

# InClass

*A spotlight on faculty and their work*

## Out of Thin Air

*Doug LeVan is working to make manned missions to Mars a reality.*

By PAUL KINGSBURY, BA'80

**I**N JANUARY 2004, PRESIDENT BUSH announced a renewed American commitment to manned exploration of space. He spoke of mankind returning to the moon sometime between 2015 and 2020, with an eye toward a manned mission to Mars afterward. "We do not know where this journey will end," said the president in his Jan. 14 speech at NASA headquarters in Washington. "Yet we know this: Human beings are headed into the cosmos."

Traversing the 239,000 miles to the moon takes three to four days. But a mission to Mars—nearly 34 million miles away at its closest point to earth—is a voyage of at least six months. Once astronauts land there, they will be expected to stay for months, if not years.

The environment they encounter there will be harsh and inhospitable. As previous unmanned missions have made plain, the landscape is a cold, rocky, red-dirt desert. The daytime high temperature usually doesn't rise much above the freezing point, while the Martian night can plunge to minus 100 degrees Fahrenheit. The atmosphere is unbreathable: 95-percent carbon dioxide. Although Spirit and Opportunity—the twin Rovers that began exploring Mars early in 2004—detected significant evidence that water once flowed on Mars, no usable supply has yet been found.

Despite these huge environmental hurdles, Doug LeVan believes that man will walk on Mars in the foreseeable future. "I believe we'll get there," he says. "It's just a matter of time." He himself is at work on crucial parts

of the mission that will get them to Mars and help sustain them once they touch down.

"We're looking at enabling technologies for human flight or unmanned sample return missions," he says. "What we're doing now might be useful in the 2020s or the 2030s. Our work is related to taking the Martian atmosphere and extracting oxygen from it.

"You don't carry everything you need to Mars [that would enable you] to return. You are going to make use of what you find there to prepare materials to get back. NASA calls this 'ISRU':

In Situ Resource Utilization. It means that you might carry hydrogen—or something else you can burn—with the expectation that you will get oxygen once you get to Mars. NASA has talked about many different plans. Some of them involve landing small robotic factories on Mars to produce oxygen before the astronauts get there."

M. Douglas LeVan, 54, is the J. Lawrence Wilson Professor of Engineering at Vanderbilt. He also has been chair of the chemical engineering department since he came to Vanderbilt from the University of Virginia in 1997. On a spring Friday towards the end of the semester, as students and faculty are franti-

cally trying to tie up the academic year's loose ends, LeVan spends a calm and unhurried hour and a half talking about his work, despite an impending proposal deadline at the end of the day and five hours of scheduled meetings still ahead. We adjourn to a conference room just outside his orderly office at Olin

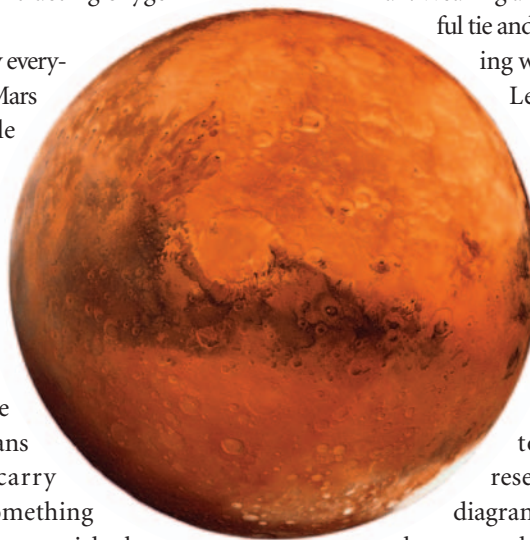
Hall. Wearing a crisp dress shirt, colorful tie and navy slacks, and speaking with low-key precision,

LeVan comes across as analytical, efficient and quietly self-assured without the slightest trace of intellectual arrogance.

A teacher to the core, LeVan walks over to the conference-room blackboard to explain his Mars research, sketching quick diagrams of boxes and arrows

that trace a three-stage process. First, the thin Martian atmosphere of carbon dioxide, which has an atmospheric pressure less than one-hundredth of Earth's, is compressed to bring it to Earthlike pressure. Next a solid electrolysis cell breaks down the carbon dioxide into oxygen and a 60/40 mixture of carbon dioxide and carbon monoxide. The oxygen passes through a membrane in the electrolysis cell and is stored. Then the stream of carbon dioxide and carbon monoxide is separated, with the carbon dioxide recycled back to the

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Extraction of oxygen from the ultra-thin atmosphere of Mars is the focus of Professor Doug LeVan and his team of graduate-student researchers, whose work is funded in part by NASA.

