{ INTERVIEW }

Space Bu

Apollo 11 Moon-walker Buzz Aldrin talks about the future of space flight.

When you sit down with Buzz Aldrin, you feel the presence of a larger-than-life figure. Although he is now 75 with tufts of white hair edging his head, the passion and energy are still very much in the retired astronaut and fighter pilot, as evidenced by the intensity of his eyes, articulate ideas, and deep thoughts. The second man to walk on the Moon, some 35 years after the fact, remains a highly impressive human being.

For three of *Astronomy*'s editors, Robert Burnham, Frank Reddy, and me, and Mark Paternostro of Chicago's Adler Planetarium, the moment came together in a strange place. Always a friend and supporter of the magazine — and a member of our editorial advisory board — Aldrin spent a day at the iHobby Expo, the international toy and hobby fair, in Chicago in October 2004. We had a short time to talk with him, squeezed into his busy promotional schedule. By the time Aldrin sat down with us, relieved to be talking about space exploration and weary from signing autographs, he seemed in his element. We talked for more than 90 minutes and produced more than 7,000 words, mostly on where he sees space programs going.

Apollo 11, the Moon mission he completed with Neil Armstrong and Michael Collins — an event that transfixed the world — is only one milestone in the Aldrin tapestry. A native of New Jersey, he is the son of an aviation pioneer who studied rocketry under Robert Goddard. Aldrin was graduated third in the West Point class of 1951 and flew 66 F-86 combat missions in the Korean War, shooting down two MiG 15s. He was selected as an astronaut in 1963.

DAVE EICHER

"IF WE CONTINUE TO QUESTION what we decide to do, then we have a problem."

Altogether, Aldrin logged 290 hours in space. He flew on Gemini 12 with James Lovell before walking on the Moon during the historic Apollo 11 mission. Since resigning from NASA in 1971, he has remained at the forefront of promoting America's leading role in space exploration.

Aldrin has created a plan for a spacecraft he calls "The Cycler," which would shuttle between Earth and Mars. He received a patent for a space-station design. His rocket-design company, Starcraft Boosters, and the nonprofit ShareSpace Foundation, devoted to space tourism, take much of his time and energy these days.

Aldrin has written five books and numerous articles on his adventures. He actively speaks, travels, and analyzes space exploration and technology. Our opportunity to talk with him produced an array of thoughts about the past, present, and future of space flight — the highlights of which follow. — *Dave Eicher*

BUZZ ALDRIN WALKS on the Moon July 20, 1969, becoming the second human to set foot on another world.

NASA

Astronomy: **Where do you think space flight is going, and how do you think the private space sector will develop?**

Aldrin: Well, we're just beginning to see private space companies trying to launch satellites with small and medium payloads. The big companies were the ones that were involved in government military launches.

Private companies haven't had a great amount of success. I'm thinking of the number of rocket companies that have tried to get underway. Orbital Sciences succeeded fairly well. Kistler Aerospace introduced reusable two-stage rockets, but they're bankrupt now and trying to figure whether they can come out.

Now, in terms of adventure travel initiated by the X Prize, that's taking a little bit longer to develop than we thought. There are lots of ideas, but really only one [Scaled Composites] that so far has come anywhere close to trying to develop what was envisioned by the prize: something that might be converted into a commercial activity. And it looks like after demonstrating the capability with SpaceShipOne, it's not commercially attractive. There aren't enough people on board, so they're going to defer trying to get it qualified for commercial operations and not fly it again, but instead go for a more viable number of passengers.

Astronomy: **What do you think about the Moon-to-Mars initiative?**

Aldrin: We really have to complete the space station first, if at all possible. That means we have to return to flight and then, as soon as possible, retire the shuttle by 2010 perhaps and not keep it going until 2020 or 2025. Those were all good decisions.

Now, how can we afford to do that in this political environment, with an economy that doesn't look good and a war going on? I evaluate what was offered by the president as being very good. Where do we want to go? Not just to Mars. If we ever skipped the Moon and said we're going to go straight to Mars, it would get bogged down in the

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AFTER WE RETURN TO THE MOON, "I think we should follow up on asteroid detection and characterization by having robotic visits followed by a human visit to an Earth-crossing asteroid."

process of design without much happening. We'd end up going once or twice and then it's canceled.

