operating costs. On deep-space missions longer than 21 days, a still-to-be-developed habitation module would be required, making the Orion capsule dead weight for those missions. SLS will be sustainable only as long as Congress is willing to provide funding.

Regarding costs, NASA says the 70-metric-ton version will cost \$7 billion to develop, but it has not publicly given an estimate for the 130-metric-ton version that would be required to send humans to Mars in the 2030s. If those costs were made public, the resulting sticker shock would kill the program.

On the issue of crew safety, Orion will be equipped with small rockets called the Launch Abort System that would boost the capsule away from a failing launch vehicle. That addresses the Challenger scenario of an emergency during ascent. But what about the Columbia scenario of a mishap during entry? Orion won't have an escape system for that phase. The Orion entry systems must work correctly or the crew dies.

NASA's statement that Orion will be 10 times safer during ascent and entry than the shuttle orbiters was challenged in January by the Aerospace Safety Advisory Panel, a group of non-NASA employees assembled by NASA to examine matters of safety. The panel's 2014 annual report, released in early 2015, predicts that the SLS-Orion combination will not be significantly safer than the shuttle since there is no crew escape system for entry failures.

The Commercial Crew program's privately developed crew capsules have the same safety weakness. Only a crew escape pod would increase survivability, but neither Orion nor the commercial capsules are large enough to accommo-



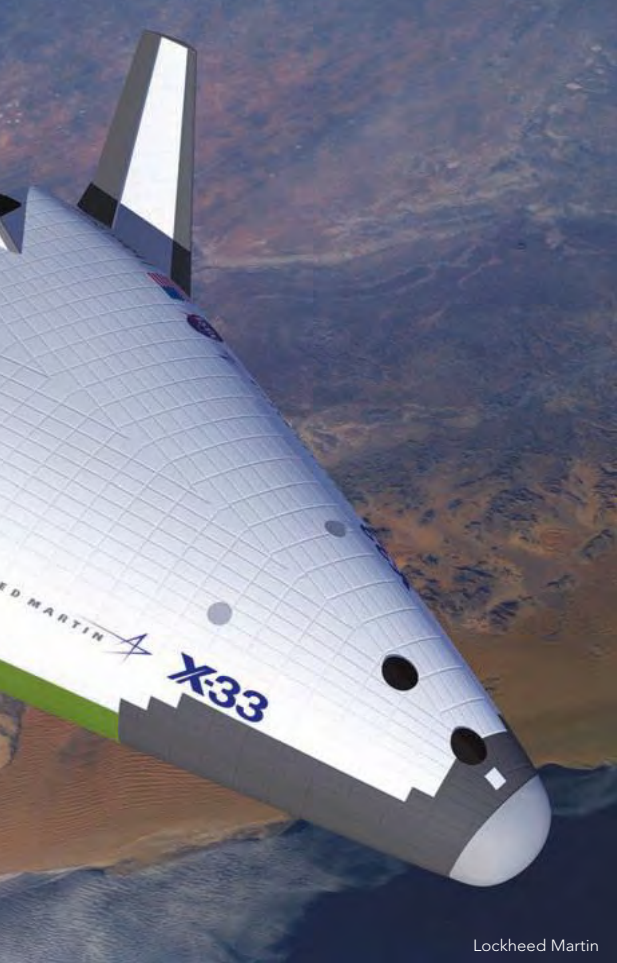
The X-33 Venture Star, shown in an artist's concept, was NASA's intended privately operated replacement for the space shuttle. The program was canceled in 2001.

date such a pod.

All told, the CSS would be more affordable because it would target commercial, military and international launches. It would be safer because of its crew escape pod. Our mission design copies the decommissioned space shuttle's maximum payload and orbital mission, calling for delivery and return of 20 metric tons to a circular orbit of 240 nautical miles at 28.5 degrees inclination. The CSS freighters would be developed with existing technologies and have a launch turnaround capability of five days. Each CSS freighter would resemble the shuttle orbiters, but their construction and operation would be vastly different.

The orbiter, external tank, and solid rocket booster will be constructed primarily of composite materials, which results in a significant weight savings and reduces manufacturing costs for the expendable tank and booster motors. The freighter will be designed for maximum affordability. All subsystems are to be modular with a plug-in replacement capability. It will maneuver in space with environmentally friendly green propellants instead of hydrazine. It will have upgraded main engines, long-life batteries and solar arrays.

