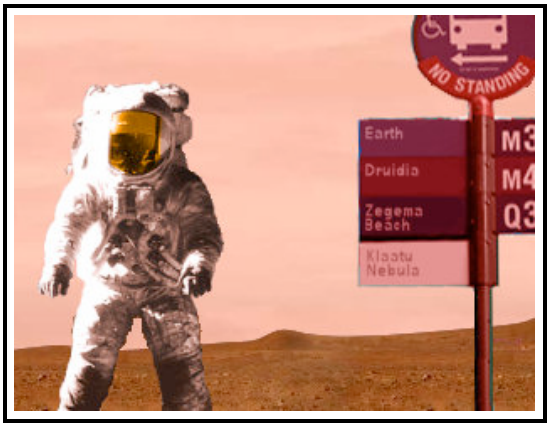
The Martian Express

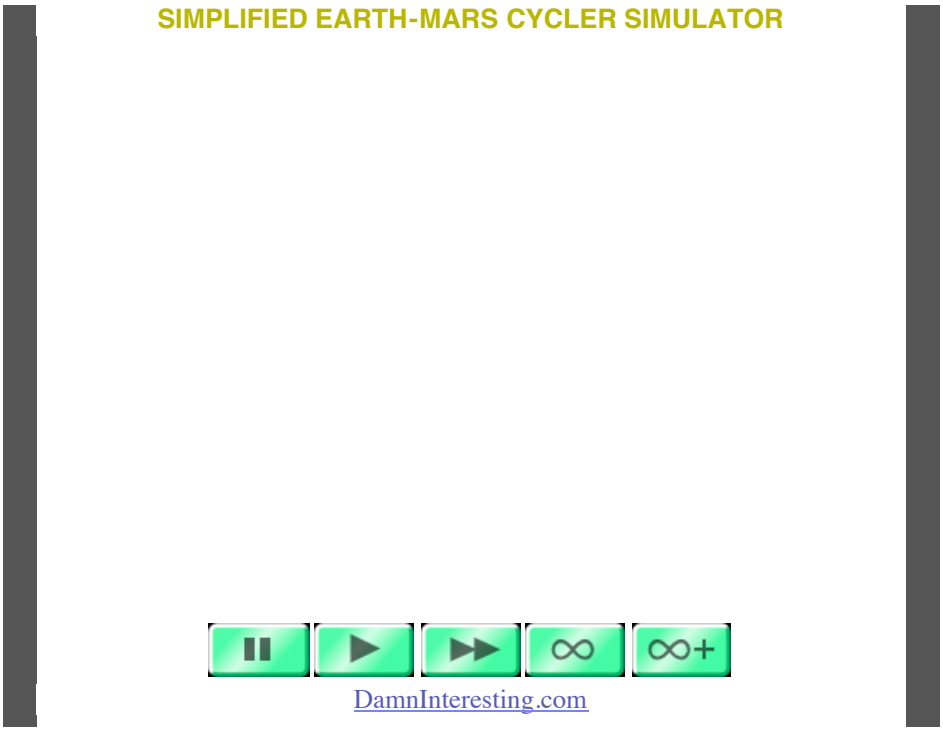
Written by Alan Bellows on April 10th, 2008 at 9:15 am
From DamnInteresting.com



On the 5th of February 1974, NASA's plucky Mariner 10 space probe zipped past the planet Venus at over 18,000 miles per hour. Mission scientists took advantage of the opportunity to snap some revealing photos of our sister planet, but the primary purpose of the Venus flyby was to accelerate the probe towards the enigmatic Mercury, a body which had yet to be visited by any Earthly device. The event constituted the first ever *gravitational slingshot*, successfully sending Mariner 10 to grope the surface of Mercury using its array of sensitive instruments. This validation of the gravity-assist technique put the entire solar system within the practical reach of humanity's probes, and it was used with spectacular success a few years later as Voyagers 1 and 2 toured the outer planets at a brisk 34,000 miles per hour.

