To Mars and Back

BY SHIRLEY DODSON COBB

For University of Oklahoma graduate Donna Shirley, the journey from her birthplace in Wynnewood, Oklahoma, to the planet Mars and the universe beyond is an expedition of vision and determination. One of the women pioneers in the field of space exploration, Shirley's achievements have earned accolades and set an example for young dreamers who would follow her path.

To trace her steps is awe-inspiring—from the quiet streets of a small Midwestern community to a place as the first female engineer at the Jet Propulsion Laboratory (JPL) in Pasadena, California. There she served as the manager of NASA's historic Mars Exploration Program, leading the team that built Sojourner Truth. The world's first solar-powered, self-guided planetary robotic rover, Sojourner Truth was landed successfully by the spacecraft Pathfinder on July 4, 1997, to explore the Martian landscape.

Recognized as one of the nation's most dynamic women, Donna Shirley's face graces scores of magazines; she appears on such TV shows as "Today" and "Good Morning America"; she is a sought-after public speaker and has authored two books, *Managing Creativity* and *Managing Martians*. Among her numerous awards are NASA's Outstanding Leadership Medal, a place in the Women in Technology International Hall of Fame and the Oklahoma Aviation Hall of Fame and an honorary doctorate from the University of Oklahoma.

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In August 1998, Shirley announced a shift in direction, stepping down from her JPL leadership position to assume an emeritus post—still involved with the Mars program while opening the door to pursue other career interests.

During a recent interview in her JPL office, she pondered future goals and announced, "I haven't decided what I want to do when I grow up . . . After all, where do you go after you've been to Mars? The sky's the limit."

NASA/JPL/Caltech

Donna Shirley's college adviser insisted that women couldn't be engineers. She spent the next four decades proving him wrong.

This is the attitude that has taken her so far.

As a youngster during the 1940s and '50s, the daughter of Dr. Edward and Ada Shirley walked a line between the bounds of tradition and seeking new horizons. In her book, *Managing Martians*, which recounts her quest to "get to Mars," she shares her childhood experiences, "growing up as a smart, mouthy tomboy where the ideal of womanhood carried with it . . . chiffon and mascara."

Her fantasies were not of teas and fashion shows. "I wanted to do exciting, adventurous things, not girlie things. The only role models I had were men." This was not a matter of sexual identity confusion, the author explains, but simply a love of action and heroics with no women heroes available. Shirley dreamed of being a bush pilot. At the age of 10, she decided to build airplanes and settled on the goal of becoming an aeronautical engineer. At the age of 12, she read Arthur C. Clark's *The Sands of Mars*; the images "pointed her toward the sky." At 15, she began flying lessons and two years later earned her private pilot's license.

As a senior at Wynnewood High School, Shirley was named yearbook editor, class vice president and band queen; such achievements were "not hard," she modestly recounts, as there were only 49 seniors among the total 150 high school students.

The yin and yang continued. One high school English teacher remembers Shirley as the only girl enrolled in mechanical drawing, always coming to class with a science fiction book in her hand.

Graduating from high school in 1958 with a 3.93 grade average, Shirley enrolled in the University of Oklahoma—a campus five times the size of her hometown. At her first meeting with her adviser, she recalls, "I walked into the office with a huge smile of anticipation." After reciting her intention to enroll in aeronautical engineering, she says, "I was told,

Above: This is a "geometrically improved" version of the 360-degree panorama known as the "Gallery Pan," the first contiguous, uniform panorama taken by the "Imager for Mars Pathfinder (IMP)" over the course of Sols 8, 9, and 10. Rover tracks lead to Sojourner, shown using its Alpha Proton X-Ray Spectrometer (APXS) instrument to study the large rock "Yogi."

'Girls can't become engineers' . . . and I responded, 'Yes, I can' . . . and I did."

While her objectives were clear, she admits that the classes were tougher than anticipated. By midterm she was flunking two courses. Assessing her situation that Christmas, "study" became her focus, and she ended the semester with grades of B and, as her book recounts, "a humbler opinion of myself."

Intertwined with her classes was the sorority experience. Accompanied by a Gamma Phi Beta sister, she joined an international women's flying club. The summer after her sophomore year, Shirley earned a multi-engine rating. At the same time, life in the sorority—with social events and the bond of friendships—was gaining credence—along with a romantic attachment to a guy named Johnnie.

Broadway Books photo by Eric Tucker, design by Roberto de Vica de Cumptich

"By my junior year, we had decided to marry," Shirley says. The focus moved from achieving academic and professional goals to graduation and marriage; she also notes that her grade average had dropped from a 3.5 to a 1.2. Deeming an engineering degree impossible, Shirley switched to journalism. "I wanted to graduate as soon as possible and took 22 hours a semester." She planned to work after marriage, putting her husband through medical school.