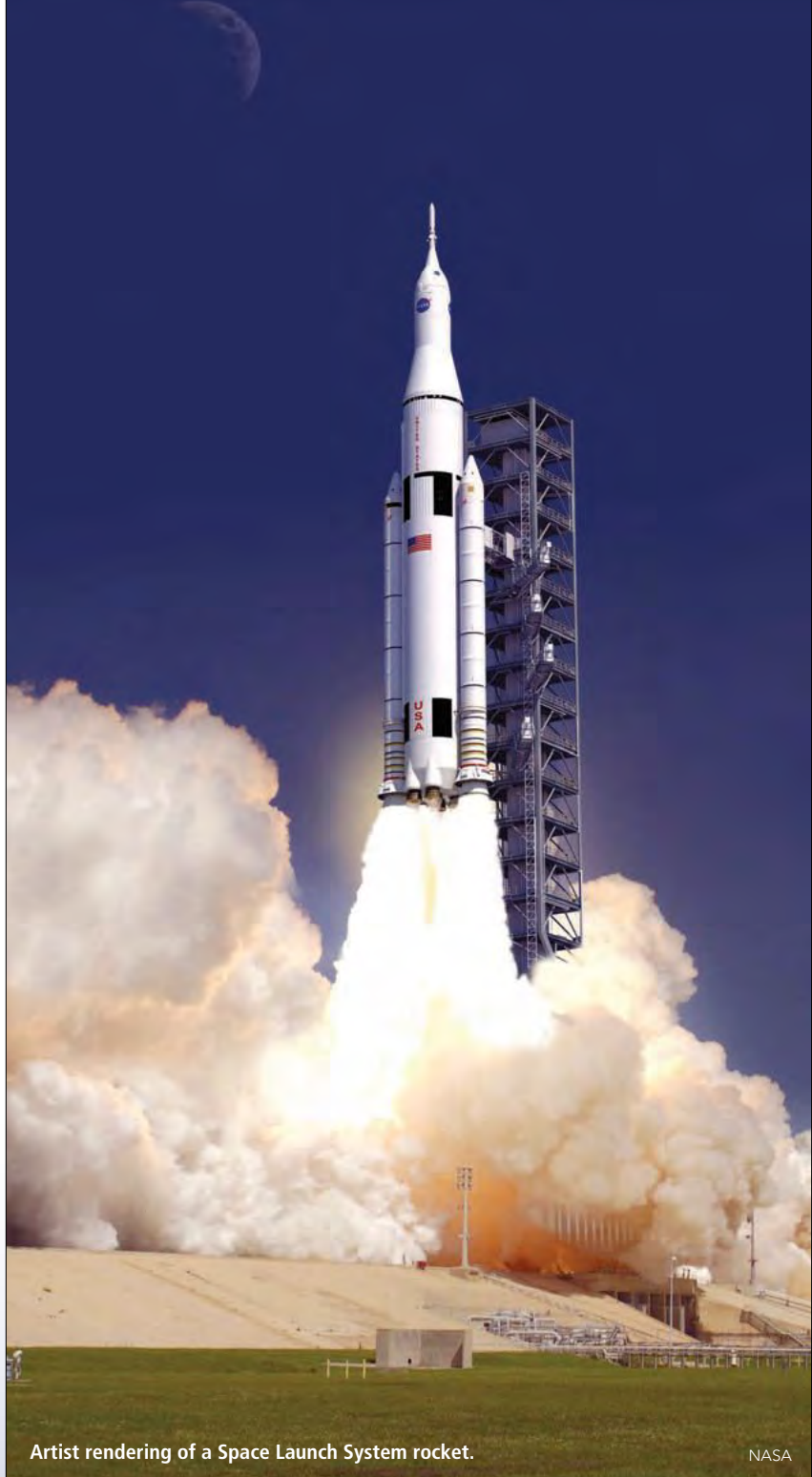
The launcher will be assembled at the



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pad and the freighter will accommodate ship-and-shoot payloads and crew escape pods for manned flights. The thermal protection system will be fourth-generation tiles designed to be repaired or replaced on-orbit. In this configuration and with no civil service overhead, it can provide safe, affordable launches for civil, military and commercial near-Earth missions. With the addition of space tugs and cruisers, CSS could enable missions beyond LEO. The CSS would compete strongly in the international launch market and would have the unique capability in the commercial world to return payloads from LEO.

The concept capitalizes on the nation's operational history with the shuttle program. The shuttle's role in assembling and supporting the space station proves the concept for the CSS freighters. The fast turn-around could help the Air Force respond quickly to foreign threats or a dangerous asteroid or comet, avoiding the almost unimaginable price of failing to meet such threats. Looking to possible competitors, the China National Space Administration reportedly is considering development of a space shuttle, and China appears determined to secure natural resources in space, as shown by the country's lunar program. At the moment, only the U.S. has the reusable tech-



Artist rendering of a Space Launch System rocket.

NASA

nology to accomplish that goal. We should not let that go to waste. The only obstacles for a CSS freighter are political.



Aerospace engineer Don A. Nelson retired from NASA in 1999 after a 36-year career. He worked on the Gemini, Apollo and Skylab projects and was a member of the space shuttle design team. He is coordinator for the Commercial Space Shuttle freighter group, www.spacetrans21.org.