Higher education prides itself on being the conservator of tradition and the definer of sacred texts. In this issue, however, we celebrate the revolution that has hit higher education, jolting it out of its traditional orbit. It is the impact of computer technology on the workplace, in general, and on higher education, in particular, that we want to explore.

Computer technology brings the global marketplace into the classroom, connects learners who are miles apart, facilitates the manipulation of models and simulations, and manages data sets of infinite complexity. For the student, it creates flexibility, convenience, access and new ways of learning. Computer technology, whether used in the traditional classroom, or coupled with a distance learning program like Old Dominion’s TELETECHNET, forces a paradigm shift from an emphasis on teaching to one on learning. The teacher and the student can exchange roles, be miles apart, be intimate or faceless. Office hours are no longer three hours/week, they are 24/7!

Kurt Maly, computer science chair, and William Swart, dean of engineering, write about advances in high-performance computing and telecommunications that impact the classroom and the boardroom and our capacity to teach, learn, evaluate and plan. These new technologies increase interaction and feedback loops, and the use of simulations and animations enhances the learning process. Computer scientist David Keyes encourages us to celebrate also the power of supercomputers to solve bigger, more complex problems – whether it’s weather prediction, human genome modeling or pollution dispersion.

Broadly speaking, this issue focuses on the innovative, the entrepreneurial and the almost unimaginable! Not only do we explore the impact of teraflops computing, but also aerospace engineer Robert Ash discusses ways to make a round trip to Mars practical and affordable. Chemist John Cooper reports how laser-based chemical analysis of liquids and polymers can help reduce vehicle emissions, as well as lead to new generations of super-light, super-strong airplanes that fly farther and faster than today’s models. New worlds are opening up, broadening the way we think and conceptualize the future.

The quest for new knowledge is never over. The advances that we celebrate in this issue help us envision life in the new millennium.

Jo Ann M. Gora
Provost
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A Road Map To Mars

BY ROBERT ASH
When the lander of the spacecraft Pathfinder came to rest on the surface of Mars two years ago, humans once again had panoramic, rust-colored views of the pebbles, rocks and boulders of that body popularly known as the Red Planet. We had been there before, most famously in 1976, when Project Viking brought human cameras and scientific instruments to Mars for the first time. Now we had legs, so to speak: a little machine known as the Rover Sojourner managed a rolling exploration of its own, telling terrific science tales.

For centuries Mars has occupied a special place in the human imagination. In the earliest civilizations, Mars was considered an important heavenly object because of its red color and the peculiar path that it followed across the night sky. Between 1609 and 1610, Galileo Galilei wrote about his telescopic studies of Mars. Surprisingly, English satirist Jonathan Swift described Mars’ two satellites in Gulliver’s Travels in 1726, approximately 150 years before they were actually observed. As recently as 1964, Percival Lowell’s observatory was still being used to study the seasonally varying “canals” on the Martian surface, which Lowell, in the late 19th and early 20th centuries, had claimed were the work of an intelligent civilization.

On Halloween 1938, Orson Welles radio company’s broadcast of War of the Worlds had convinced a nationwide audience that Martians were attacking. By the 1960s, Martians were more peaceful and friendly: My Favorite Martian was visiting Earth, at least fictionally, in the television program of the same name.

By the time NASA’s successful Viking Project placed two landers on the surface of Mars in 1976, the question of whether or not humans should go to Mars began to shift from a philosophical debate to a technical question. It was no longer a question of whether, but when, human beings would set foot on the Red Planet.

So how to do it? In short: live off the land.

Left: On a one-way mission to Mars, Pathfinder is launched at 2:11 a.m., Dec. 4, 1996. It will land seven months later on July 4, 1997. Above In cruise stage, Pathfinder, looking like a small disk, hurtles through the atmosphere toward the Red Planet.
To And From Mars

I arrived at NASA's Jet Propulsion Laboratory (JPL) in California as a National Research Council (NRC) senior research associate in the fall of 1977. I had been encouraged to apply for the NRC appointment by chemical engineer Warren Dowler, a specialist in rocket propulsion. But (as I later discovered) while I was driving my family from Norfolk to Pasadena, NASA's funding for my proposed rocket-motor research project at the JPL was canceled. When I finally arrived I was given the opportunity to work with the Mars Mission Advanced Planning team as an alternative. That seemed like a better idea than turning around and driving back to Virginia.

Warren and I were assigned to investigate some of the alternative Mars surface-exploration concepts, including a robotic airplane, an inflatable, wind-blown balloon, and a free-flying, weather-balloon-like concept. We were also asked to investigate the possibility of making rocket fuel required for an Earth return directly from local materials processed on the Martian surface. At this point, a human mission to Mars wasn't part of our thinking.

After looking at some rather ridiculous robotic mining concepts, and even studying the possibility of digging a one-kilometer-deep hole into Mars' surface and filling the hole with hydrogen and oxygen slush to make a large rocket-launching cannon, we made up our minds that Mars-based rocket-fuel production wasn't feasible. However, we decided to look a little deeper before we reported back to the study team. It was during this one-week exercise that we had a conceptual breakthrough.

Our "eureka" was that man-made machinery could "breathe in" Martian air and "drink up" available Mars water to make methane rocket fuel on site, without prospecting or mining. We could use very simple chemical processes. Methane fuel is nearly as energetic as hydrogen fuel and it could be kept in liquid form at temperatures that were no colder relative to the Mars environment than temperatures maintained in a home freezer on Earth. A tiny factory could stockpile an impressive volume of methane during the 100 days or so that explorers would wait for the orbital window to once again open for the return to Earth.

Even before departure of the first manned Martian expedition, a small
Old Dominion University's QUEST

A chemical processor could be built and sent to Mars, along with solar- or nuclear-power generating equipment, to slowly convert on-planet materials (such as water and carbon dioxide) into oxygen and fuel for surface exploration, life support and the return trip to Earth. By the time the astronauts completed a 100-plus-day transit from Earth and entered orbit around Mars, an Earth-return spacecraft (included with the other equipment in one or more pre-landing packages) could be fully fueled and waiting. In addition, our explorers would have in place a power plant that would be used to provide the electricity for their base, as well as a supply of breathable air and drinkable water.

Our ideas made a round trip to Mars practical and affordable. Furthermore, our approach removed the hazards associated with carrying large additional quantities of rocket propellant inside a human-occupied spacecraft.