But if you build up the capability, and you don't get stuck in just going to the Moon … it's a question of future management. I think we need to spell out what we're doing not in NASA decadal intervals, but in political 4-year intervals that start January 20 of the post-election year, when the president takes office. That's when he institutes his 4-year plan. We can't just have successive new programs every 4 years, we need to look ahead eight or nine 4-year programs — chart out in that grid what it is we think we can do. The closer it is to the present time, the more precise it is. It gets more nebulous out in the future. By the eighth plan, in 2033, we ought to have reached Mars. I think it's a good plan that's been set out.

One problem is that we have left a big hole by not having a lifeboat at the International Space Station. And that's unfortunate because I suggested the X-38, which was a lifeboat only, wasn't versatile enough. For us to build that when it wouldn't provide alternate transportation probably would have been a mistake. But, when NASA canceled the X-38 without a follow-on and some possible competition, it left us in a pickle. Now, exploration is going to defer that even further.

***Astronomy*: How much international cooperation do you think we should seek in doing these projects?**

Aldrin: I want to visit China to inquire about their Shenzhou rocket. I think I could try to build consensus around our country encouraging the use of Shenzhou as a possible lifeboat. If a lifeboat is built in China, it would compete with Russia's Soyuz, which will then drive the Russians to lower their cost and not put so much of it on their international partners.

The Russians will be encouraged to put their money into Kliper [for "clipper ship"], which is a six-person vehicle, and a much better design. And then, if that design also can be useful to international exploration efforts, we can have a commonality of components in some parts of the design for a crew-carrying, passenger-carrying spacecraft. We'd have an assured human access to space, which is something that's needed.

We can't really begin exploration when we have the potential for a single failure that can ground our ability to get people up and down when we've got people at the Moon or somewhere else. We have to have something else in our overall plan. And I think that can come from the gap that exists by bringing China in and moving Russia to do something better.

***Astronomy*: What do you think of NASA's decision on servicing Hubble?**

Aldrin: The whole idea of canceling a human shuttle mission to Hubble was clearly poor public relations, and poor timing in the announcement. I think it should have been anticipated. The groundwork should have been laid where the top priorities were the criticality of flight safety and the crucial question of how many missions we can fly before we approach the shuttle's retirement, which we'd like to see in 2010. I think it's going to be very difficult to fly all the station-assembly missions with the shuttle and finish by 2010. The difficulty of adding one or two more missions for servicing Hubble was behind the desire not to send a crew there as much as anything else.

Well, what else can we do? We can develop the robotic ability to accomplish the mission. We need to develop that capability anyway, to do things like attach a reentry propulsion module to Hubble.

The situation wasn't handled too well. I know a lot of people say maybe it's simpler to send a shuttle there and fix it. I guess we can always do that. I would rather let the president set a course and then support it. Let NASA decide it's not going to service Hubble. And then, if that won't work, we do something else. So I tended to support the decisions that were made rather than disturbing the whole setup by questioning what we're doing. If we continue to always question what we decide to do, then we have a problem.

I'm a military guy. We've got to have a chain of command. We've got to make

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> ... we should commit to a permanent settlement on Mars before we start making big investments.

some decisions and then stick by them. If we don't like them, elect somebody else and then carry out a different set of plans.

There's a lot of good work Hubble can still do. It's a big investment we've made. But it's already exceeded its design life, and we should move on to other things.

We could keep flying the shuttle until there's only one left. There's a tendency in government never to terminate things when they should be terminated. You move on to something else. Sure, you can continue to put money into something and get a little bit more out of it. Then, if somebody who's in a position to make those judgments and has been given that responsibility decides to do that, I'm in favor of letting that decision stand. Instead of saying: "Hey, wait a minute, that's disturbing my pet idea." Now we've wasted a lot of time arguing about things. That just goes with discipline, organization, and chain of command.

Astronomy: **Where should we go after we return to the Moon?**

Aldrin: I think we should follow up on asteroid detection and characterization by having robotic visits followed by a human visit to an Earth-crossing asteroid. This is what we would want to do to bring resources back. The first purpose, though, is to demonstrate, maybe robotically, that we can somehow nudge an asteroid to keep another one that is going to impact Earth from actually impacting. It's planetary defense.

