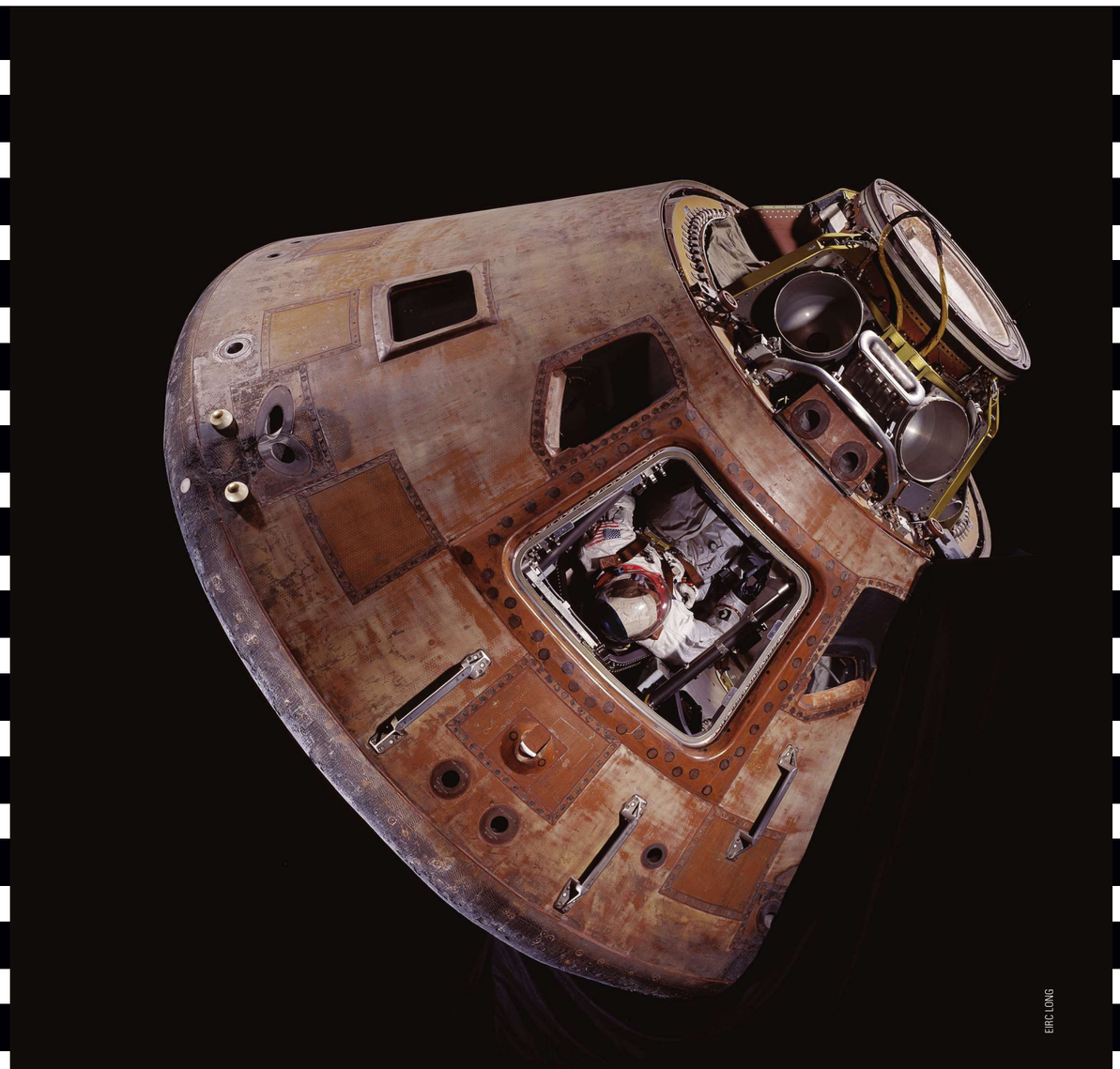


ERIC LONG

Forty years ago, they figured out how to reach the moon. Now they have one word for NASA: "Capsules."