As she juggled classes and marriage prospects, Shirley was encouraged by her mother to enter the Miss Wynnewood competition, which she won. Then came the Miss Oklahoma pageant in Oklahoma City, with 47 other contestants. It was, Shirley says, the "final act in trying to please my mom."

As college came to a conclusion—she graduated in January 1963—she broke her engagement. Whether it was the maturing experience of college, a sense of accomplishment in her own achievements or simply that moment when individuals move from "roots" to "wings," Shirley set out on her own course.

"OU was a good place to grow . . . the sorority, social skills, the intellectual environment . . . it was well-balanced, offering a solid education," she recalls.

At a time in her life when changes seemed rampant, she opted to renew her interest in engineering. After meeting with aerospace company recruiters on the OU campus, she was offered a job in technical writing by McDonnell Douglas in St. Louis. Her lifelong quest to "get to Mars" commenced.

Her engineering background and writing skills quickly gained her notice. Soon, Shirley was given the responsibility to "teach" engineers in the specification department how to write more clearly. She became sensitive to the fact that, despite her ability to recognize engineering "errors" in design, her words would not be taken seriously without a degree in that field. Taking a leave of absence in 1964, she returned to the University of Oklahoma and, in the spring of 1965, earned her B.S. in aerospace and mechanical engineering.

Back in St. Louis, she sought opportunities to transfer into aeronautical design and eventually landed in a department developing a proposal for a NASA mission to Mars in 1971. The project, with two orbiters and two landers, was to be supervised by the Jet Propulsion Laboratory in California.

Assessing her objective to get to Mars, she said, "I decided no matter which aerospace contractor proposal was selected, if I worked for JPL, I would work on the project." Shortly after, she noticed an advertisement for an aerodynamist job at JPL, applied and was hired—the only female with an engineering degree out of approximately 2,000 engineers. Shirley was on her way to Mars—though it would take her the next 31 years to get there.

In Shirley's snug office, she patiently traces her career experiences since joining JPL in 1966. Almost

immediately, she began graduate studies and earned her M.S. in aerospace engineering from the University of Southern California.

"I was working on the Mars mission for a couple of years, going to school at night. Then the Mars mission was canceled . . . so I didn't get to land on Mars until years later," she muses.

"I worked for four years on Mariner 10, which went to Venus and Mercury in 1973-74," she says, noting Mariner 10 made the only exploration so far to Mercury. Shirley also led teams designing solar and geothermal energy systems during the 1970s oil crisis; in the 1980s, she was part of the team that generated the first design for the space station. "Then my dream began to come true . . . I became the leader of the Jet Propulsion Laboratory's automation and robotics efforts, which included Mars rovers.

"At JPL, we were working on rovers in the 1960s and the early 1970s . . . the Russians had two automated rovers on the Moon in the '70s," she says, tracing the history of rover development. "But when Viking landed on Mars in 1976, it did not carry a rover . . . it just had two arms that could scoop dirt into instruments on the lander . . . then we knew we needed to (be able to) move around . . . This resulted in a rather intense effort during the 1970s and 1980s working on rovers, because we thought if we ever landed on Mars again, we'd better have a rover."

The rover evolution continued. The 1990 pickup truck-sized mobile rovers built to move on the rocky Martian surface to collect samples, were downsized, Shirley explains. A series of eight scale models of large rovers were built and named Rocky. But when the budget was cut, only small rovers became affordable to fly.

The descendant of Rocky—Sojourner Truth, named after a 19th century feminist abolitionist—landed with Pathfinder on July 4, 1997, after a 7-month, 119-million-mile voyage from Earth. The design team Shirley guided built the 25-pound, microwave-size, six-wheeled rover that explored Mars. Traversing 100 meters of Mars' surface, Sojourner returned 550 images and 15 chemical analyses of rocks and soil.

The Pathfinder mission, including development and deployment of the rover, was on time, on budget and highly successful. With Shirley encouraging creative teamwork, the rover team used a combination of new and modified off-the-shelf technology; such methods made the launch of space missions cheaper and quicker than anyone thought possible.

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The moment Sojourner trundled away from the lander and began to investigate rocks on the Martian landscape, Shirley experienced a feeling of elation: "It's like having your first child, but not as painful." In fact, Shirley's 21-year-old daughter, Laura Diane Pivirotto, considers Sojourner almost a sibling. Her father, divorced from Shirley, is a retired JPL engineer.

"Landing on Mars for the cost of a major motion picture was pretty wild," Shirley says. "On Pathfinder (a $266 million project), there were about 200 to 300 people at a time . . . There were a total of about 100 people who worked on the rover . . . an average of about 30 at a time. We spent $25 million (on the rover), including operations, and it's all primarily salaries spaced over five years."

