



Jerry Garrett for The New York Times

John R. Wright uses a computer in California to "drive" on Mars. A rendering of a rover, left, by the Jet Propulsion Laboratory.

## Off-Off-Off-Roading on Mars In a \$414 Million S.U.V.

By JERRY GARRETT

PASADENA, Calif.

**T**O date, there are no traffic jams on Mars. This is a good thing for John R. Wright, an engineer at the Jet Propulsion Laboratory here, whose daily drive includes time at the controls of the Mars rover Spirit, whose \$414 million price tag makes the most luxurious Range Rover look cheap.

But even with so many vehicular dollars in his control, Mr. Wright is not the most attentive of drivers: while his rover explores the Martian surface he has been known to watch TV, play on the computer, participate in staff meetings, yak on the cellphone, go for coffee — even visit the men's room.

But lightning-quick reflexes are not really necessary in his job, given the distance in light speed between the two planets. If either of the two rovers now on Mars — the other is called Opportunity — decided to emulate the homicidal HAL 9000 from "2001: A Space Odyssey," it would take 15 minutes for Mission Control to find out.

But Spirit is no HAL anyhow. Compared with the independent-thinking spaceship command system of the movie, the computer aboard each Mars rover is a relative dimwit. Scientists at the Jet Propulsion Laboratory, which is affiliated with NASA and the California Institute of Technology, had design objectives for the rovers that stressed the need for comparatively little computer power — less, in fact, than the laptop on which this report was written. The designers needed something straightforward, simple, direct and light enough to be hurled 35 million miles on a tankful of rocket fuel.

The "less is more" theory of computing works better on Mars than a recent "more is more" effort on Earth: a vehicle designed by some of the same scientists, with no limits on computer size or weight, went only a few miles before crashing last weekend in an attempt to travel from Barstow, Calif., to Primm, Nev., by remote control.

Granted, the Spirit rover didn't work as well as expected in its initial Mars outings. "The problem was like one you'd have on your home computer," Mr. Wright explained. "Its hard drive was full." Once Mission Control figured out how to cleanse Spirit's memory, control was restored.

To prepare for each day's explorations, the drivers sit before twin computer monitors. For a multidimensional view of the terrain, each wears sophisticated goggles (more so than the plastic 3-D movie glasses that a prankster placed atop the monitors).

"Looks like Barstow," a visitor said of the

Martian view, to which Mr. Wright replied: "Yeah, there's the outlet mall over there." Driving a rover involves little more than uploading a batch of command macros (control M is a right turn) to Mars each morning. Each Mars morning, that is.

A day on Mars is 20 minutes longer than one on Earth, and the earthbound crew lives on Martian time during the mission. Each day, they go to work at progressively later times. "Even on your days off, you have to stay on Martian time," Mr. Wright said. "So you wind up visiting a lot of all-night diners, watching bizarre movies on cable."

Many of the laboratory's scientists own fast sports cars. (Mr. Wright has a Corvette.) Their need for speed may be intensified by days spent driving rovers around at considerably less than 1 mile an hour.

Each Rover runs on six 20-watt direct-current motors capable of generating a whopping 0.06 horsepower, powered by lithium-ion batteries recharged by solar panels. The batteries are stored in a warm electric box that keeps them toasty enough to maintain a charge. Batteries tend to lose power faster in a cold climate, like that of Mars.

Top speed is officially listed at 0.1 mph, but Mr. Wright concedes that Spirit could go faster if it needed to hurry. As it might, for instance, to avoid capture by territorial Martians. ("We see a lot of 'Earthling, go home' signs up there," he confided.)

The 384-pound rovers go exploring only during daylight hours on Mars. "We could drive at night," Mr. Wright said, "but we didn't put any headlights on the rovers. So we would probably just crash into stuff."

And with no body shops in sight, crashing isn't an option.

A rover driver who crashes would be likely to lose his intragalactic driving privileges, not to mention the secret T-shirt that each of the nine drivers wears. The shirts say "Rover Driver" on the front and display the image of a flaming skull on the back.

Not that crashes are likely. While capable of climbing over 15-inch rocks without tipping, the six-wheel rovers are seldom asked to do much more than scoot a few feet a day to take a closer look at something. Each has a scraping tool capable of testing soil composition and evaluating rock samples.

The mission is scheduled to come to a pragmatic end sometime this spring, when the financing runs out. "At that point, I guess we'll just turn out the lights, lock the doors in here, and go on to something else," Mr. Wright said.

Then the trusty rovers will sit patiently on Mars waiting, like Pavlov's dogs, to answer a bell that is unlikely to ring again.