## **VJournal** *continued from page 9*

I finished my 12-hour shift ashamed and disgusted with myself for letting my professional mask slip. Never again, I promised. What must they have thought of me? A poor excuse for a nurse, I berated myself. As I was finishing up my charting and getting ready to go home, I was surprised to see the Collins family come back into the ER. Mrs. Collins' eyes sparked with recognition when she saw me, and the family walked purposefully across the room toward me. Dread iced my mind

and my heart. What could they want with me?

Mrs. Collins took both my hands and held them. She wanted me to know how much she appreciated seeing the tears in my eyes when I had talked about her husband. He never made it out of the OR, of course. She said her sons had waited for a couple of hours before the doctors had admitted defeat, and then there were phone calls and arrangements to be made, so six or eight hours had passed since she'd seen me. But she had been com-

forted during that time by knowing that he was being cared for by real people, people who cared, people who cried. I was deeply touched that she went so far out of her way on this horrible day, to come back and look me up, to thank me for caring for her husband. "For not being a robot," she said.

Mrs. Collins taught me my first and best lesson on How to Be a Nurse. She taught me that nurses do cry.

## **Sports** *continued from page 16*

Off the field, Cutler is majoring in human and organizational development through Peabody College. "It's been a positive experience," he says. "It leaves so many doors open because you can do just about anything with it." He can graduate in May if he chooses, or stay around for his final year of eligibility. "A lot depends on how this year goes. I'm not sure what I want to do with my career yet. Right now I'm just worried about this football season, and I'll take it step by step."

In his first intercollegiate game, the job of starting quarterback was a unique experience. Vanderbilt had to rely on a number of freshmen and sophomores to carry the game. "It was crazy," he recalls of his first start at Georgia Tech. "There was so much stuff going on. You're so anxious, and before you know it the game is on. A lot of young guys were playing in that game, and it was a mess. We got pounded pretty good (3-45). But it was something we could learn from. We've only

gotten better since that day."

As one of the team's captains, Cutler leaves the locker room early during a game for the coin toss. "We give our parting words as we're leaving," he says. "They start getting amped up and a little rowdy in there." After the coin toss, it's all business. "It's time to go. We throw some balls and get warm again. The butterflies start hitting me about then. You get the kickoff, the first play, and we're off."

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solid electrolysis cell for more breakdown, and the carbon monoxide is removed and stored. The oxygen can be used for fuel or breathing, while the carbon monoxide can be used for fuel or in the production of hydrocarbons and plastics.

This process to transform Martian atmosphere into oxygen for breathing and carbon monoxide for fuel has been the result of a research collaboration involving LeVan and his Ph.D. graduate student Krista Walton, the University of Arizona, and NASA's Ames Research Center in California. Vanderbilt's part of the work is the third stage, where carbon dioxide and carbon monoxide are separated using a process called "adsorption." In adsorption, the molecules of a gas or liquid are made to stick to the surface of a solid but porous material, causing a filtering effect. Using a crystalline aluminosilicate known as zeolite, LeVan and Walton have been able

to adsorb CO<sub>2</sub>, allowing CO to pass through.

"We've been looking at a few different zeolites," he says. "They all work pretty well. But what we want is one that adsorbs CO<sub>2</sub> strongly and doesn't adsorb CO."

The Martian atmosphere work is only part of LeVan's ongoing research. For NASA he's also working on improving trace-contaminant control systems and carbon dioxide removal. "This is what keeps spacecraft-cabin air clean," he says. "If you saw the movie 'Apollo 13,' that was the problem those astronauts were having: CO<sub>2</sub> levels were getting too high in the Apollo capsule."

Currently, NASA funds about half of LeVan's research to the tune of about \$150,000 annually. In addition, he is doing basic research funded by the U.S. Department of Defense on adsorption of toxic industrial chemicals and trace-contaminant control for military and nonmilitary uses.

LeVan's research on adsorption processes began in graduate school at the University of California at Berkeley. Early in his career he focused on removing petroleum-based dry-cleaning solvents from the air with activated carbon. His work with NASA began in 1993 when he was still with the University of Virginia. "NASA found me," says LeVan. "I think they recognized that I knew a lot about what they were interested in, which was removing trace contaminants with carbon and humidity effects on those materials."

Hired as chair of the chemical engineering department, LeVan came to Vanderbilt with the idea of building on the department's strengths to create a department of truly national stature. It appears he has made substantial progress. Research funding for the department is now 14 times what it was before LeVan took over as chair. New faculty and increased numbers of graduate students have

come on board. In the latest *U.S. News & World Report* survey of graduate programs, Vanderbilt's chemical engineering department broke into the Top 50 for the first time.