One of the more intriguing theories to fall out of the early gravity-assist research was a hypothetical spacecraft called the *Cycler*, a vehicle which could utilize gravity to cycle between two bodies indefinitely– Earth and Mars, for instance– with little or no fuel consumption. Even before the complex orbital mathematics were within the grasp of science, tinkerers speculated that a small fleet of Cyclers might one day provide regular bus service to Mars, toting men and equipment to and from the Red Planet every few months. Though this interplanetary ferry may sound a bit like perpetual-motion poppycock, one of the concept's chief designers and proponents is a man who is intimately familiar with aggressive-yet-successful outer-space endeavors: scientist/astronaut Dr. Buzz Aldrin.

The year was 1985: David Hasselhoff was fighting crime in a sass-talking Trans Am, Mr Mister's *Broken Wings* were learning to fly again, and Buzz "Dr Rendezvous" Aldrin was unraveling the mysteries of the cosmos. The first primitive Cycler orbits had been discovered sixteen years earlier, but these curiosities depended upon irregular planetary encounters, and they had round-trips on the order of a decade. In 1985, however, Dr Aldrin reasoned that there *must* be trajectories which swing by Earth and Mars every twenty-six months or so. This interval corresponds to the Earth-Mars *synodic period*, the time required for Earth's orbit to overtake Mars around the sun. Guided by Aldrin's advice, physicists sprang into action with renewed vigor and fistfuls of formulas. As predicted, such an orbit was indeed discovered, and it was promptly christened the Aldrin Cycler.



The value of a perpetually repeating trajectory was immediately evident to NASA's engineers. Rocket scientists must contend with an immense expense when hefting material into low-Earth orbit– roughly $20 million per metric ton. Even a simple brain surgeon can grasp that a Cycler would allow mission planners to shed much of the rocket's fuel flab. In 1999, for example, NASA estimated that a rocket-powered manned mission to Mars would require 437 metric tons of stuff to be lifted into space. This equates to $8.74 billion to orbit the materials for *one* round trip to our rusty neighbor. Over half of that weight– 250 tons– is propellant for the Mars transfer. In contrast, a Cycler adheres to a philosophy of practical re-use rather than littering the cosmos with discarded multi-billion-dollar vehicles. Although Dr Aldrin's massive vehicle would need an initial thrust to insert it into the sweet spot, only occasional coaxing would be necessary to maintain the rhythmic encounters.

If a network of shiny new Cyclers were to be established, each one might spend its first few years making automated supply runs to the Red Planet. This approach would help to shake any lingering bugs from the system, while ensuring that the anticipated human visitors would be properly equipped upon their arrival. It would also afford mission planners the opportunity to deploy a fuel manufacturing unit on Mars to slowly convert some of the planet's plentiful carbon dioxide into oxygen/methane rocket fuel. Once the Martian supply depot is fully stocked, the first human passengers would clamber aboard a small, fuel-efficient rocket ship and intercept Cycler *Alpha* during one of its regular Earth flybys. Onboard the space-station-like Cycler, the travelers would spend the five-month trip to Mars in relative comfort, protected from most of the gamma-rays, high-energy protons, and cosmic rays which pepper the vehicle's exterior. The hull's gentle spin would also produce some *centrifugal gravity* to counteract the health effects of weightlessness, though this incessant spinning may cause occasional disorientation, nausea, and troublesome low-gravity "protein spills."

When Mars looms large in the viewport, the crew

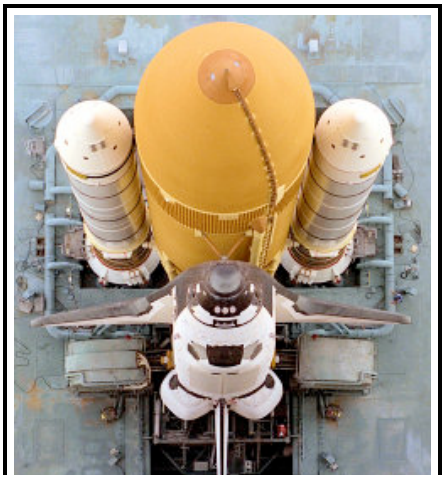
The Cycler's "taxi" vehicle could use *aerobraking* to shed excess speed upon arrival at Mars.