Our initial results were published in 1978, but we could not convince mission planners at NASA headquarters that this was the logical approach for sending humans to Mars. After numerous trips to Washington, where our requests for funding were passed from division to division, I decided in 1979 that it would be easier for me to do my part in keeping this idea alive by returning to Old Dominion University than by accepting a permanent JPL position.

Where Do We Go From Here?

In 1987, a team of Old Dominion students successfully designed, built and tested a stabilized zirconia cell which converted simulated Mars atmosphere into oxygen. During the past decade, others have suggested that transporting liquid hydrogen from Earth, allowing some of it to boil off during the trip to Mars, and then combining the remaining hydrogen with carbon dioxide to form either methane or any number of other hydrocarbons, may have advantages over our original concept.

Since the first publication of our proposal in 1978, such areas of research
have become known as "in situ resource utilization," or ISRU. In 1997, as part of their Human Exploration and Development of Space (HEDS) initiative, NASA published a "Manned Mars Mission" design that incorporated ISRU as the preferred approach. Not only does ISRU reduce the mass and cost of the missions, but it also represents a major shift in contingency planning.

Early unmanned missions could leave behind surface-transportation vehicles, power-generation equipment, fuel and oxygen processors, water-processing equipment (eventually) and so on. Also, by selecting specific base-camp locations on Mars where successive missions can land and leave equipment for re-use, it would be possible to build up the infrastructure needed for an outpost that would be similar to the site maintained at McMurdo Station, Antarctica.

The parallels between a human voyage to Mars and Columbus' first voyage to the New World are remarkable. Length, cost, supply and resupply, communications lag time: all are quite similar. Columbus' voyage was thought to be impossibly long and too dangerous to undertake. His voyage was motivated by an incorrect assumption: that he would open up additional commerce with Asia, rather than gaining access to the wealth of a new continent.

A future voyage to Mars might be undertaken solely for scientific reasons. Yet it is likely that after setting foot on the Martian surface, we, like ancient terrestrial explorers, will discover undreamed-of opportunity on a planet that has so long dominated our hopes and dreams.
In 1946, at the age of 15, John McPhee sat with a friend on a windowsill of the Joseph Henry House, near the heart of the Princeton University campus. His friend’s father was the Dean of the College and his friend’s family lived there. Along with a few thousand other people, they listened to Harry S. Truman address a group of students on the occasion of the 200th anniversary of the university. People milled about and attentive observers peered from other windows.

When McPhee told me this story ... he looked up at the sill where he had sat nearly a half century ago and said: “It’s a different country now. [Today] that building would be filled with Secret Service agents ...”

From John McPhee, by Michael Pearson.
Journalist and novelist John McPhee was never overly interested in the careers of American presidents. His magazine articles and books nevertheless carry a kind of chief-executive imprint: the stamp of strong individuals who, in their own place and way, exert an indelible statecraft. McPhee writes not about lone celebrities, but lone achievers, men and women who make the world by making their way in it. For these, it is not enough to simply live, but to live in ways that are equal measures of passion and commitment.

McPhee burst upon the imagination of Old Dominion University’s Michael Pearson, associate professor of English, when Pearson was a teenager growing up in New York City in the 1970s. For Pearson, McPhee’s books fascinated — in particular, McPhee’s 1968 work on the nearby Pine Barrens, a heavily wooded area in southern New Jersey. Wild, untamed, cheek by jowl with some of the most densely populated real estate in the Northeast, the 1,300-square-mile Barrens seemed an undiscovered country, a next-door frontier that might as well have been in Patagonia as a mere car drive from Pearson’s boyhood home in the Bronx.

“There was a wild world right next door to me,” Pearson says. “It wasn’t closed and claustrophobic. McPhee had ventured out and came back to tell us about it.”

Pearson says as McPhee’s interest in the Barrens illustrates, McPhee is drawn to places that seem to hold time at bay: the Scottish highlands, the Alaskan wilderness, Swiss mountains, dense forests and remote rivers. In these rugged landscapes live equally rugged people. They may not be challenged by constant physical danger, but they challenge themselves in other ways: intellectually, emotionally, spiritually. The details of those challenges are what enrapture McPhee readers.

For Pearson, author of the only combination biography and literary criticism ever written of McPhee, McPhee exemplifies a style of writing that owes much to other distinctly American literary voices. Like Mark Twain and Willa Cather before him, McPhee captures the souls of those who speak in his books, characters who stick to the mind precisely because McPhee captures so closely the intimate rhythms of daily living. McPhee’s subjects are believable because they are real.

“McPhee is after ordinary lives,” Pearson explains. “He is after what it’s like to live on a Wednesday afternoon, not on the eve of battle. He gives us the dignity of ordinariness.”

McPhee’s journalism goes deep into the heart of what it is to be American in the modern world, what it is to be human. He strikes a profound chord, but he does it subtly, not by philosophizing but by artfully telling the stories he has brought back from Alaska or Florida or the New Jersey Pine Barrens. Creatively, he tells his story, arranging the facts along the narrative like beads on a necklace...

What readers have noted are [McPhee’s] clarity of mind, the generous sympathy of his artistic vision, his memorable characterizations, and his knack for finding the delicate balance between informing and dramatizing.

His success as a writer comes first from his talent as a reporter. He is an artist who ventures into the world with a notebook in his hand. But without his openness to the world — be it a green market in New York City or a wilderness town in Alaska — he would have little chance of seeing with the fullness that he does.

Michael Pearson
McPhee was born in 1931, in Princeton, and graduated in 1953 from his hometown university with a degree in English. In 1965 he became a staff writer for The New Yorker magazine, a move that would launch in earnest his literary career. McPhee has written 23 books, most of which have been critical and commercial successes. The books’ subjects are eclectic, ranging from the citrus industry, experimental aircraft, the Merchant Marine, the development of the atomic bomb, professional tennis and basketball, and geology.

McPhee has been one among the practitioners of a movement known as New Journalism. Born in the 1960s and made famous by such writers as Tom Wolfe, New Journalism paid as much attention to literary style as to factual substance. It was no oxymoron to call this nonfiction literary; and, as with any great work of art, immortalizing ordinary life required more than ordinary talent. No longer would it suffice to render happenings in dry, uninolved prose. Journalists could be — should be — novelists, not simple recorders of events.

