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The shuttle's SRB could be combined with an upper stage to launch a CEV more effectively than an EELV, some believe. (credit: ATK Thiokol/The Planetary Society)

CEV: a different approach

by Jeff Foust
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Although many elements of NASA's Vision for Space Exploration remain ill-defined at this point, eight months after President Bush unveiled the plan, one exception has been the Crew Exploration Vehicle. While design studies for the CEV are only now getting started—such as the exploration studies awarded to eight companies at the beginning of this month—and requirements for the vehicle still being hashed out, there is some consensus about how the CEV will work. Most proposals—primarily in the form of artists' renditions at this stage—envision a capsule-shaped vehicle launched atop an EELV, either an Atlas 5 or a Delta 4 (or both).

There's good reason for this consensus. Before the Vision was released, NASA and industry were working on a similar concept, the Orbital Space Plane. The studies by Boeing, Lockheed Martin, and a Northrop Grumman-Orbital team (which eventually abandoned its effort to cooperate with Lockheed) explored a wide range of potential architectures similar to what the initial version of the CEV will be tasked to do: carry humans into low Earth orbit. Although some of those studies explored winged and lifting-body concepts, there was an evolution in designs towards a capsule, which in nearly every case would be launched atop an EELV.

Nor surprisingly, much of that work was adopted by the same industry teams as they started work on the CEV. In the fall of 2003, Lockheed Martin opened an OSP "Demonstration Center" in the Washington DC area to show off its OSP concepts to government officials and lawmakers; within weeks of the President's January 14th speech, the center became the "Space Exploration Vision Center" . Thus, there's already considerable momentum for the concept of a capsule-based CEV launched atop an EELV. However, there have been some studies, both within and outside of NASA, of an alternative: a capsule CEV with a very different, yet very experienced, launch vehicle.

New life for the SRB

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A major drawback of using an EELV to launch the CEV is that neither the Atlas 5 nor the Delta 4 are "human-rated", that is, not designed to carry people. At the time the Air Force developed the EELV program, it was never envisioned that these vehicles would carry people: that was a task to be left to the space shuttle or its reusable successors then under consideration. Exactly what's required to human-rate either vehicle is uncertain, but most engineers and analysts believe it will require considerable work on both vehicles to increase redundancy and lower the risk of a fatal accident. Although the Air Force funded the development of the EELV—with contributions by both Boeing and Lockheed—any human-rating activity will likely have to come out of NASA's pockets. That's a cost that could potentially run into the billions and take several years—perhaps one reason why the first manned CEV flight is not currently contemplated until 2014.

Despite these problems, and the schedule and cost risk they pose to the Vision, the EELV remains the primary choice for launching the CEV. This is largely because there are few other options for launching a spacecraft the size of the CEV, which will likely weigh in excess of 10,000 kilograms. Once the Titan 4 is retired next year, the only existing American launch vehicles capable of placing that much mass into LEO will be the two EELVs and the shuttle. While entrepreneurial efforts, like SpaceX, might eventually produce large enough vehicles, their focus for the near term is on smaller vehicles.

That's not to say, though, that there are no alternatives to the EELV. Over the last several months a different concept has emerged that uses one of the components of the shuttle: its solid rocket booster (SRB). Although rarely viewed as a launch vehicle in its own right, the SRB is a capable and reliable vehicle that has been used to help carry humans into space for over two decades. Combine it with an upper stage, proponents of the concept argue, and an SRB could carry CEVs into orbit sooner and less expensively than an EELV.

"It started as an idea of safe, simple, and soon," NASA astronaut Scott Horowitz said during a plenary session of the Mars Society's annual conference in Chicago last month. "After the Columbia accident, a few of us in the office were thinking about how we can do this better. How do we get to the point where we can launch lots of people to and from low Earth orbit?"

That philosophy of "safe, simple, and soon" led them to adopt a capsule design for manned spacecraft. Horowitz said they then turned their attention to a launch vehicle for that capsule. "I was thinking, 'What is one of the most cost-effective, safest pieces of hardware that we have to use as a lower stage?'" Horowitz recalled. "I said, 'Hey, what about a solid rocket booster?'"

Horowitz said he ran the performance numbers of the SRB on his computer and found that, in his words, it would be "a hell of a ride." The SRBs burn out after just over two minutes, and although powerful, a single SRB doesn't have enough performance alone to put a manned spacecraft into orbit. At burnout "you're going about Mach 18 and pulling about 20 g's," he said.