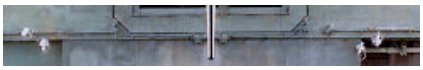
would then disembark using the "taxi" which brought them to the Cycler from Earth. Meanwhile the Cycler would pilfer some momentum from Mars to increase its own speed; this results in a negligible loss to the planet's orbital velocity, but a substantial gain for the spacecraft. Fortunately this exchange is in accordance with the *law of conservation of momentum*, therefore Sir Isaac Newton's body can remain at rest. After releasing the taxi and passing the planet, the unattended Cycler would start its lonely twenty-one-month trip back to Earth.

Upon their arrival on the Martian surface, the intrepid explorers would no doubt utter their pre-prepared profundities, erect a flag or two, and photograph their footprints. In the ensuing weeks, the pre-delivered cache of food, water, habitats, and equipment will support the astronauts as they conduct the earnest business of astronauting. Several months later, when the time comes to depart, the travelers will refuel their short-sprint space taxi and blast back into orbit to dock with the passing Cycler *Omega*. This sister Cycler shares the same trajectory shape as *Alpha*, but with a complimentary route that puts the journey from Mars to Earth on the short leg of the orbit. Within five months of leaving Mars, the members of the first manned-and-womanned Mars mission would return home to a tempest of ticker tape and talk shows. Cycler Omega, in the meantime, would be en route to another Martian rendezvous.

As grand and simple as it all may seem, the Aldrin Cycler concept is not devoid of drawbacks. The Cyclers' construction would certainly require more upfront money and resources than classic point-and-shoot rocketry technology; however the reusable Cycler would ensure that the *second* Mars journey is much more economical, as well as any subsequent manned or unmanned missions. Another concern is that the departure and arrival times would be governed by the iron fist of Newtonian mechanics, offering no arrival/departure flexibility, and very little margin for error. An additional inconvenience is the flyby speed: as designed, the Cyclers would swing by Earth at approximately 15,000 miles per hour, and fly past Mars at 22,000 mph. In order to intercept such speedy Cyclers, the rocket-taxis would need to be capable of splitting a lot of lickety.

To address such concerns, the incorrigible Dr Aldrin is perfecting plans for a new hybrid vehicle which mates the charm of a Cycler with the convenience of a rocket. With this revised design, the outbound journey to Mars would still be handled by an Aldrin-brand Cycler, but the return leg would be served by a *Semi-Cycler* capable of parking in a low-velocity orbit around Mars. This craft would be much much easier to intercept, however a brief engine burn would be required to break from Mars orbit. Additionally, its lower cruising speed would prolong the trip home by approximately three months. On the Earth end of the trajectory, the Semi-Cycler would perform a normal slingshot to make its way





Rocket fuel tanks such as the Space Shuttle's rust-colored external tank could be carried into orbit rather than jettisoned, and used as building blocks for the Cyclers.

back to Mars. Although this method has greater propellant demands than a straightforward Cycler, it is still quite frugal in contrast to regular rocketry. Research continues.

Ultimately the Cycler's greatest calling is not to serve as a low-cost transportation service, but as a stepping stone towards a true space-faring future. It was the establishment of railroads which finally opened up the western frontier of the United States, and so could the Earth-Mars Cycler help to tame the wilderness of space. An interplanetary transit system would encourage a spirit of long-term commitment rather than the myopic "footprints and flagpoles" mindset that undermined the Apollo moon missions. Certain astronomical sticks-in-the-mud will argue that space exploration should be relegated to the robots, and insist that rovers can make the same discoveries as humans at a lower cost and lesser risk. For many of us, however, it is better to inhabit the universe than to observe it from afar; and if there are indeed more giant leaps in store for mankind, then Dr Aldrin's revolutionary spaceship may just be the most practical way to make them.

Further reading:

- *Popular Mechanics* article on the Aldrin Cycler
- Analysis of a Broad Class of Earth-Mars Cycler Trajectories (PDF)
- Learn to fly again
- Amazon: Buy Buzz Aldrin's kids' book, *Reaching for the Stars*

Alan Bellows is the founder, designer, and managing editor of DamnInteresting.com, and he is perpetually behind schedule.