RETRO ROCKETEERS

by James Oberg

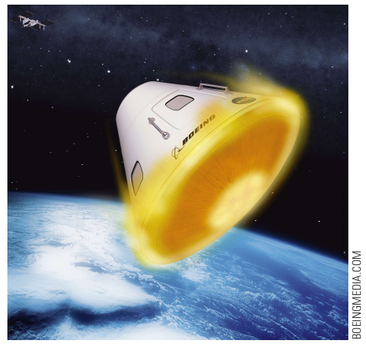
During his 34 years at NASA, Ken Szalai had plenty of interesting work, from testing the world's first digital fly-by-wire airplane system in 1972 to running the Dryden Flight Research Center in California in the mid-1990s. But he never got an assignment quite like the one he was handed in March 2003—five years after retiring from the space agency, and less than six weeks after the space shuttle *Columbia* accident. NASA wanted to know if Szalai, by then a private consultant, could lead a handful of veterans from the agency's golden years in a study to determine if the Apollo space capsule, or at least the Apollo design, could be dusted off and turned into a vehicle for future astronauts.

Their answer was yes, in all likelihood. And that opinion, along with more detailed engineering analyses now being conducted by NASA and its contractors, is figuring prominently in the new White House plan to send astronauts to the moon in the next decade. If NASA's Project Constellation, which aims to build a Crew Exploration Vehicle for reaching Earth orbit and beyond, revives the 1960s-style space capsule, at least some of the credit should go to the high-caliber panel of Apollo veterans who gathered for two days last year in Houston.

Theirs was an old-fashioned meeting—no viewgraphs, massive handouts, or even laptops. It was retro space culture at its best. When they were done, Szalai, who at 60 was the youngest one there, thanked each participant personally and paid the group perhaps the ultimate compliment for engineers: "It was easy to see why everything you once worked on was successful."

At the time Szalai got his call from NASA, the agency's space transportation plans were in disarray. The heartbreak of the *Columbia* accident was only part of the problem. Concepts for a next-generation space vehicle, the shuttle's eventual replacement, were becoming more confused each day, at least to outsiders. Even the name of the program kept shifting—Space Launch Initiative, Orbital Space Plane, Reusable Launch Vehicle. No one was more perplexed than Congressman Ralph Hall (D-Tex.) of the House Science Committee, who asked why the agency had canceled the $3 billion X-38 mini-spaceplane it was building as a lifeboat for the space station, only to replace it with something called the Orbital Space Plane. The Orbital Space Plane, said NASA, would serve as a lifeboat as well as an "up" vehicle for getting astronauts to orbit. Someday, that is. The only thing going up for sure was the price tag: NASA estimated the

Déjà vu? A current Boeing concept looks a lot like the Apollo 11 command module (opposite), now in the Smithsonian.