Effective New Journalists had to experience life along with their subjects and then be able to vividly transcribe that experience. Like other New Journalists, McPhee practices the art of “immersion,” the practice of living closely with and around the things and the people that one depicts. Pearson writes in his McPhee biography that, as part of his preparation to write the 1977 book Coming Into the Country, McPhee spent months at a time over a two-year period traveling in different parts of Alaska. For a New Yorker magazine story entitled “Travels in Georgia,” McPhee drove along 1,000 miles of back-country roads, examining roadkill and participating in a detailed wilderness inventory conducted by field zoologist Carol Ruckdeschel.

While New Journalists are deeply involved, they are also discrete and precise. Not everything observed is put on the page. But that which is stakes the narrative deeply into a reader’s sensibilities.

[McPhee] is left-handed and always carries a bandana with him. He relishes good food and the company of interesting people. He takes pride in his Scottish heritage. He loves rivers and his preferred mode of transportation is the canoe. The dedications in his books suggest the importance of family and friends... But it is between the lines he reveals the most about himself...

Michael Pearson
Despite a voluminous production, McPhee as a person remains elusive. He has told Pearson that he is nothing more than an "old journalist." He doesn’t believe in putting his photograph on his book jackets, eschews interviews, and is modest about his professional achievements. Details of McPhee’s life sometimes spill through, though, such as the fact that he suffers from insomnia and endured a difficult personal time as his first marriage ended.

"McPhee doesn’t unveil a lot of himself in any one piece," Pearson says. "If you read all of his work, a picture of the entire man begins to appear. You have to pay attention to his shadow passing over the page."

McPhee’s choice of subjects reveal him most clearly to the world. In this respect, Pearson writes, McPhee’s subjects present a full portrait of the artist, revealing his motives, values, dreams and nightmares. The traits McPhee admires he writes about: competence, curiosity and a decided moral perspective. Like those whom he often profiles, McPhee is an expert craftsman, a writer who fashions narrative as meticulously as a master builder carves a bark canoe.

Perhaps, Pearson muses, it is McPhee’s ability to understand the world’s paradoxes and the ways people resolve or accept them that makes McPhee such an effective communicator and artist. McPhee wanders, but stays put long. He is a modest man, but eloquent writer. He ventures into the wilderness but returns with stories that sit comfortably on library shelves, awaiting discovery by new generations of readers.

"Not all writers happen to be brilliant. McPhee is," Pearson says. "People know he understands. He has what all writers should have: a childlike, incredible curiosity and the perspicacity to do something with it. I think he’s the premier nonfiction writer in America — and one of the premier writers of the second half of the 20th century."
A college education has not always been the birthright of every American. Only within the last half-century has widespread gender and racial discrimination been sufficiently vanquished to permit more than half the national population uncontested access to university degrees. But access alone doesn't equate to achievement. Graduates still must struggle to define their roles in a rapidly changing world, one in which the rate of technological advance appears bewilderingly rapid and unpervasive.

Enter computer technology, with the promise of unprecedented access to information. Computers, we were told, would level the playing field significantly. Computers would make our lives easier to live, bring abundance, perhaps even peace of mind. Nothing, of course, is ever as simple as it seems. The reality of putting computers to work — in schools, in the workplace, at home — has been gratifying in many ways, yet frustrating in many others.

Educators are still sorting out the best ways to apply computer technology. It is not enough to graft computers wholesale upon existing methodologies and expect harmonious coexistence. Rather, genuine innovation must be met with an equal measure of creativity to guarantee against the computer's devolution into mere fad, a curious footnote in history's vast annals.

The stories that follow demonstrate how Old Dominion University is working to apply the promise and potential of computer technology to education. As yet, the tale is not fully told. But, as you'll read, the beginning appears promising indeed.
Broadening The Circle

By James Schultz

By the spring semester of the year 2003, Old Dominion University’s entire undergraduate computer-science curriculum will be available over the Internet. Students won’t need to be physically present inside a classroom to earn credit for some 30 courses, from software engineering to database design and management.

The university’s Interactive Remote Instruction program, or IRI, is part of a spectrum of Old Dominion distance-learning options that permit students to learn “remotely”: sometimes at their own pace and other times as part of a greater, virtual community, where interaction is instantaneous and encompassing. For those pupils using personal computers as part of their instruction, vast amounts of information will be literally within fingertip reach, including real-time access to data, software programs and audiovisual information.

Sometimes, says Kurt Maly, Kaufman professor of computer science and chair of Old Dominion’s Department of Computer Science, IRI-related instruction will be self-directed; pupils will need only to individually interact with computer-resident coursework. At other times, and depending on the specific course, IRI mandates “synchronous checkpoints,” scheduled Internet interactions between a computer-using student, his or her peers and the instructor.

“The active-learning paradigm is one wherein people learn by doing. You live out the knowledge,” Maly explains. “Interactivity is therefore very important. Interactivity on a computer network leads to back-and-forth communication. It allows interactions of all types: audio, video, data and programs. Feedback is the crucial component.”
Delivering The Goods

A quarter century after the introduction of the personal computer, colleges and universities are just beginning to capitalize on the technology potential of the Information Age. As yet incomplete is the comprehensive integration of information technology with education’s core processes. Old Dominion is among those universities nationally leading the way, in particular with its critically acclaimed project TELETECHNET.

TELETECHNET debuted in 1994 as a partnership between the university and Virginia’s network of community colleges. The program utilizes television and computer technology to provide students in remote areas the opportunity to obtain baccalaureate and master’s degrees in such disciplines as engineering technology, nursing, criminal justice, education, professional communication, taxation, business, public and health sciences administration, and human services counseling. TELETECHNET also offers courses to a number of military bases, corporations, the Library of Virginia and other institutions around the country. Community colleges, hospitals and businesses host the 40-plus sites across the United States where students may enroll in classes.

For its part, IRI, like TELETECHNET, requires more than electrons to succeed. IRI’s physical needs in its first years of full operation will include six satellite sites to house high-performance computing and telecommunications equipment. Up to 100 users will be able to participate simultaneously in a given virtual course.

Eventually, Maly says, students will be able to “attend” IRI classes from home — but only when the higher rates of data delivery and access to powerful computers that can quickly deliver the sights and sounds of instruction become widely available. Given the exponential rate of personal computer development, he adds, that time should not be far off.

“Learning doesn’t take place with computers in the same way learning takes place with books. The idea is flexibility and time convenience for the student. It is then up to the student to decide how to proceed.”