Turning the SRB into a launch vehicle requires an upper stage. Horowitz said he and colleagues settled upon the J-2, an engine used on the Saturn 1B and 5. "It turns out that with the J-2 and about 200,000 pounds [90,000 kg] of LOX/hydrogen on this thing, you can launch 40,000 or 50,000 pounds [18,100 or 22,700 kg] to LEO," he said. While the J-2 hasn't been used since the last Saturn 1B launch in 1975, he was confident that the engine would be available, based on conversations with executives at Rocketdyne, the Boeing subsidiary that built the J-2. "They actually have 12 J-2s sitting around," he said, and added that the company felt they could get a production line for new J-2 engines going in a couple years.

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The upper stage would be wider than the SRB—about five meters in diameter—enabling the use of a larger capsule. Horowitz said a capsule five meters across could "comfortably" seat six to eight people, compared to four people that the CEV's predecessor, the OSP, was planned to carry. Horowitz also believed that such a vehicle could launch for about $100 million a flight, although he had yet to run specific cost estimates on the proposed system. That combination of cost and crew size opens up the potential for other markets. "Now you're almost getting competitive with the rates people are paying to go up on the Soyuz as tourists to the space station," he said.

Other voices for the SRB

Horowitz and others at NASA are not the only people speaking out in favor of using an SRB-derived vehicle to launch the CEV. As one might expect, ATK Thiokol, the company that builds the SRBs, is a supporter of the idea. "A human rated and flight proven CEV launch system can be available by simply utilizing a single booster combined with a liquid engine second stage," Mike Kahn, vice president of space operations at ATK Thiokol, said in May during a hearing of the Senate Commerce Committee's space subcommittee. "Additionally, if there is a 35-40K lb payload/cargo requirement instead of the CEV, the same system could be used, further improving overall cost effectiveness."

"So if you polled the astronaut corps," said Jones, "you'd probably find that people, almost uniformly, would be willing to step onto an SRB on the next flight."

In July, the Planetary Society released a report, "Extending Human Presence into the Solar System". The report was the product of an independent blue-ribbon panel, chaired by Owen Garriott and Michael Griffin, who examined alternatives to implementing the Vision for Space Exploration. "We are recommending that strong consideration be given to a specific design using the Shuttle solid rocket motor (SRM), together with a new liquid propellant upper stage" to launch the CEV, the report concluded. "It allows us to take advantage of the existing Shuttle human space flight assets at the Vehicle Assembly Building (VAB) and Launch Complexes 39A and B that would otherwise become idle upon termination of Shuttle operations." The report also noted that the reusability of the SRB "could result in significant cost savings relative to fully expendable vehicles."

Tom Jones, the former astronaut who was one of the members of the Planetary Society's panel, believes SRBs are the way to go for the CEV. Jones noted that the SRBs have flown 176 times since the 1986 Challenger accident—88 shuttle missions using two SRBs each—without a failure. "That's the highest reliability of any rocket flying in the world today," he said during a panel session on space exploration last week at the 2004 International Military and Aerospace Programmable Logic Device (MAPLD) Conference in Washington. "So if you polled the astronaut corps, you'd probably find that people, almost uniformly, would be willing to step onto an SRB on the next flight."

Is there a future for the SRB?

Despite the discussion within NASA and elsewhere about using the SRB to launch the CEV, it's not clear whether there's sufficient momentum behind the idea to at least allow further studies, let alone selection of the concept for development. ATK Thiokol is strongly behind the idea because it gives new life for the SRB—a significant portion of their business—once the shuttle is retired around the end of the decade. For the same reason, the idea may get a lukewarm reception at Boeing and Lockheed, the two companies that would likely be on the inside track to win a CEV procurement contract, because of their vested interest in their own EELV systems.

There are technical issues that a SRB-derived launch system would have to address, notably the development of a new upper stage. However, in the long run the bigger challenges that an SRB-based launcher might have to face are perceptions: that the SRB is an old technology, best left to the past; that solid-propellant motors like the SRB, which can't be turned off once ignited, are unsuited for manned spaceflight applications; that the EELV will need the anticipated volume of CEV launches to lessen the cost burden of the two vehicle programs on NASA and the Defense Department. Successfully handing those perceptions will depend on the champions the SRB design wins within NASA and industry. In a brief interview after his Mars Society presentation, Horowitz admitted that industry was skeptical about the idea at first but has since started to warm to it. There's certainly a lot more work that Horowitz and others will have to do, though, to gain converts to an SRB-launched CEV.

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