Shirley noted the Mars program benefited from Viking mission inventions. "The Viking mission was difficult . . . we were trying to do things that were cutting edge, inventing computers and other instruments from scratch. By the time we got to Pathfinder, we could use a lot of off-the-shelf equipment . . . much cheaper than having to invent it."

Viking computers had 8,000 words of memory, she recalls. "A computer like this (motioning to the Macintosh adjacent to her desk) has several million words of memory, so the technology has come a long way.

"Also, because Viking had successfully landed on Mars, we know a lot about Mars . . . we could use the Viking parachute design and just modify it," she continues. "We could use the Viking heat shield to enter the atmosphere and keep from burning up . . . we lived off Viking a lot."

Still, the Pathfinder and Sojourner offered educational adventure, too—in addition to the thrill of viewing the Martian landscape. "Once we got some initial glitches handled, the rover worked perfectly, just like we thought it would. We learned a lot about how to rove on Mars; it's not easy," she says. "It turns out to be very difficult because Mars has a 24-hour and 37-minute day, called a sol. Mars is 50 million miles farther from the Sun than Earth is, and that means you have to survive at night in very cold temperatures, 150-200 degrees below zero.

"And the air on Mars is like being at 130,000 feet on Earth; it's practically not even there. There's no oxygen, it's all carbon dioxide . . . you have to make everything withstand incredibly cold temperatures and be

Robert Taylor

Donna Shirley, holder of OU degrees in journalism and aerospace engineering, receives presidential congratulations from David Boren on the awarding of a 1997 honorary doctorate from the University of Oklahoma.

able to wake up the next morning," she explains the challenge of keeping the solar-powered rover operating.

Recounting the past and envisioning the future, Shirley recalls the Mars program objectives. "When we set up the program, there were three themes: Life, Climate and Resources . . . All are dependent on water, so the existence of water is a unifying thread . . . we'd like to find water on Mars . . . We are interested in resources because if humans ever go to Mars, they will have to live off the land; it costs too much to take all your water with you." The Mars Exploration Program, a series of "faster, cheaper, better NASA space missions," is projected to continue until the year 2008.

Now that the multifaceted talents of this trailblazing engineer have helped NASA reinvent itself and lead the way to more economical, effective space exploration, Shirley is free to pursue other paths. The destinations are many.

Concluding the office interview, she laughingly says, "Now I want to write a book entitled, *Yes, I Have* ***Had*** *a Life*. In fact, one of the (*Managing Martians*) reviews said that I was a woman married to her job, that I had no personal life. I got married, had a daughter, got divorced . . . no personal life at all. It's simply not true."

While Shirley's personal life is entangled with career—evidenced by the fact her phone number spells MARS, her car is a Saturn and the space memorabilia in her La Canada living room includes a "Hug A Planet Mars" pillow—she announces, "I'm not working 80 hours a week anymore."

The direct, intense aerospace engineer is involved in her community, serving on the board of a nursery school and with organizations across the nation. One upcoming endeavor is the Mars Village Project, a national outreach to enable students to envision a village of 100 people on Mars in the year 2030.

"You have to think about it," she muses. "They can't get anything from Earth. How would they govern themselves? How would they keep from going crazy? How would they get food? What kind of arts, sports would they do? . . . We want them to think in a multidisciplinary sense and design a total community." Sounds like a Shirley dream.

She also is working on a Ph.D. from the Fielding Institute, a Distance Learning endeavor where, she says, the age of the average student ranges from 50 to 60. "Everyone communicates over the Internet . . . we have these discussion forums. You write up a contract, pick a professor, sign-off the contract (course), fulfill the obligations and move on to the next course," she says, launching enthusiastically into an explanation of her cyberspace adventure where eight contracts and a successful dissertation can result in a Ph.D.

Her desire to share her insights on management as a speaker and author is honed by her work with the JPL team. "Planets wait for no one. If you don't launch on time, you have to wait years to get to launch again," she cautions, drawing from her experiences in space exploration programs.

"How do you harness creativity and get a product out within a schedule? Our schedules are inexorable. Our budgets are completed, sealed; you cannot exceed the costs set. But at the same time, by our very charter, you have to do things no one else has ever done before . . . we are inventing on a schedule, and that's tough."

In *Managing Martians*, Shirley says, "When you are managing really brilliant, creative people, at some point you find it's impossible to command or control them because you can't understand what they are doing. Once they've gone beyond your ability to understand them, you have a choice to make as a manager. You can limit them and the project by your intelligence, which I believe is the wrong way to do it. Or you can trust and use your management skills to keep them focused on the goal."