As IRI is put into place at Old Dominion, commercial versions may be developed and sold. Maly believes that IRI’s strengths — its ability to bridge distance with large amounts of constantly updated information and to deliver that information effectively to individuals — would interest anyone who has ongoing need of Information Age-style communications, such as corporate and military training or business-oriented service and product updates. “There are competing products. We are not the only ones in the game,” he says. “But this is something so good it ought to be commercialized.”

Even as IRI matures, Maly doesn’t believe its success will signal the death knell for more conventional educational techniques. Despite innovation, Maly believes that books remain central to instruction. IRI augments but does not replace. “Computer technology is an enhancer, not an enabler,” he contends. “Learning doesn’t take place with computers in the same way learning takes place with books. The idea is flexibility and time convenience for the student. It is then up to the student to decide how to proceed.”

As for the belief that ventures like IRI may contribute to computer-induced social isolation and dysfunction, Maly points to the rise of so-called Internet cafes. T here, consumers buy not just inexpensive access to data, but coffee and sociability as well. It isn’t likely that anyone, IRI user or not, will opt to remain cloistered, hermetically sealed from the hustle and bustle of the world at large. Academic and life success, he observes, appear to be predicated not on exclusive reliance on any single technology, but the integration of many.

“We are not going to the science fiction world where everyone is in a cocoon, looking passively at a video screen. The physical experience has got to and will stay,” Maly insists. “A learning approach like IRI simply broadens your circle. You’ll be able to reach the greater world. That’s the difference computer technology makes.”

Books Still Required

IRI was born in January 1995 with an initial National Science Foundation (NSF) grant of $100,000. An additional, larger NSF grant of $800,000 was augmented by $700,000 in university funds and donations from two industrial partners, Sun Microsystems and Cox Cable, which enabled Maly and his colleagues to fully develop the program’s first phase that ends this July. The university is seeking more funds to ensure the program is fully implemented by its target date of 2003.

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Kurt Maly is a Kaufman professor of computer science and chair of Old Dominion’s Department of Computer Science.
Tackling The “Grand Challenges” With Super Supercomputers

BY JAMES SCHULTZ

In 1965 Gordon Moore, co-inventor of the microchip and co-founder of Intel Corporation, captured the imaginations of electronics afficionados worldwide with a bold prediction that computer circuitry would double in density and in power every 24 months. Moore’s Law, as the axiom came to be known, has held for nearly 35 years. Now, as engineers continue a torrid pace of chip design, introducing dramatic improvements almost yearly, personal computers are beginning to best all but the brawniest machines.

But today’s supercomputers are poised for quantum leaps of their own. As one-step-at-a-time processing gives way to parallel processing, a software approach that allows much faster calculation by parceling out tasks simultaneously to banks of microprocessors, new supercomputer architectures will likely achieve routine speeds of trillions of calculations per second. At present only a handful operate in this “teraflops” range. A decade hence, even teraflops computing may seem archaic as calculating speeds continue an astonishing acceleration.

“Ten years from now we’ll be in the petaflops range — a million billion ‘floating-point operations’ per second,” predicts David Keyes, Old Dominion associate professor of computer science and an associate research fellow with NASA’s Institute for Computer Applications in Science and Engineering. “It’s computing for the so-called ‘Grand Challenge’ problems: weather prediction, human genome modeling, pollution dispersion, ocean circulation and so on. Petaflops computing is a big leap, but I think the technical challenges will be met.”

The Meaning Of A New Machine

With unprecedented amplification in capability, super supercomputers may eventually, like intelligent machines immortalized in science fiction books and movies, listen to, understand and speak human language, accurately translating one language into another as it is spoken. Designers may also be able to create intelligent “software agents” that roam the Internet snaring and summarizing information from a vast ocean of data, delivering it to users.
Turbocharging The Net

As the pace of technology development accelerates, Keyes is among those expecting Old Dominion to stay comfortably current with innovation. While the true benefits of any advance become apparent only over time, he believes the university is well positioned to ride the crest of any foreseeable technological wave.

"Old Dominion is supple, not ossified," Keyes explains. "It's part of the culture here already, with such initiatives as TELETECHNET and IRI. Compared to many in the rest of the world, we try more things, faster and with a broader range of applications."

Old Dominion is one of 130 universities nationwide that have joined the University Corporation for Advanced Internet Development (UCAID). UCAID's university members have committed more than $50 million per year in new funding for Internet2 — a far faster, vastly more efficient version of the existing system — while corporate members have promised to provide nearly $20 million over the life of the project.

The UCAID initiative is part of a broader effort to intensify and deepen the benefits of computer-related information technology. As part of its fiscal year 2000 budget, the Clinton administration has proposed a nearly 30 percent increase in the federal government's investment in information technology (IT).

This $366 million initiative, known as IT2 — Information Technology for the Twenty-First Century — will support long-term information technology research intended to lead to fundamental advances in computing and communications, in the same way that 1960s-era government investment led to today's Internet.

The agencies involved in IT2 include the National Science Foundation, the departments of Defense and Energy, NASA, the National Institutes of Health, and the National Oceanic and Atmospheric Administration. Roughly 60 percent of the funding will go to support university-based research, which will also help meet the growing demand for workers with advanced IT skills.

The intersection of these projects with petalops computing could likewise boost the prospects for university-led innovation. In particular, the ensuing quality and wealth of information should result in more informed, capable graduates. Keyes predicts that when large-scale simulation is fully absorbed into curricula, 30-year-old students with Ph.D.s from universities like Old Dominion will have the functional knowledge of 1999-era 60-year-old professionals.

Yet he cautions prudence when viewing future prospects. Computers must be judged against a backdrop much broader than this or that breakthrough. In the long run, Keyes believes computer technology will not supplant education. Rather, it will help to support it.

"I'm not a computer utopian. We should be careful not to ignore the dangers of abandoning all the cognitive abilities we have developed as human beings..."
Learning Made Vivid

BY WILLIAM SWART

Into the bowels of an active volcano you go without worrying about melting your shoes or burning your body. Navigate through thousands of feet of rock to find mineral deposits or oil, or maybe try out the machinery in an advanced factory that you and your classmates are designing as part of a senior-class project.

These seemingly fanciful examples are not just what could happen. They are what will happen as the imaginative use of technology expands beyond the traditional confines of the classroom and incorporates into education the emerging field of computer simulation. Computer simulation promises to become an essential tool to create more and better learning in virtually all arenas.

