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News Service
1132 ENAD
West Lafayette, IN 47907-1132
(765) 494-2096 Fax (765) 494-0401

February 5, 2002

Former astronaut Aldrin, Purdue engineers planning Mars hotels

WEST LAFAYETTE, Ind. — Buzz Aldrin, the second man to walk on the moon, is leading a team of researchers, including engineers at Purdue University, to design a new class of spacecraft that would serve as orbiting hotels perpetually cruising between Earth and Mars.

The "cycler" spacecraft would constantly ferry people and materials between the two planets, enabling earthlings to explore, commercially develop and eventually colonize the Red Planet.

"We believe these regular planetary flybys would create an entirely new economic and philosophic approach to space exploration," the researchers wrote in a December report prepared for NASA's Jet Propulsion Laboratory. "Reliable, reusable and dependable cycler transportation can be the key to carry humanity into the next great age of exploration, expansion, settlement and multi-planetary commerce."

Aldrin is working with a team of researchers, including professors and engineering graduate students at Purdue, the Massachusetts Institute of Technology and the University of Texas. The former astronaut is an engineer by training and holds a doctorate from MIT.

"We are going to put in a proposal for a more detailed study to narrow down some of the choices of the different kinds of cyclers and decide which ones seem to fit into a very nice operational mission," Aldrin said.

Modified versions of the space shuttle's external fuel tank might be used as building units for cyclers. The tank ordinarily is jettisoned during shuttle flights, and it burns up in the atmosphere. However, the shuttle's external fuel tank could be modified, adding two additional empty tanks atop the existing fuel tank. Instead of being jettisoned, the modified external tank assembly could then be carried by the shuttle all the way to low-earth orbit, where the dry tanks could be separated from the main tank and used to construct the spacecraft.

Cyclers would take advantage of the gravitational forces that are exerted by the sun, the planets and their moons, which provide "gravity assists" to passing spacecraft. As a spacecraft travels close to a planet, its flight path is bent, causing it to whip around the planet while boosting its speed. The path is commonly called a "slingshot" trajectory, which enables a spacecraft to achieve the proper speed and heading.

"The cycler essentially is in orbit around the sun and makes regular flybys of Earth and Mars," said team member James Longuski, a professor of aeronautics and astronautics at Purdue. "Once you put your vehicle into a cycler orbit, it continues on its own momentum, going back and forth between

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Earth and Mars. You may need to carry some propellant for an occasional boost, but it's pretty much a free trip after that."

In their report to JPL, researchers said a cycler would practically fly itself and "become a permanent, man-made inner solar system companion of Earth and Mars, tapping the free and inexhaustible 'fuel supply' of gravitational forces to maintain orbit. Like an ocean liner on a regular trade route, a cycler will glide perpetually along its beautifully predictable orbit."

However, it is difficult to precisely design cycler trajectories because of the complex orbital relationship between Earth and Mars as the planets travel around the sun. While the Earth orbits the sun in a nearly circular route, Mars' orbit is oblong, or elliptical. That means the distance between Mars and the Earth varies dramatically depending on Mars' orbital position around the sun, complicating the design of spacecraft trajectories between the two planets.

"If they were both in circular orbits, any cycler that you would design would repeat perfectly over and over again," Longuski said. "Mars' orbit is somewhat eccentric. That throws a curve ball into the whole design."

Determining the precise path for cyclers requires engineers highly skilled in celestial mechanics who use mathematical techniques to create and evaluate numerous possible trajectories, eventually arriving at the best choice. Longuski and his students have previously designed trajectories for an unmanned spacecraft to Jupiter's moon Europa, which is tentatively scheduled for launch in 2006. The team also designed trajectories for a hypothetical manned mission to Mars.

"Some day, people will be going to Mars on a regular basis," Longuski said. "Most people are convinced that we are going to do this; the only question is when."

The cycler spacecraft would have to encounter Mars and Earth at precisely the right distance and speed. If a cycler approached Mars too fast or at the wrong distance, too much fuel would be needed for steering rockets and it would be more difficult for "taxi" spacecraft to dock with the cyclers as they sped by.

A cycler might fly past the Earth at about 21,000 kilometers per hour, or roughly 13,000 miles per hour. Small taxi spacecraft carrying people and supplies would have to rendezvous with the speeding cycler.

"This is sort of like a bus that doesn't stop," Longuski said. "When it comes by, you have to run alongside of it and grab on. "

The outbound trip to Mars would take six to eight months.

"Then, when you get to Mars, you get in the taxi and de-orbit down to the planet," said Longuski, who is working with Purdue graduate students to design "outbound" and "inbound" trajectories, or the trips from Earth to Mars and from Mars to Earth.

"These cyclers would be like space hotels," Longuski said. "They would provide the usual creature comforts."

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Cyclers would rotate slowly to create artificial gravity and prevent the debilitating effects of weightlessness on its passengers. The spacecraft also would be roomy enough to make the trip tolerable. The earliest versions of the space hotels might accommodate up to 50 passengers.

One cycler would not be sufficient: By the time that craft arrived at Mars, the two planets would have moved much farther apart, making a return trip impractically long. Rather, a family of perhaps three cyclers, continuously providing outbound and inbound flights, would ensure that passengers could get to Earth and Mars within a reasonable amount of time, Longuski said.

While the Purdue engineers are working on the interplanetary celestial mechanics of getting back and forth between Earth and Mars, researchers at the University of Texas and MIT are helping with other critical aspects of the trip, such as getting a cycler into the proper position to begin its trip to Mars and learning how to design the taxis.

"We have to look at the configuration of those taxis and how much energy will be needed to intercept the cyclers," Aldrin said.

Perhaps the first cyclers could fly around 2018, he said.

"The first mission will be more conservative, and it will have more safety supports until we are sure we know what we are doing," Aldrin said.

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Writer: Emil Venere, (765) 494-4709, venere@purdue.edu

Sources: James Longuski, (765) 494-5139, longuski@purdue.edu