I think that after human landings and resource acquisition on the Moon, we should tend to withdraw people from there and automate lunar missions. The next step is a human visit to an asteroid once or twice. That would serve as a precursor to a mission to the moons of Mars, for at least one Mars launch window and maybe two. Primarily, we would keep crews at the moons of Mars, but they could make forays to the surface and back up again during a year-and-a-half stay, if we feel qualified to do that. But then, we should follow that with missions to Mars' surface, now that you have a habitat on the moons of Mars as an escape or safe haven in orbit.

Astronomy: **If you look at Wernher von Braun's original ideas, he was talking about building a space station and then assembling a Moon-ship in orbit. And there would be this space plane that would bring you back to Earth.**

Aldrin: The problem with that is you need a lot of propellant when it comes back, if you don't use air braking. I don't think we're quite ready for coming back and grazing the atmosphere, slowing down, and then making the orbit circular. I think we'll go through some of those ideas. What choices we make, perhaps, could be governed by which leads us best to a Mars capability. I'm still an advocate of the efficiencies that are enabled by the use of semi-cyclers or cycler spaceships.

Astronomy: **Could you explain those?**

Aldrin: Well, in 1985 and '86, I pioneered the idea of Mars cyclers. Basically, you place a spacecraft in an orbit that goes

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PILOT BUZZ ALDRIN STROLLS outside the Gemini 12 spacecraft November 12, 1966. Here, he is seen next to the Agena work station.

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PAUSING FOR A MOMENT inside the cramped Apollo 11 lunar module, Eagle, pilot Buzz Aldrin anxiously waits to make the first descent to the Moon's surface.

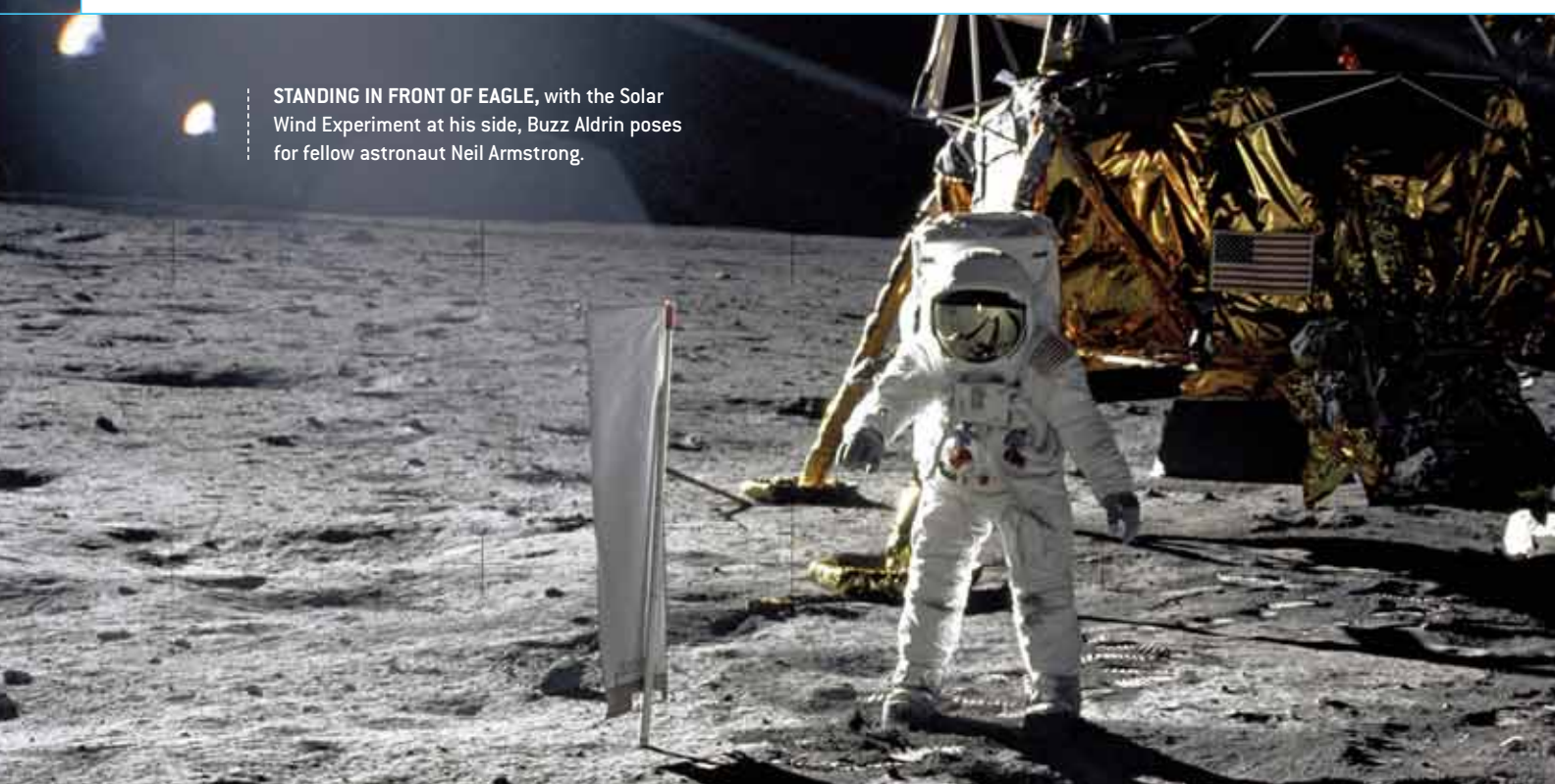
around the Sun, like Earth and Mars, but it ranges from just inside Earth's orbit at closest approach to somewhat outside Mars' orbit at its greatest distance. So, the spacecraft connects the two planets by swinging by each. You get a gravity assist from each swing-by that fine-tunes the trajectory. Then, you have smaller "taxi" spacecraft that deliver crew and cargo from orbit around either planet to the cycling spaceship.