In terms of simulation infrastructure, Old Dominion University is fortunate to be located near three major military training and education centers in Hampton Roads: the Joint Training, Analysis and Simulation Center (JTASC), the Joint Warfighting Center (JWFC) and the Armed Forces Staff College. The area is also home to major service-doctrine commands and numerous operational commands, all of which use state-of-the-art computer simulation techniques for training, evaluation, and operations planning and management. By simulating battles and exercises on a computer, instead of using actual tanks, planes and ships, the military saves time and millions of dollars in resources.

Building upon these existing strengths, the university has created the Virginia Modeling, Analysis and Simulation Center, known as VMASC. In addition, the university’s College of Engineering and Technology now grants both master’s and doctoral degrees in modeling and simulation. At Old Dominion we are in a singular position to use our insights in the field to adapt simulation to significantly augment and expand upon the traditional learning process.

Abstraction Becomes Experience

Through the use of simulation (the term is used in its broadest sense and includes virtual reality, immersive collaborative environments and other synthetic environments) it will be possible to develop courses that allow students to learn based upon personal experience. In simulated learning environments, computers become the new instruments for vicariously extending our senses and intuition. We are discovering that, in creating simulated laboratory experiences for our students, the trick is not to turn experiences into abstractions, but abstractions, like the laws of thermodynamics, into experiences.

Initially, instruction made use of computers to speed up manual calculations, to make typing more productive through word processing, and to expedite financial calculations via spreadsheets. Educators are now doing more of what they have always done, but faster, cheaper and neater, becoming more efficient.
within the existing paradigm of education and training. But they — we — can do, and are doing, more. The coming wave of computer-related use and applications in education is a result of faculty, trainers and their management asking the question “To what ends can we put computer technology to work?”

At Old Dominion, for example, we are presently bringing effective classroom instruction to more students and more places. We are putting technology in place and in practice with computerized slides, animations and simulations. Through such university programs as TELETECHNET and Interactive Remote Instruction (IRI), we communicate remotely and interactively with students in distant locations. For the military, the university is able to put training manuals online and be far more effective in distribution and access of those materials.

Multi-media technologies have become intimately linked, if not synonymous, with distance learning and technology use in the classroom. The equipment most requested by faculty in Old Dominion’s College of Engineering and Technology are notebook computers and projection devices to take the “show,” mostly PowerPoint slides of lecture notes, on the road. Thus, at least anecdotally, there seems to be substantial consensus that multimedia helps to create better learning.

At Old Dominion University, bachelor of science programs in engineering technology have been delivered via TELETECHNET to multiple locations. Multimedia, routinely and pervasively has been used in the delivery of lectures. However, that technology was not adequate to provide students at remote sites with appropriate laboratory experiences. We are now in the process of determining the most efficient technologies to create and bring virtual laboratories to our distance-learning students.

A Post-Agrarian Paradigm

The schedule currently followed in most academic and training environments was not designed to facilitate learning outcomes or pedagogy. It evolved from our agrarian roots, when it was essential for students to be on the farm during the summers, to assist with spring planting and fall harvests.

Furthermore, teachers needed a day between lectures to prepare for the next lecture and to grade papers, while students needed the time to absorb the material presented and to do homework. Hence, the semester system with the typical three-credit-hour course became ideally suited to the scheduling and administrative needs of society, the institution, and the instructor’s role as teacher and dispenser of knowledge.

Given a modular, competency-based curriculum in which students take more responsibility for their own learning and faculty act as learning managers, the drawbacks of this model become obvious. Simulation is a new path to walk, one on which students will be able to take greater responsibility for their own learning and faculty can assume more sophisticated roles as managers and mentors.

Universities currently strive to provide access to higher education, especially to historically underrepresented groups such as African-Americans and Hispanics. Too often, however, mere access alone hasn’t served the student well. Students learn best when they can ask questions and seek multiple sources for answers, when challenged with conflicting views, and when they are in a position to communicate and interact with each other, electronically or directly, in a collaborative peer environment.

With learning simulation, the goal shifts from providing access to achieving success. If done correctly, it uses shortfalls in performance as the opportunity to revise learning materials and learning environments as required.

Learning simulations permit faculty to interact freely with students, providing meaning and context for the learning in a myriad of ways that transcend traditional lectures. Teachers can integrate course material into overall student learning, and assess and certify when students achieve competency. As always, they will continue to assess the relevance of course work, improving materials and creating additional content as new knowledge is generated.

In this view of the simulator-classroom of the future, the professor is now focused on the actual learning experience and learning results of the student, as opposed to simply dispensing expertise. The student is now focused upon learning objectives and content as opposed to the next exam. It is this paradigm — the sophisticated combination of simulation, knowledge and virtual but compelling experience — that will, in our view, create unlimited flexibility in the approach to learning styles and the needs of learners and society.

William Swart is the dean of Old Dominion’s College of Engineering and Technology.
Shortly after midnight on the morning of January 1, 2000, I and many others who are pioneers in the world of “smart home control” will, of necessity, perform a cold re-boot of our systems. For those of us who use a computer to command our lights, coffee makers, heating and air conditioning, and security and home entertainment systems, this will be a relatively easy task: We’ll simply press a few buttons to change the time and date. Nothing to it — assuming, of course, that over the past year the electrical power companies have performed their upgrades as they have assured us they have and that the so-called Year 2000 bug is a small, harmless creature long since tamed.

On that historic morning there will, however, be a need for someone to check on the function of a few other items. We’ll assume that the Social Security and national air-traffic control systems will perform as promised. We’ll hope checks arrive on time, that traffic lights function, that elevators won’t get stuck, that paychecks are mailed for the correct amounts and that anything moving on the ground or in the air won’t suddenly come to a screeching halt.

But by that January day, that first day of a new year, in a new century, in a new millennium, we will know that we are in a new age. Call it what you will: the Oh-Ohs, the Zeros, the Noughts or (to borrow from the British) the Zeds; there will be a clearer demarcation between where we are now and where we will be. There are no signs the rate of change in adoption of telecommunications technology is slowing. If anything, rates of “telecomputing” adoption are accelerating, as more and better procedures and gadgets are devised and, literally, plugged in.
Fast And Furious

Consider where we are now. Prototypes are already being tested in which your grocery bill is being tabulated as you place items in your shopping car. This information will simply be added to the vast amounts of data that are already being compiled on each and every one of us. The mechanisms used to gather consumer information encompass such items as video checkout and discount grocery cards. Even now, our reading and listening habits are being analyzed as we order items through various forms of e-commerce on the Internet. Devices presently in production will someday allow your grocery store to reorder and eventually deliver “just in time” merchandise to restock, not only their shelves but your cabinets as well.