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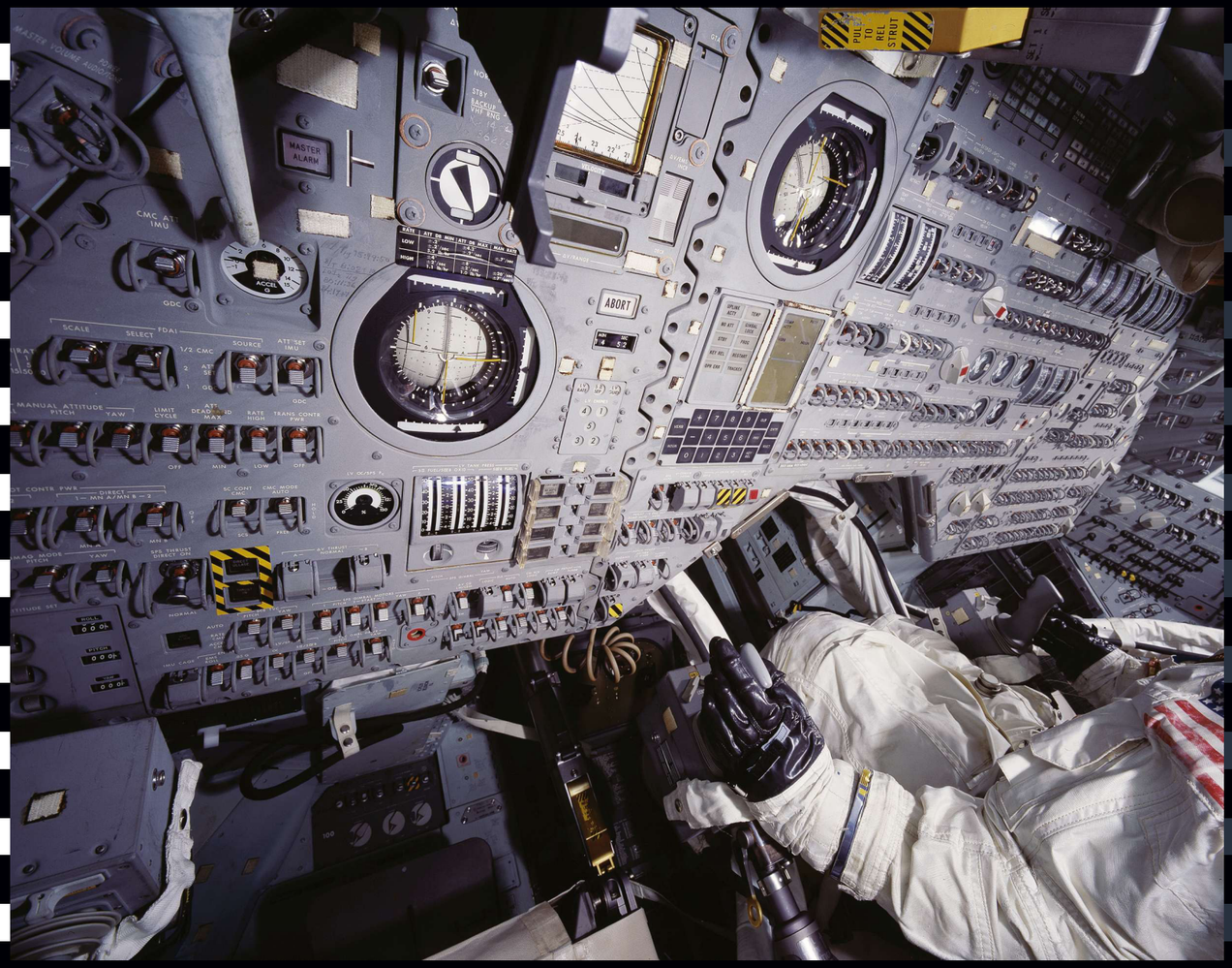
space plane would cost $12 billion, and the cost was climbing.

Against the backdrop of growing Congressional unease, Szalai got a call from managers in NASA's Space Launch Initiative office. It had been several years since they had last looked at the advantages of winged vehicles versus capsules. And now that the agency was talking about a combined up and down vehicle for the space station, the question had once again beeen raised: Could NASA save money by using old Apollo hardware or blueprints? Was there some technical reason why that design couldn't be adapted for this new Orbital Space Plane?

It wasn't a totally novel idea. Prior to the first shuttle flight, in 1981, a serious proposal had been made to place a leftover Apollo command module inside *Columbia*'s cargo bay, docked to the airlock hatch. In an emergency, the astronauts could have entered the module, separated from the shuttle, and returned safely to Earth. Similar ideas kept popping up over the years. Yet NASA had not studied the question in light of its new requirement for a vehicle that was both a lifeboat and a means of getting astronauts to orbit.

"I got the call on a Monday," Szalai recalls. "I was to get the answer to them the following Monday." He spent the first few hours making up a schedule. "I decided immediately on a small team" to keep the discussion manageable. "I didn't want any pushovers—I wanted very strong and opinionated people."

For starters, he knew that Dale Myers, 81, a former deputy head of NASA who had led the North American Rockwell team that built the Apollo command module, was available. From his tenure at NASA, Szalai knew veteran astronaut Vance Brand, 71, who had worked on a five-person command module configuration for rescuing astronauts from the Skylab space station in the 1970s. "And I really wanted John Young," says Szalai. "He's one of the smartest people I know." Young, 72, had traveled twice to the moon in an Apollo capsule, and was still on NASA's payroll in Houston. Aaron Cohen, age 73, was the fifth panel member. Now an engineering professor at Texas A&M, he had headed NASA's program office for the Apollo command and service



The command module's main control panel was state of the art in the 1960s. But an Apollo-derived vehicle built today would likely have all new electronics, displays, and other onboard systems, as well as lighter-weight materials.

One question debated by the Apollo veterans (far left, left to right: Aaron Cohen, Dale Myers, Vance Brand, John Young) was whether ocean splashdowns like Apollo 11's (left) still made sense. Coming down on dry land would be better, they concluded.