"Without question, he's a national and international figure in adsorption research," says School of Engineering Dean Kenneth Galloway. "And Doug has simply been an exemplary leader. He has recruited exceptional young people into the department. He's breathed new life into that department. In many ways he leads by example."

"He's clearly a world-renowned leader in his research area," adds Kane Jennings, assistant professor of chemical engineering. "Also in line with that, he trains his graduate students exceptionally well. I've had the pleasure of sitting on a lot of his students' dissertation committees, and when they sign up to work with Doug, they become experts on adsorption as well during their time here at Vanderbilt. He's all about the total graduate experience for his graduate students. I think he's one of the best teachers in the School of Engineering. He teaches both undergraduate- and graduate-level courses, and all his students say very nice things about him. More often they talk about how hard his

courses are, but they never say anything bad about him—just how he's challenged them."

After our interview LeVan leads me down the hall to one of his lab rooms on the first floor of Olin Hall. On the day we stop in, five of his six graduate students are at work at their desks spread around the edges of the spacious, clean, brightly lit room, most of them peering into computer screens. Here and there on tables are various torpedo-shaped cylinders of gas feeding into narrow pipes and various pieces of boxy apparatus, some containing little tan-colored pellets that LeVan identifies as zeolite. After doing introductions LeVan points around the room at the various graduate students, indicating the source of their research funding: "Army, NASA, Vanderbilt University Discovery Grant, Army, NASA, and then one more new NASA student who we don't have a desk for in here yet."

We walk downstairs to another lab space on the basement floor, which is identical in size to the one above, though this one is filled with larger pieces of equipment and the room thrums with sounds of machinery. One piece of apparatus looks something like an oversized microwave oven. It's an environmental chamber, explains LeVan, capable of heating

or cooling what's inside to unearthly extremes. Inside is a metal canister the size and shape of a flashlight, which contains the zeolite that adsorbs CO<sub>2</sub> and allows CO to pass through. Various curlicues of metal tubing run into and out of it. This is the equipment that graduate student Krista Walton is using for LeVan's Mars atmosphere research.

"It's a test apparatus to show that the concept works," says LeVan. "And the concept works. We're getting beautiful results."

LeVan takes me around the room and patiently explains the functions of various other pieces of intricate-looking experimental equipment in the lab, such as a pressure-clean adsorber and a gravimetric adsorption equilibrium apparatus. It's clear that these complicated scientific devices are so central to his research that he's eager to have visitors understand them as fully as possible. And like all the best teachers, he apparently believes that if he's doing his job, eventually you *will* get it.

Some pupils, however, are not so apt. LeVan concludes our brief tour saying, "So that's basically what we do. It's pretty simple stuff." Seeing my look of uncomprehending disbelief, he adds a friendly, understated, "Well, it's simple to me."

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### **After Death** *continued from page 42*

Pope has overseen the day-to-day operations of VUMC's Anatomical Donation Program for more than 18 years. Over time she and Dalley have learned to anticipate the number of donor deaths during a given year and enroll only enough donors to meet the projected educational and research needs for the following year.

Unlike Vanderbilt's program, some medical schools around the country still rely on unclaimed bodies provided by medical examiners' offices and deceased wards of the state through a state's hospital or prison system, and they may reimburse the expenses of approved procurement agencies for bodies to be used for medical education.

The Anatomical Donation Program took sole possession of the Medical Center North

morgue, otherwise known as "the old morgue," in 1988, thus offering the program enhanced confidentiality and security. All bodies donated to VUMC for medical education and research are housed here and go through an elaborate preparation process by an anatomical donations specialist.

Jason Ridley, the current anatomical donations specialist, has a master's degree from the University of Tennessee in forensic anthropology. Ridley's expertise is necessary for proper preparation of the bodies. He also works with first-year medical students, providing expertise concerning osteology (the study of bones) during their anatomy lab work.

Earlier this year Dalley and Pope were shocked by allegations, which proved to be true, that the anatomical donations director

at the University of California–Los Angeles School of Medicine was caught selling body parts to commercial brokers supplying drug companies and medical-device manufacturers against the school's policy.

"I cringed when these stories came out," says Pope. "Certainly, we don't do anything like that at Vanderbilt."

Vanderbilt's Anatomical Donation Program never sells any bodies or body parts. It is a whole-body donor program that neither accepts nor provides body parts. All remains of each individual are identified and kept together, separate from the remains of others, up to and including the time of burial. Only in instances where there is a surplus of necessary bodies for VUMC's needs, and the donor has expressly given written permission