Recently, Compaq, Microsoft and Intel joined six of the regional Bell Systems in a pact to deliver asynchronous digital subscriber lines (ADSL) via existing copper lines. This is accomplished by way of a certain kind of modem and computer protocol that will allow us to maintain both a telephone and data connection without having two lines.

The hottest new items at the recent Consumer Electronic Show were the Audible and the Rivo, small handheld gadgets associated with the spoken word, audio books and CD-quality music. In both cases there were no moving parts, and the devices came with the ability to deliver material in the range of up to seven hours. Items, along with digital cameras, have captured the imagination of potential users and will see further development over the next few months.

Data transmission rates over the Internet are bound to improve. Audio and video will get better as the compression gets better. This is not “pie in the sky.” It’s happening in some areas today and may, in fact, be universally implemented within the next few hundred years.

The Role Of Education

How do these advances affect the university community at large? New applications will follow, once there is the bandwidth to really make use of them. The cost of these services — phone, cable or utility — is going to provide high-speed connectivity. In the context of deregulation of phones and cable, it will be possible to get local phone service, long distance service, TV and Internet service from the same provider. Customers will subscribe to whatever company brings the service most quickly and cheaply.

Students in the workplace or at home will be liberated from the requirements of time and place, education will become a reality as we transition into the 21st century. The difficulty with this approach is that, as past experience has demonstrated, the student must be highly motivated and diligent to stay current in completing the course material. If any student begins a course of study but the overall success rate indicates that a large percentage of these students fail to complete the prescribed work, new methods of handling a data signal in order to monitor household appliances and to contact the service manufacturer if an appliance failed. But that same third wire can now be used for video or data or phone conversations.

The great advantage of this approach is, of course, the ability of an instructor to add to the material available to the student from the wide resources of the Web. Students could also be visible to the instructor as well as other students, both in the classroom and at their contact sites, by means of video connectivity through the Internet. Old Dominion's Interactive Remote Instruction (IRI) project is one example; other universities are also planning or implementing similar efforts.

This approach, however, is not unlike the use of video tapes of classes that in the past were mailed to students. In these cases the student watched the tapes and completed the assignments at their own pace. The difficulty with this approach is that, as past experience has demonstrated, the student must be highly motivated and diligent to stay current in completing the course material. If any student begins a course of study but the overall success rate indicates that a large percentage of these students fail to complete the prescribed work, new methods of handling a data signal in order to monitor household appliances and to contact the service manufacturer if an appliance failed. But that same third wire can now be used for video or data or phone conversations.

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If you've ever been told you're diabetic, you've likely been bombarded with information. You've learned that certain of your pancreatic cells have been destroyed by an autoimmune process and that your body is now deficient in insulin, a hormone essential for uptake of glucose from the bloodstream into individual body cells. You've been told how to monitor and control your blood sugars, prevent complications, eat right and instigate the multitude of changes necessary to live a healthy life with diabetes.

Eventually, you may discover that an estimated one million individuals in the United States alone have Type 1 (formerly called insulin-dependent) diabetes mellitus and must take insulin injections daily to stay alive. Many more with Type 2 (non-insulin-dependent) diabetes initially do not use insulin injections, but may eventually depend on injections as the disease progresses and the beta cells in the pancreas finally fail.

More often than not, exercising with diabetes may have been completely overlooked, or even advised against, because of the complexities involved with maintaining normal blood-sugar levels during any physical activity — even though exercise is considered a cornerstone of diabetes management. Determined to continue your workouts and your other physical pursuits, you may decide to dig up information on your own about exercise. What you'll tend to find are only general guidelines that leave you learning everything by trial and error (mostly error).

As a diabetic and athlete, I've developed a unique exercise guide that provides insulin-using individuals with basic, practical and experiential information needed to more easily and effectively manage blood sugars while participating in all types of exercise, sports and recreational physical activities.
Mastering Complexity
Few individuals actually understand the physiological changes that occur in the body during exercise. Activities lasting less than two minutes (sprinting or power lifting, for example) are fueled only by substances called phosphagens that are stored in skeletal muscle, as well as by carbohydrates stored as glycogen in the muscles. For any exercise lasting two minutes or longer, the body actually uses three different energy systems, and a whole host of hormonal changes occur in an attempt to maintain adequate blood-sugar levels. More prolonged aerobic activities use a mix of fuels, but mainly fats and carbohydrates. The training level of the individual as well as the intensity of exercise can affect the combination and proportions of fuels used.

Exercise training has the effect of improving fat utilization for a given exercise intensity; at higher intensities, carbohydrates in the form of muscle glycogen and blood glucose are the body’s fuels of choice. In individuals with diabetes, exercise type can have a profound impact on blood sugar response, as can the circulating insulin levels prior to and during the activity. Studies involving individuals with Type 1 and Type 2 diabetes have shown that very intense exercise such as weight training or near-maximal aerobic exercise can actually cause a rise in blood sugar levels, contrary to the usual glucose-lowering effect of prolonged exercise. This effect occurs due to the surge of hormones released to raise and maintain blood-sugar levels. All of these variables and more must be considered by an exercising individual who injects insulin.

My own surveys reveal a wide variety of food and insulin changes made by individuals participating in an array of sports and recreational activities from common sports like running, soccer and swimming, to more unusual recreational activities like in-line skating, rock climbing, scuba diving and wind surfing. Most of the respondents are current members of the International Diabetic Athletes Association and are avid sports participants. A compilation of the practical and experiential exercise information reported on by these individuals reveals the complexity of regulating blood sugars during physical activity with all the various insulins and insulin combinations. The blood-sugar response to exercise varies, just due to use of a different insulin. Other responses are similar: despite the regimen used, morning exercise done before insulin injection usually reduces blood-sugar levels less than exercise later in the day, due to the effects of circulating cortisol, growth hormone and other hormones.

Take an NPH user, for example, and compare her or him to a user of ultralente or to someone using an insulin pump. NPH is an intermediate-acting insulin that peaks between four and 10 hours after injection and will persist in the body for up to 16 hours. An NPH user will be affected by exercise in the late afternoon differently than an ultralente user, since ultralente is a longer-acting insulin with a minimal peak designed to provide only basal insulin coverage. By contrast, an insulin-pump user can turn off the pump or reduce the basal rate, thereby creating circulating insulin levels that are more similar to the body’s normal, lower physiological levels during exercise.