OPPOSITE: COURTESY MARY SZALAI; LEFT: NASA; TOP: MARK AVINO

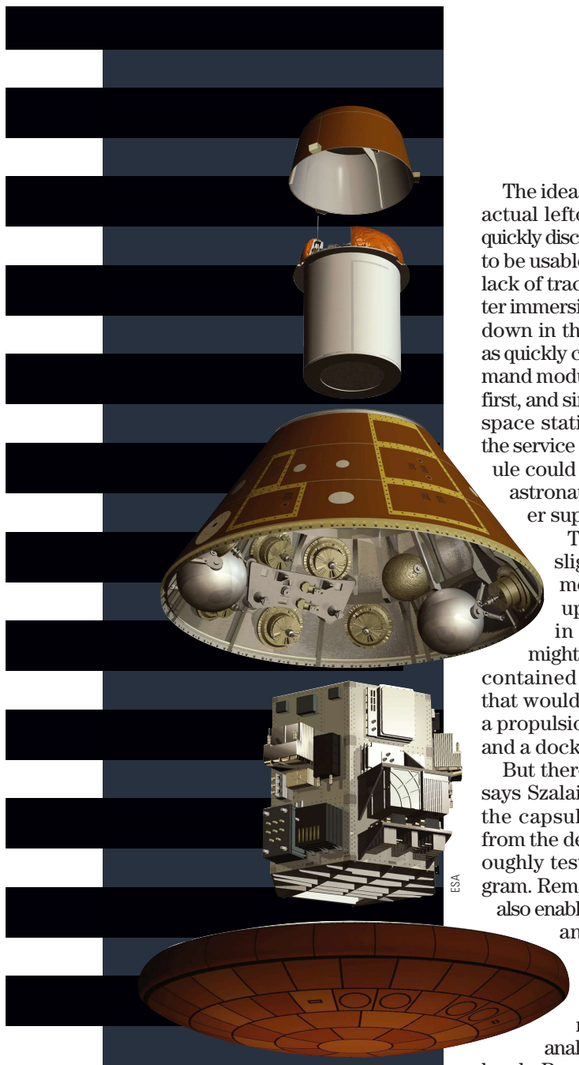
modules and had gone on to direct the Johnson Space Center in Houston.

Szalai got them all on the phone—there wasn't time for a formal invitation letter. He was ready to use flag and country to persuade them to cancel their plans for the week and fly to Houston, but he never had to. "Everybody usually has an excuse," he says, "but none of these people did."

Brand, Myers, and Szalai flew to Houston on Wednesday, while Cohen made the two-hour drive from College Station. On Thursday morning, they got a brief welcome from JSC director Jefferson Howell, then went to work in a conference room on the top floor of the center's administration building. "One of the nice conference rooms," says Myers, with carpeting, soft chairs, and a restroom across the hall. "There wasn't anybody there except us chickens," he adds. "There were no other NASA looker-onners." And no time, really, for reminiscing. Yet the feeling of a reunion was inescapable. "I was stuck in a room with all my old buddies," says Brand.

The first task was to assess the Apollo command module as a possible lifeboat, or crew rescue vehicle, for the space station. That remains NASA's most immediate need, since without it the station crew is limited to three people, the seating capacity of the Russian Soyuz craft. The second question was whether an Apollo capsule could serve as the proposed crew transfer vehicle, which was envisioned to launch from Earth on an expendable rocket, visit the space station, and return to Earth, possibly many times.

The team began by ticking off the Apollo design's advantages. In their formal report, the members called the Apollo command and service module—the cramped three-person capsule plus the cylindrical module that provided propulsion and stored critical items like oxygen and fuel—a "highly successful, rugged, and robust system." Compared with a vehicle like the shuttle, it was simple and well understood, which meant reduced risk. And only six weeks after the *Columbia* accident, risk was very much on the team members' minds. "Everybody reacted that you've got to do everything you can to make the thing safe," says Myers.



ESA

Apollo's advantages have been obvious to other space agencies besides NASA. In the 1990s the European Space Agency came up with this concept for an Atmospheric Reentry Demonstator to return cargo from orbit.