Successive pathways from Earth to Mars change the launch opportunity. By the time the Sun, Earth, and Mars line up, at opposition, you should have left Earth and be about halfway to Mars or you should have left Mars and be halfway back to Earth. Now, that opportunity reoccurs about every 26 months, so the cycling spacecraft's orbital ellipse has to be bent. And the only way to do that is swinging by Earth and getting most of the bending from Earth.

There are ways of easing into this with two cycler spaceships that give you paths from Earth to Mars and Mars to Earth. One cycler is always taking you there; the other is always bringing you back. A disadvantage is that because the spaceship goes quite a bit outside Mars' orbit, the encounter velocity at Mars is fairly high. You intercept the return cycler at a high velocity; we'd like to have it lower. For early missions, this means a very critical intercept is required to get home.

You usually want a backup to that. Well, whatever the alternative is may be a better choice than the primary. That's why you get into the possibility of semi-cyclers, where you have something in orbit at Mars that leaves there, swings by Earth but doesn't stop here, and then goes back to Mars and waits there. That's the semi-cycler. And there are different combinations where you can decrease the velocities. That just hasn't been as thoroughly examined. It will take ingenuity, creativity, and computer time — it doesn't cost a lot of money.

Building a nuclear rocket, testing it, seeing whether you can shorten the transfer time through propulsion — that's expensive. And, besides that, you've got to convince the public it's an acceptable thing to do. We know we need nuclear power for electricity when we get out to Mars' distance. It would be nice to test it at the Moon, in addition to testing other things at the Moon.



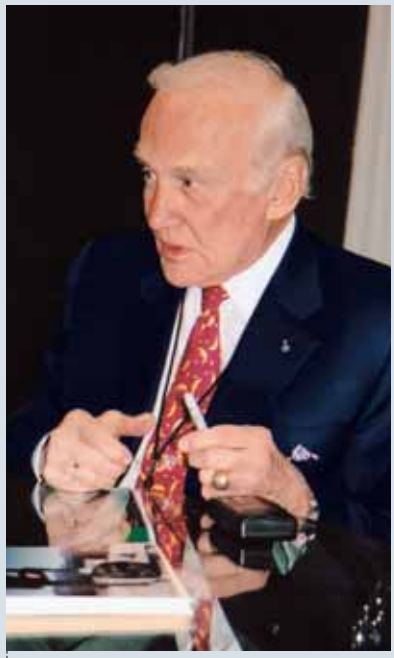
STANDING IN FRONT OF EAGLE, with the Solar Wind Experiment at his side, Buzz Aldrin poses for fellow astronaut Neil Armstrong.