Power From Knowledge
The normal blood glucose-lowering effect of prolonged exercise varies considerably with the amount of insulin present during the activity and the amount of food ingested. While this experiential information can help tremendously in predicting a usual exercise response and in approximating the appropriate regimen changes needed, the best way to ultimately deal with this multitude of
variables is to learn your own individual responses to all of them by checking blood sugar levels before, during and after exercise. Some individuals choose to lower the amount of insulin injected prior to exercise (or, for those on an insulin pump, to maintain basal rates during the activity). Others increase intake of simple and/or complex carbohydrates, while some may choose to manipulate both components simultaneously.

Knowledge is power when it comes to controlling blood sugar levels. Armed with as much information as possible and with the use of a blood-glucose meter, diabetic athletes can undertake virtually any physical activity. Understand the fuels used for an activity and the effect of insulin levels and food intake during exercise, and learn of the changes that other individuals have made while using the same insulin regimen, and you can manage your own blood sugars effectively during light, moderate or strenuous workouts.

If you already participate in an activity but change to another insulin regimen, this information will also help you to effectively make the transition, or may simply help you fine-tune the changes that you are already implementing for participation in various sports and activities. For those diabetics not yet exercising, I say: What are you waiting for? Benefit from everyone else's hard-gained knowledge, lose the excuses, and get out there and exercise!

Sheri Colberg uses computerized technology and a water tank to accurately access this individual's underwater weight and percentage of body fat.

Athlete and Type 1 diabetic Sheri Colberg is the author of The Diabetic Athlete's Guide to Blood Sugar Control During Exercise: A Practical Approach and an Old Dominion assistant professor of exercise science.
A drinkable cocktail it’s not. But the concoction of some 300 different chemicals swirling in your car’s gasoline tank is as meticulously blended as is any fine liquor. Not all libations are created equal, however. What if you could create from scratch the fossil-fuel equivalent of a fine, single-malt scotch or a brandy or a hearty dinner wine or the perfect post-meal liqueur?

Where gasoline is concerned, new blends can be more valuable than even the oldest bottle cached in the cellar. Innovative formulations can reduce vehicle emissions, increase mileage, even afford protection against inevitable engine wear. For refiners and auto makers worried about pending, stringent new restrictions on the amount and quality of air pollutants, a new formula — particularly one that leads to clean-burning gasoline — would likely be worth millions in profits and more in public good will.

John Cooper, assistant professor in Old Dominion University’s Department of Chemistry and Biochemistry, believes he’s found a way to hasten that day.

Cooper, intrigued by the challenge presented by the analysis of gasoline’s complex chemical interactions, became convinced he could monitor moment-by-moment changes in gasoline as they occurred. Essential to the process would be a new generation of small, powerful lasers that would employ a technique first identified nearly 70 years ago. Researchers wouldn’t have to wait for accurate results for hours, perhaps days, using less precise sampling techniques. Cooper’s system would produce accurate data in a matter of seconds.

“If you want to measure gasoline composition in real time, you need to measure the properties you’re interested in,” Cooper explains. “It’s a very complex problem. There are a lot of problems to solve.”
No Foregone Conclusions

Cooper's initial proposal, made to the Petroleum Research Foundation in 1994, was rejected as unfeasible and undoable by a panel of technical experts. Cooper and several of his graduate students nevertheless persevered. Shortly thereafter, the venture attracted the attention of oil-refining company Ashland Inc., which agreed to underwrite Cooper's research.

Cooper went on to solve the outstanding technical issues, creating a device that can accurately track gasoline's precise chemical makeup, octane number and vapor pressure. Old Dominion now holds four patents on the invention jointly with Marathon Ashland Petroleum LLC, and has granted a licensing agreement to a manufacturing company to build a commercial version of Cooper's brainchild.

"At first, no one thought we could do it," Cooper says. "But every objection was answered with novel techniques that led directly to patents. We were at the right place at the right time — and we realized we were there."

Key to Cooper's success was the use of a procedure known as Raman spectroscopy, named after researcher C.V. Raman. In 1928, Raman discovered that the interaction of the light-emitting particle, known as a photon, with an organic molecule momentarily raises that molecule's energy state. Once the photon is released, the molecule returns to its original state.

Given the light energy required to first create the effect and then to monitor it, Cooper's innovation wouldn't have been possible without the invention of lasers. Other enabling technologies, such as microelectronics and new generations of fast computers, were also required.

Despite the availability of new technology, the development of a Raman-based gasoline analyzer was not a foregone conclusion. Cooper and his team confronted a number of vexing technical issues, not the least of which was the tendency of hydrocarbons to fluoresce in the presence of laser light. Although Cooper was able to correct for this limitation, he points out that technological excellence is no guarantee that the gasoline analyzer will be a hit in the marketplace.

"We've demonstrated the technology," Cooper says. "Ours offers a lot of significant advantages. But I don't know if it will make it into the mainstream. You always have a channel to cross: the point at which industry accepts it and it becomes widespread commercially."

Real Tough Stuff

Cooper's involvement with laser-based chemical analysis is not just limited to examinations of the liquid variety. Cooper and his research team are also helping NASA examine the structural properties of thermostet polymers: plastics that, when heated, form a strong solid and can themselves endure very high temperatures for long periods of time. Thermostets are already playing a limited role as components of certain external pieces of airplanes, such as tail assemblies, rudders and ailerons. Other space-age applications could lead to new generations of superlight, superstrong airplanes that fly farther, faster and more economically than can today's models.

But because thermostets radiate heat as they themselves are heated, the possibilities for widespread structural failure are also great. Cooper is examining ways to validate a thermostet's strength. "In the center it gets very hot — heat that doesn't dissipate easily," he explains. "You start to get thermal stresses forming. It can pose a structural problem if it's not properly managed in the construction process."

As with his gasoline work, Cooper is using a sophisticated laser-based process to analyze thermostet properties. Laser light, funneled through optical fiber, strikes the target material and is scattered by it. The light scattering is "read" by sensitive detectors, which essentially produce a unique chemical fingerprint. Researchers are able to follow the chemical reaction as that reaction changes over time in response to heating. Areas of greatest activity suggest points of weakness that should be strengthened.

"These and similar challenges, Cooper says, are difficult to master. They require creativity, a desire to innovate and a refusal to accept conventional means of problem-solving. Yet the rewards are many, not the least of which is unearthing solutions thought improbable, if not impossible."