The idea of ransacking museums for actual leftover Apollo hardware was quickly discarded. None of it was thought to be usable, due to age, obsolescence, lack of traceability of the parts, or water immersion—the capsules had come down in the ocean. But the team just as quickly concluded that a rebuilt command module would work well for the first, and simpler, of the two roles—the space station lifeboat. Even without the service module, the command module could accommodate at least four astronauts and enough air and other supplies for a bailout mission.

The vehicle could even grow slightly larger than the 1960s model. "If the CM were scaled up by 5–8%," said the group in its report, "a crew of 6-7 might be accommodated in a self-contained vehicle." The only things that would have to be built new were a propulsion module for leaving orbit and a docking adapter for the station.

But there was a limit to scaling up, says Szalai. You didn't want to make the capsule so big that you strayed from the design that had been so thoroughly tested during the Apollo program. Remaining within that envelope also enabled you to keep the parachute and launch pad escape systems used for the lunar missions.

Whatever data the team members needed for their analysis, they mostly had in their heads. Brand brought along "some stuff about the Skylab rescue mission," and Cohen had "a few thought-joggers, like Apollo dimensions and weights." But, recalls Szalai, "the amazing thing is, nobody referred to notes. The things that are most important to you are burned into your brain."

To keep the stretched Apollo capsule from getting too heavy, the group counted on 40 years of progress in lightweight composite materials. And even though upgrading to a station-compatible cabin air pressure of 15 pounds per square inch, three times Apollo's pressure, would add weight, that wasn't considered to be an insurmountable problem.

This was only the basic vessel, though. Inside the roomier command module, practically nothing would remain the same. "Virtually every system would have to be redesigned, even if it were decided to be replicated," the group concluded in its report. "Entirely new electronics systems and displays will be required."

Szalai recalls wondering, "Could you use *any* of the [old] hardware? We spent a few hours, system by system. None of it was supportable; vendors were long out of business. Could we even use the seat? No, we knew how to build better ones now." One item did survive, though. The Apollo hand controller, used for pilot inputs, could "probably be replicated," the report stated, although the software that ran it would have to be rewritten from scratch.

"By the end of the first day," Szalai recalls, "we knew where we were going." The team disbanded for the evening, some heading to the homes of relatives, some to dinner (and further discussions) at their hotel. The next morning, they turned to Apollo's landing method, the classic splashdown. Here the group departed from tradition: They agreed that there is an advantage in coming down on dry land: After all, the Russians had been doing this for years with Soyuz capsules (see "Aiming for Arkalyk," Aug./Sept. 1998). Dry landings would eliminate the expense of rescue ships but would require the engineering of new descent hardware.

Myers, briefing the House subcommittee on space a few months later, called the dry-land landing system "the only major new technology, other than long-duration storage in space," needed to convert an Apollo command module to a lifeboat. The requirement to make an emergency return anywhere on Earth within 24 hours would add expense and complication, since NASA would need a large number of landing sites to be on standby. But if a service module were attached to provide steering and propulsion, the number of sites would drop dramatically.

Testifying before that same panel, Michael Griffin, a former NASA chief engineer, dismissed worries about landing accuracy. Now with In-Q-Tel of Arlington, Virginia, Griffin told the panel: "Most of the Apollo landing dispersions would have fit easily within the boundaries of Dulles Airport. It is not necessary to do better than that."

Szalai's group then turned to the subject of heat protection. The ablative material used on the Apollo heat shield—a phenolic epoxy resin—is no longer manufactured. Fortunately, better materials have come along since, some of which have even been flight-qualified. In fact, the heat shield for an Apollo-derived crew rescue vehicle would have a key advantage over the original: It could be a clip-on, discarded after the fiery return to Earth. And that, said Griffin, made the Apollo-derived rescue vehicle "a system with only one non-reusable component that…can be, almost literally, dirt cheap."

If the Apollo command module appeared to be a perfectly good lifeboat, all the same advantages applied to the crew transfer, or "up" vehicle. The capsule could easily be perched on an expendable rocket, like a Delta or Atlas, for delivery to orbit. If NASA wanted to return to the moon, a wingless capsule looked even more appealing. Griffin told Congress that a semi-ballistic capsule like Apollo's would be "much better adapted [than winged vehicles] to any requirements to go beyond low Earth orbit."