Born:
January 20, 1930, in Montclair, New Jersey

Education:
- Bachelor of Science from the United States Military Academy (1951)
- Ph.D. in astronautics from the Massachusetts Institute of Technology (1963)

Air Force:
- Flew 66 F-86 combat missions in Korean War (1950–53)
- Commander of U.S. Air Force Test Pilot School at Edwards Air Force Base, California (1971–72)
- Retired as colonel in March 1972

NASA:
- Selected to third astronaut group in October 1963
- Logged 289 hours and 53 minutes in space
- Flew with James Lovell on final Gemini mission, Gemini 12, in November 1966; established new record for extravehicular activity, spending 5½ hours outside capsule
- Flew with Neil Armstrong and Michael Collins on Apollo 11 in July 1969; became second person to walk on Moon, spending 2 hours and 14 minutes on the surface



DAVE EICHER

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Astronomy: **What about robotic exploration in the future? How do you see things that will be done robotically in the solar system versus manned missions?**

Aldrin: I think you'll always send robotic vehicles first, to see what things are like, to prepare the way, to put beacons down, maybe to use the local resources — whether it's the atmosphere of Mars to produce propellants, or whether it's using some surface material and some process to generate propellants, or just to land propellants there ahead of time. Get the places ready so that when you get there, you have augmented your living capacity and your return capacity. You do that robotically. You also can go farther distances robotically.

I think you can carry that maybe one step further, and you start looking at robotics for something close by like the Moon. For communication, it's only a second and a half away. We know how to deal with that kind of lag time. With feedback and the increased ability of automation, we can control robots on the Moon from Earth pretty well. Why do we need people there? Let's send people there initially to set some things up. But there's 14 days of darkness and 14 days of daylight, temperature extremes, no atmosphere, not much water — it's not too good a place.

We can send things up and then have minimum occupancy or zero occupancy. Then, if we need people there, we can send them if we have a good transportation system. So going back to the Moon, you go back with humans as a precursor because you're learning how to operate humans there, and then you're going to use what you learn to operate people on Mars.

Robotics could work in much the same way at Mars. It's clearly advantageous to send a precursor mission to set up some habitable spaceport facility on Phobos or Deimos, whichever moon turns out to be more convenient, or maybe both of them. You then can use them as safe havens. You also get great coverage to control robots all over the martian surface with human intelligence at less than a 1-second time delay.

Now, Mars is not as easy to get to as the Moon. If things go wrong, they're harder to fix; it takes more effort. I definitely think it justifies a growing permanence. So much so that I think we should commit to a permanent settlement on Mars before we start making big investments. Barring some catastrophe, we should establish a settlement and continue to build it up indefinitely. If we're not willing to commit to that, don't go.

Astronomy: **On a different note, can you tell us what the Moon looked like while you were heading there on Apollo 11?**

Aldrin: Surprisingly, the Moon looks the same until you get quite close. But by that time, it just so happened, our path was taking us in a direction that brought the Sun into view as well. So, as we're approaching the Moon, pretty soon the Moon is big and it eclipses the Sun.

As soon as we looked out and saw this happen — it was really amazing because the Sun was behind the Moon, and the Moon was big and the Sun was small. But there was this glow. There's no atmosphere on the Moon, so it probably was the solar corona we were seeing. What it looked like was a three-dimensional, suspended Moon with this beautiful glow surrounding it. It was like nothing we'd ever seen before. We tried to take some pictures, but they didn't turn out.

Astronomy: **And that was on the way?**

Aldrin: Well, we were getting pretty close. And pretty soon, we had to knock that off and get pointed in the right direction, because we had to get ready for a maneuver to stay in the Moon's orbit.

That maneuver, of course, worked flawlessly, as did the rest of the Apollo 11 mission. On July 20, 1969, Aldrin watched from a few feet away as Neil Armstrong took a small step onto the Moon's surface. Later, Aldrin voiced the crew's sentiment: "We feel this stands as a symbol of the insatiable curiosity of all mankind to explore the unknown." It's clear, three-and-a-half decades later, Aldrin remains dedicated to that vision.

To read the entire interview with Buzz Aldrin, visit www.astronomy.com/toc

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