"This is the end of the century," Cooper says. "All the easy stuff has been done. What's left on the table is the real tough stuff."

John Cooper is an assistant professor in Old Dominion's Department of Chemistry and Biochemistry.
Comeback Of The Caring Docs

By James Schultz

Teaching doctors to care for individuals on a humanistic level is one of the challenges in medical education. Increasingly, doctors are expected to practice compassionate medicine, whether their patients are infants or senior citizens.
rammed into an overflowing waiting room, the afflicted ache, sniffle, slump and otherwise suffer. When your name is called, you rise, shambling into a tiny examination room. Minutes turn into quarter and then half hours. When a doctor finally does enter, she can barely remember your name, much less the nature of your ailment. Weary, spent, you lie back, prepared for the inevitable prodding and probing.

The exam is professional and competent. But it lasts a mere 10 minutes. You are but one of dozens, perhaps a hundred, who will be seen by this physician today and there’s little time to waste on extraneous conversation. You do leave with the correct diagnosis and a prescription that will get you through this particular crisis. So why on your way home do you have the persistent feeling you’ve just been processed like an ingot in a metal factory?

It’s because you have. Like uncounted numbers of fellow convalescents, you’ve slid wholesale into the impersonal maw of the modern health care system. Brilliantly effective, technologically dazzling but largely indifferent to your feelings, late 20th century medicine is expert at physical cures but uneasy with psychology. What you think and how you feel matter less than the malfunctioning biological machine that is simply the sum of various organic parts.

At least, that has tended to be the attitude of many contemporary physicians. Now, says Stacey Plichta, assistant professor of community health professions at Old Dominion University, culture, economic pressure and burgeoning numbers of computer-literate, information-savvy consumers are conspiring to reunite the care of the body with that of the heart and soul. In response, medical schools are establishing programs to encourage compassion and empathy to augment the traditional focus on anatomy and technology.

“Consumers are much more educated. Consumers want to work as a partner,” she explains. “What physicians are challenged to do is work with patients as an equal, to move from the aloof-scientist mode back to the involved mode: someone who knows you, knows your parents and knows your kids.”

**Humane Care From The Beginning**

With support from the Arnold P. Gold Foundation, a public, not-for-profit organization established in 1988, Plichta is conducting studies at medical schools nationwide to determine the extent to which “humanistic” attitudes are taking hold. She has surveyed more than 6,000 students and has sent questionnaires to hundreds more. The effort is intended to quantify the willingness of young, would-be doctors to be emotionally open to those whom they will someday treat.
"There is no universal definition of humanism," Plichta says. "I define humanism as taking into account the patient’s interests, their needs, relating to them as people. It’s viewing the patient as a whole person, treating them with respect and empathy."

Plichta says three primary questions are at the heart of her surveys: What are the basic attitudes of the country’s future doctors? What do students think of humanism and how should a humanistic physician behave? And how do medical school administrators view humanism?

"What we’ve found is a major problem: a lack of consensus on what makes a humanistic M.D.," Plichta says. "While most agree that empathy is important, fewer agree that a holistic approach is important. There’s a lot of debate about emotional openness and about always being honest with a patient. Should you, for example, tell someone how long they have to live?"

Plichta’s work, and that of others in the field, could well lead to substantial changes in medical school curricula. If so, potential docs would need more than high scores on medical aptitude tests. They may need proof of humanity, in the form of interviews with members of admission panels and scores on personality tests. No longer would the best and brightest automatically make the cut.

"Patients come in sick and vulnerable," Plichta points out. "It’s important to keep doctors humanistic because they have so much power. Humanism keeps doctors from abusing that power."

**More Science Than Art**

Medicine’s very success in treating illness and curing disease appears directly responsible for eroding empathy. Particularly in the years during and after World War II, physicians made enormous strides in treatment and care. With the widespread introduction of antibiotics, what once could have killed millions became a tolerable inconvenience. With increased understanding of physical maladies and their causes, medical practitioners were expected to be objective scientists, not emotionally engaged caregivers. Explosive technological innovation accelerated the healer-as-scientist movement.

Unlike their house-calling predecessors, doctors today are rarely rewarded financially or otherwise for lingering with those in their care. There are simply too many procedures to grasp, too much state-of-the-art equipment to master and too much information to process — not to mention the desire of patients, every one of whom expects his or her personal physician to be infallible.

"Advances in technology have been explosive. Treatment has become so much more effective," Plichta points out. "There are so many more ways to learn in terms of technology and how the system tends to produce a very competent but not caring physician."

The rise of fee-for-service medicine, made possible by the government’s 1960s-era creation of and involvement in Medicaid and Medicare, provided monetary incentives to individuals to practice medicine. Not all who entered the field, Plichta says, were interested only in helping to heal the sick. A very good living was to be had; and until the spread of managed care in the 1980s, a trained physician was at the top of the self-employed earnings heap.

**A Pendulum Swing?**

But the pendulum may have swung too far the other way. Critics cite managed care organizations, particularly HMOs, for overreliance on cost savings and a lack of regard for human frailty. Physicians are also expressing their dismay, citing the triumph of accounting over compassionate and competent medicine. Users of the system — the patients — have also weighed in with widely publicized stories of neglect and indifference.

In an encouraging and a symbolic nod to a physician’s responsibility as a person-centered caregiver, some medical schools are beginning to conduct “white coat” ceremonies for all entering students. The ceremony is conducted as students arrive and includes lectures and first-person accounts of the need for emotionally engaged patient care. Plichta says that the intent is to impress upon students a doctor’s historical responsibility as a responsive, engaged healer.

"Whether reality trumps symbolism remains to be seen. As always, economics will play a major role in the extent to which empathetic care stages a comeback. No limiting factor may be medical school debt. Physician-graduates usually end up owing money counted just south of six figures, and sometimes higher. Young doctors, even those employed for a salary, may have no choice but to increase waiting-room volumes — thereby decreasing quality and extent of time spent with patients."

Plichta believes the movement toward humanistic medicine will succeed only if both the will and the money are present to support it. Strong feeling alone will not suffice.

"We’ll see a lot more compassionate care than we have in the past," Plichta predicts. "There’s a social movement in that direction now. But the payment mechanism will set some upper limits on the extent to which doctors spend time with patients. As a society we will get what we pay for."

Stacey Plichta is an Old Dominion assistant professor of community health professions.