As their analysis kept pointing to the advantages of the Apollo capsule, some of the oldtimers found themselves surprised. Coming into the meeting, Szalai thought "there were expectations [within NASA] that the [Orbital Space Plane] would end up as some type of winged vehicle." The space veterans he invited were future-oriented, and their instincts were to produce new designs. If anything, he says, "initially the bias in the room was away from the capsule, not for it." But toward the end of the second day, Szalai voiced his thoughts: "I'm an airplane guy. Why am I recommending a capsule?" Then John Young piped up: "So am I."

At the Congressional hearing, Myers said, "If all things were equal, I'd choose winged vehicles," based on their gentler entry and ability to reach a wider range of landing sites. "Unfortunately, they are not known to be equal. And that's why the team recommended a thorough study of the Apollo CM/SM as a CRV/CTV." The team estimated it could be built within four to six years of NASA's go-ahead.

And so it may be. Even before Szalai's group met, NASA's two main contractors, Boeing and Lockheed Martin, were studying capsules—some rounded like the Soyuz, some cone-shaped like Apollo—as contenders for the crew rescue vehicle. Now that the plans also call for going beyond Earth orbit, the wingless designs may win the day.

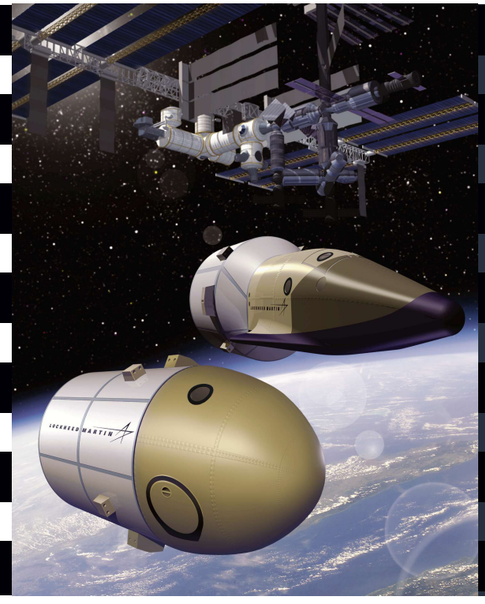
"Everybody likes sleek and beautiful," notes Volker Roth, deputy director of Boeing's Office of Orbital Space Programs in Huntsville, Alabama. "But is that safe and robust?" And former astronaut Michael Coats, who heads Lockheed Martin's advanced space transportation division, says current astronauts may not be that stuck on wings. He thinks they'll go for whatever is "safe, simple, and soon."

Not everyone has jumped on the Apollo bandwagon. Last July, at a forum held in Washington, ex-Congressman Robert Walker, now a consultant who often serves on aerospace advisory committees, said that any capsule design would be a problem for Congress. "It becomes, in the minds of people here on Capitol Hill, a huge step backwards," he says. "It means, essentially, that we're trying to adapt technology that we know how to build."

Some advocates of reusable spaceplanes don't want to give up on the possibility of building a true single-stage-to-orbit vehicle, which could also have military and civilian passenger applications. Dana Rohrabacher (R-Calif.), who chairs the House subcommittee on space, has been among those pushing hardest for NASA to invest in "next generation" space transportation. But, he told *Space News* last year, "If somebody came in and showed me that a capsule, engineered in the right way, could accomplish all the things we need and was cheaper and would be ready to go quicker, than I would be open-minded to it."

As for NASA, it's mulling the whole business over. In January, Administrator O'Keefe appointed retired Navy Rear Admiral Craig Steidle, who headed development of the Joint Strike Fighter airplane, as director of the new Office of Exploration Systems at NASA headquarters. For now, Steidle steadfastly refuses to speculate on what Project Constellation's crew exploration vehicle ultimately will look like. And all O'Keefe would say before a Congressional committee in February is that a "spirited argument" is debating whether the vehicle will be reusable.

"We believe a capsule still makes a lot of sense as one element of the [crew exploration vehicle]," says Coats. It could be late summer before Steidle decides whether he agrees. If NASA opts for the capsule, it will come as no surprise to its contractors, nor to the Apollo veterans who came to the same conclusion 40 years ago, the last time the nation set its sights on the moon.



LOCKHEED MARTIN

Lockheed Martin has considered both lifting bodies and ballistic capsules for the proposed Crew Exploration Vehicle. The rounded capsule (below) is shown attached to a service module, which provides propulsion.